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Power Engineering Day-a way to attract high school students from underrepresented groups to consider careers in electric power

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Suffolk University's ABET-accredited Electrical Engineering (EE) program, located on Beacon Hill in Boston, hosted its first of what will be annual events, Power Engineering Day, whose purpose is to expose high school students to careers in electric power. The motivation for this event came, in part, from Suffolk's partners in the power industry who are in need of recent graduates to replace their aging workforce, and from the knowledge that new and renewable sources of electric power are becoming more important, and that the current aging system of power generation and delivery needs to be overhauled. This event is part of an NSF S-STEM grant awarded on January 1st 2014 to Suffolk's EE program to encourage students from Boston Public High Schools, who are predominantly from underrepresented groups, to study EE and to be exposed to the power industry. The event was held the day after spring semester final examinations, allowing Suffolk EE students to present demos of renewable electricity generation, to lead high school students to the different demos presented by the companies, Suffolk staff and students, and to in general help run the event. Evaluations of the event were obtained from both the companies and the student participants, who were overall satisfied with it although they had a few suggestions for its improvement, such as having more hands-on activities and having more contact time between the high school students and Suffolk EE students as well as more contact time with the industry exhibitors.

Introduction

This paper discusses *Power Engineering Day* run by Suffolk University's ABET-accredited Electrical Engineering (EE) program, which was held the day after final exams in the spring of 2014, and which is planned to be an annual event. In it, we will discuss the motivation for this event, its planning, its execution, and its assessment.

Motivation

Issues facing the electric power industry

The electric power industry is facing the most serious issue it ever had which is the aging of its workforce (1). Since 1990, the Utility workforce has dropped more than 23% and it is estimated that the U.S. energy industry may experience as much as a 50% turnover in power and energy engineers over the next five years (2). The expert power engineers are retiring and there are few new electric power graduates to pass the knowledge onto. Compounding the problem is low enrollment in the EE major, and fewer programs offering electric power concentrations.

Another huge challenge facing the electric power industry is the need to modernize and upgrade the electric power grid (3; 4; 5). Much of its infrastructure was built in the fifties, with seventy percent of transmission lines and transformers that are at least 25 years old, and sixty percent of circuit breakers more than thirty years old. Moreover, changing markets, new technologies, and greenhouse gas emissions need to be addressed. Hydro-fracking is shifting energy sources from coal to natural gas and wind and solar powered generators are becoming more abundant. In addition, electric cars are gaining a foothold in the consumer market.

Therefore, because of all the factors listed above, Suffolk University's EE program, at the encouragement of its industrial partners, is putting extra emphasis on power concepts in its curriculum, and is promoting careers in power to its students.

Encouraging underrepresented Boston students with financial need to study EE at Suffolk

In order to encourage underrepresented Boston students with financial need to study EE at Suffolk, the EE program was awarded an NSF S-STEM grant *EE Scholars at Suffolk University*. For this grant, the EE partnered with three local Boston Public High Schools and companies from the electric power industry so that these scholarship recipients can gain exposure to their industry. The partner schools, TechBoston Academy (70% African American, 20% Hispanic) (6), Dorchester Academy (67% African American, 22% Hispanic) (7), and the John D. O' Bryant School (8) (35% African American, 30% Hispanic) have a high percentage of students from underrepresented groups. We target recruitment from underrepresented groups because despite efforts to attract and graduate minority groups into engineering and other STEM disciplines, these groups are still underrepresented (9).

Suffolk University started partnerships with TechBoston Academy and Dorchester Academy several years ago through Upward Bound, a federally funded program that seeks to increase college access to underrepresented populations. To encourage these students to consider EE (EE), these students were taught robotics as part of this program. In addition, to encourage students to consider EE and to expose them to energy and power concepts, Suffolk EE freshmen and other Suffolk students have been visiting for the past two years the science and engineering classes and clubs from all three partner schools, performing experiments with the high schools students that teach about power,

energy and sustainability and answering questions about college life as part of their final project from a freshman seminar class taught by Suffolk's EE program. This past year, each school nominated one senior per year to be considered for the first year of Suffolk's NSF S-STEM program (the grant proposal stipulated that S-STEM scholars in this program must come from a Boston public school).

Recently, to encourage both Boston Public High School students and current Suffolk EE majors to consider careers in electric power, we introduced the event that is the subject of this paper, *Power Engineering Day.*

Planning Power Engineering Day

Power Engineering Day had been suggested at a meeting of our Electric Power Industrial Advisory Board, by the Senior Vice President at Phoenix Electric Corp in 2012, and it was quickly agreed upon by our other partners from the electric power industry from OMICRON Corp., Three-C Corp, Electroswitch, and NETA. We then had three subsequent meetings, which were attended the industrial partners, some of the Boston Public High School partners, and Suffolk EE faculty and staff to plan the details. The student president of Suffolk's IEEE student chapter also attended one of the meetings. In addition, the EE program, in conjunction with the IEEE student chapter, held a meeting for EE students asking for their suggestions about the event and deciding what their responsibilities would be. Having the IEEE chapter student president's involvement was useful because he did a good job of urging other students to be involved as well. Fourteen EE students, roughly 25% of all our majors, were involved in planning and executing Power Engineering Day.

At these meetings it was decided that each company (there were a total of seven companies represented at the event; in addition to the six already mentioned, NSTAR Corp joined as well) would have a booth where they would discuss, among other things, their role in the electric power grid. Groups of about ten high school students, led by a Suffolk EE student would spend ~fifteen minutes at each booth. There would be chairs around the booths to facilitate schmoozing between the students and the presenters, who would discuss not only their companies, but their career paths, their struggles, and whatever students have interests in. Active involvement of the high school students would be encouraged by having the group leaders award stickers for asking or answering questions from the presenters. These stickers would be placed on cards that would be used in a raffle held at the end of the event (only students whose cards had stickers could participate in the raffle). Suffolk EE students would also have a table where they would demonstrate hand-operated generators and wind turbines that they had built for other classes as well as photovoltaic panels. In addition, the engineering lab coordinator, who is a member of the Tesla Society, would demo a Tesla coil. Two seventy-inch plasma screens, on

which there were to be looping videos of power-related demonstrations and presentations, would also be set-up in case students had some time in between visiting the booths. The event would be held in a large hall, with a seating area with a dais and laptop/projector set up in front. Introductory remarks would be given there, before the students visit the demos, as well as a few brief closing presentations by young engineers, particularly from under-represented groups, about their career paths followed by a brief presentation about Suffolk's EE program, and how students can be successful in studying engineering. The closing presentations would be preceded by pizza and refreshments; students would eat while listening to the closing presentations. The event would close with the raffle and the handing out of parting gifts. The closing gifts and most of the raffle prizes would be donated by the companies, with a Mendocino motor designed and built by the engineering lab coordinator as first prize. The cost of the event, to cover pizza and refreshments, would be funded by the NSF S-STEM grant.

The Execution of Power Engineering Day

Seven exhibit areas were set up including one for Suffolk EE students and one for the engineering lab coordinator. Hydroelectric power stations, high voltage substations, and electric transmission components to Boston high school students were discussed by Phoenix Electric's VP and Marketing Manager and a Suffolk EE alumnus (Figure 1). They also urged students not to fear math. A Suffolk alumnus from OMICRON discussed the electric power industry and how important renewable energy will be in the future (Figure 2). NSTAR engineers and Suffolk EE alumni gave an overview of the utility industry and tips on how to succeed in college (Figure 3). Electroswitch had students operate their switch devices which are critical in important applications such as system protection to major utility equipment and safety to personnel, along with many applications in the military and data communications centers. Three-C, which also presented for NETA, discussed safety procedures and services that they provide to their customers. Under the guidance of Suffolk EE students, high school students participated in a contest to try to produce the largest voltage with a crank generator (Figure 4); and the EE lab coordinator had students light up gas-filled tubes with sparks generated by his Tesla coil (Figure 5). He also showed them a Mendocino Motor, a solar-powered magnetically levitated electric motor, which was the grand prize for the raffle held at the end of the event.

The event was also a good way for Suffolk's three new S-STEM scholars to be introduced the program (Figure 6 shows one new scholar) who had a chance to meet each other and the other S-STEM scholars, all of whom came from Boston, and most from under-represented groups. All four current S-STEM scholars, who had been awarded the scholarship a few months earlier, played leadership roles in the event.

Figure 1 Steve Simo, along with Suffolk alumna Georgia Beyersdorfer, of Phoenix Electric Corp, discuss hydroelectric power stations, high voltage substations, and electric transmission components to Boston high school students. They also urged students not to fear math.

Figure 2 Suffolk alumnus Wayne Bishop of OMICRON asking Dorchester Academy students if they know what renewable sources of energy are.

Figure 3 Alumna and NSTAR engineer Amanda Brown showing TechBoston students what happens when a fault is introduced on a power line. Alumnus and NSTAR engineer Matt Stas is seen in the red shirt.

Figure 4 Suffolk EE sophomores Fatoumata Sako (front left) and Pavel Zaytzev (front right) show TechBoston students different types of sustainable electric generators (the hand-crank generator is in the foreground on the left). Director of Career Counseling Tim Poynton (back) was on hand to assess the event.

Figure 5 A Dorchester Academy student lighting the neon-filled tube from the sparks generated by the Tesla coil of Suffolk's EE lab coordinator Tom Vales (right). Part of the Mendocino motor (the grand prize of the raffle), which spins as a result of light shining on its solar panels, is seen in the foreground.

Figure 6 O' Bryant School senior and soon-to-be a Suffolk EE Scholar Eric Mena receiving a Suffolk t-shirt from Suffolk EE Associate Professor and Principal Investigator of the NSF EE Scholars program Dr. Lisa Shatz. CEO of Three-C Corporation Alex Piccioli (background) performed the raffle.

Assessment

The evaluation of the Power Engineering Day consists of three parts: observations by a faculty member from the Psychology department; feedback from power industry partners obtained by email; and feedback from Boston Public High School (BPHS) students and Suffolk EE students from a survey at the end of the event.

Observations

The main purpose of the observation was to assess student engagement with the various activities while noting where improvements can be made for next year's event.

In terms of student engagement, more students were engaged than not. The presenters did an excellent job of engaging the students by asking questions and being open to any questions asked of them, but the times the BPHS students were the most engaged was during demonstrations (e.g., the Tesla Coil, manipulating switches).

It was interesting to note that early sessions were marked by BPHS student questions around the safety/dangerousness of working with electricity, while later sessions were not. This seems to indicate that the students knew of the potential hazards of working with electricity prior to attending the event, and that the presenters effectively addressed these concerns.

As had been previously mentioned, to increase engagement BPHS students were given a sticker for each question asked or answered. Yet, very few students were looking for a sticker to put on their card – more often than not, the sticker was an afterthought. It also seemed as though the stickers were difficult for some of the Suffolk EE students to manage, particularly when students had a lot of questions. Feedback on the sticker system from Suffolk EE students after the event was mixed with 60% responding that we should keep the sticker system and 40% responding that we shouldn't.

It seemed that BPHS students benefitted from being paired with a Suffolk student but more could be done to maximize the potential of this opportunity for the BPHS students who were often prospective first-generation college students. An improvement for next year then is, when students are paired with a Suffolk EE student, to provide time for the EE student to introduce themselves to the group, talk about what piqued their interest in EE, and perhaps how college is different than high school. It was interesting to note that the diversity among BPHS students was reflected in the EE students.

While BPHS students engaged well with the tables staffed by Suffolk EE faculty and students, these exhibits would have benefitted from the types of signs that the industry had to orient the

students about what they were learning. They also would have benefitted by having seats arranged around their exhibits and the industrial presenters had. The Suffolk EE students interacted with and engaged the BPHS students at this exhibit quite well, and the Tesla coil had a palpable 'wow' factor.

There were other logistically-oriented observations as areas for improvement. Four of the five exhibitors were in alcoves shared with another presenter, and at times, this made it difficult for the students (who were sitting back-to-back) to hear what presenters were saying. Also, it may make sense to have some less-structured time set aside for students to re-visit exhibits, particularly since the amount of time with each exhibitor seemed limited. While no complaints were noted, it seemed less-than-ideal to not have tables available for the students to eat lunch at. The tables would also make it easier for students to complete the surveys.

As had been mentioned, in addition to the small-group activities, there were presentations to the larger group of students. The presentations consisted of information from Suffolk faculty about EE, and 'the story' of one Electrical Engineer's career path. I found the presentation from the Electrical Engineer to be particularly powerful and important for these prospective college-bound students, as she shared initial undecidedness about a career path before discovering EE.

Feedback from Power Industry Partners

At the conclusion of the event on May 2nd, an email was sent to eight presenters from the electric power industry that were involved in the planning and presented at the event. Four replies were received.

The email message asked Power Industry partners to respond to five questions. These questions are presented below, along with a summary of the responses.

> *Do you feel like coming to the Power Engineering Day today at Suffolk University was worth your time?*

All respondents felt that the day was worth their time. In elaborating their responses, three of the four respondents mentioned how important such events are to helping people become engineers. Two respondents explicitly noted that they felt compelled to attend such an event to help young people learn about careers in math and science – not necessarily just careers in the power industry.

> *Did the format used for the day work for you? If not, do you have suggestions for changes?*

All of the respondents indicated the format was overall good, with three of the four noting that the rotating small group format worked well. Three of the four respondents suggested possible changes to consider for the future, all distinct. The suggested changes are: increase the amount of space between exhibits; have more time with each group; provide unstructured time to allow students to re-visit exhibits; and slightly increase group size to reduce the overall number of rotations needed.

It is worth mentioning that the suggestions to increase space between exhibits and the provision of unstructured time were both noted as possible areas for improvement in the observational assessment.

Please share your thoughts about how engaged the students were – were they more engaged than you expected, less engaged, or about what you expected?

The presenters seemed overall satisfied with the level of engagement of the students – two of them noting that the students were more engaged than they expected them to be. Two respondents used the word 'impressed' to describe their interactions with the students. These observations echo the evaluator's observations – while there were some students who were not engaged, far more students were fully engaged in their interactions with exhibitors than expected.

If we were to organize this event again for next year, would you be interested in coming?

All respondents are interested in attending this event again in the future.

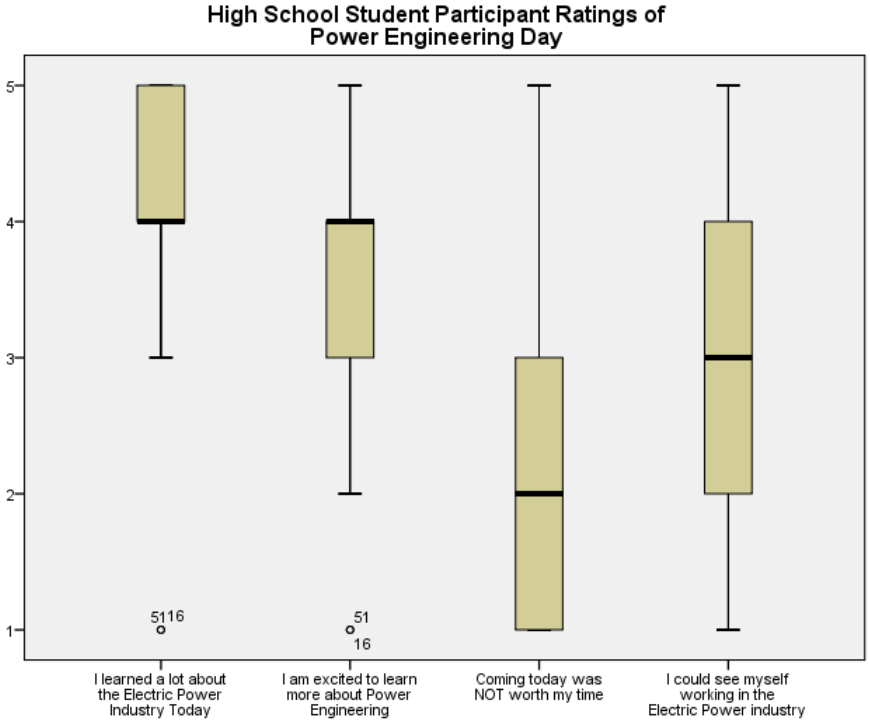
Please share any other thoughts you may have about your participation in today's event:

Three of the four respondents offered additional comments. Two of the respondents suggested providing students with an opportunity to design something, noting that the 'hands-on' activities seemed to really engage students. These same respondents also suggested having Suffolk EE student projects on hand. One respondent suggested that thought be given to inviting a military recruiter next year, noting this as another potential pathway to a career in the power industry given the presence of engineering-related military occupational specialties.

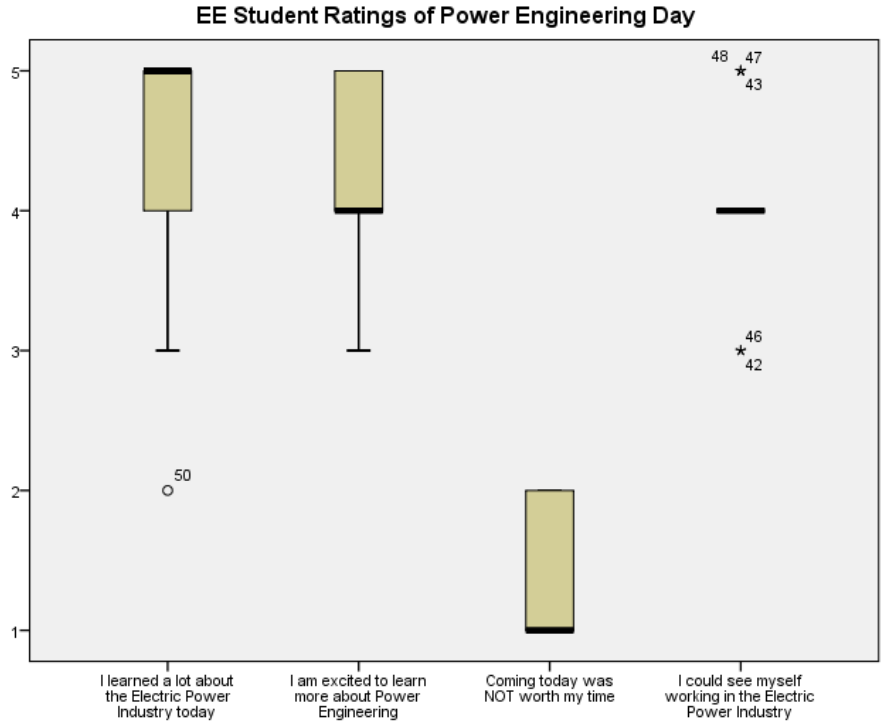
Student Survey Results

At the end of the event, a six-item survey was distributed to BPHS and Suffolk EE student participants. A total of 51 surveys were returned – 17 from TechBoston students, 12 from O'Bryant students, 9 from Dorchester Academy students, and 13 from Suffolk EE students. Four of the items were Likert-type items where respondents indicated their level of agreement on a 5 point scale where 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, and 5 = Strongly

Agree. The remaining two items were open-ended questions. Shown in the figures below are boxplots describing the observed median (dark line) and middle 50% (colored box) of responses for the four Likert-type items. The markers represent outliers, while the numbers associated with each marker represent the case number of each outlier.



The 38 high school student participants learned a great deal about the Power Industry, with more than 88% agreeing or strongly agreeing with the statement 'I learned a lot about the Electric Power Industry today'. Nearly 69% of respondents expressed agreement or strong agreement with the statement 'I am excited to learn more about Power Engineering'. Eighty percent of respondents disagreed or strongly disagreed with the statement 'coming today was NOT worth my time'. Almost 51% of the students could see themselves working in the Electric Power Industry; of the remaining 49%, 27% were neutral about working in the power industry and 22% could not see themselves working in the industry. The ratings for these four items are presented below for the 13 Suffolk EE student participants.



Forty-nine of the 51 participants responded the open-ended question 'What was the BEST thing about today's event?' Five themes emerged from analysis of this data, and accounted for 47 of the 49 responses. The most salient theme was reference to a particular exhibit, and was mentioned as the best thing about the event by 45% of the respondents. Examples include 'Tom's Tesla Coil', 'learning about NSTAR and OMICRON', 'the wind/solar thing', and 'how the CPC detects what's wrong with the system.' The second-most salient theme was the nature of the event as a positive learning experience, mentioned by 30% of the respondents. Examples include 'meeting/introduction to engineers in the field', 'learning about power', 'learning what electric engineering is' and 'getting to talk with all the different companies'. Fifteen percent of the respondents referenced free food as the best thing, while the remaining 10% of the respondents mentioned the hands-on activities or the ability to ask questions.

Thirty-five of the 51 participants responded to the open-ended question 'If there was one thing about today's event you could change, what would it be?' Five themes also emerged from analysis of this data, accounting for 26 of the 35 responses. The most salient theme, expressed by 34% of respondents, was a desire to have more hands-on oriented activities and is exemplified by comments like 'let students test technology out', and 'more hands-on activities'. The second most salient theme (17%) was to have more time – nearly all respondents who commented within this theme expressed a desire to have more time at each station. Fourteen percent of the respondents commented that they would change nothing, 11% would change something about the food, and 6% expressed a desire to ask more questions. Nine of the 35 responses to this

question (6%) did not fit into a theme and included comments like ‘more decorations’, ‘the sticker system’, ‘the way we can use and preserve energy’, and ‘more Tom Vales’.

Conclusion

In response to the electric power industry’s need for more electrical engineers, the EE program at Suffolk University hosted *Power Engineering Day* to expose Boston high school students, most of whom are from underrepresented groups, to the field of electric power and to increase the participation of Suffolk EE students in this field. Representatives from six electric power companies, three Boston high schools, and Suffolk University’s EE faculty, staff, and students planned and executed the event. Industry presenters felt that it was well worth their time, and students responded that they learned a lot from the event, were excited to learn about electric power, and that some even see themselves a working in the electric power industry. There were a few aspects that could be improved:

- Students and exhibitors both expressed a desire to have more hands-on oriented activities.
- High school students, many of whom will be first generation college students, would benefit from having more time to interact with their EE student-leader.
- Students and exhibitors expressed a desire to enhance the contact time of students with exhibitors. While the students expressed a desire to have more time at each station, contact time could also be increased through having designated time that is less structured, allowing students to revisit exhibits they are particularly interested in.

Works Cited

1. *Transformers Aren't the only Aging Utility Assets – Managing Knowledge Loss as More Utility Workers Retire.* **Bishop, W.** Minneapolis : s.n., 2006. APPA 2006 Business & Financial Conference.

2. IEEE PES Scholarship Plus Initiative. [Online] 2014. http://www.ee-scholarship.org/.

3. **Kambour, Andrew.** *Governors’ Guide to Modernizing the Electric.* Washington, DC : Association, National Governors, 2014.

4. **D. Manz, R. Walling, N. Miller, B LaRose, R.D’Aquila, B. Daryanian.** The Grid of the Future. *IEEE Power and Energy Magazine.* May/June 2014.

5. **United States Department of Energy, Office of Electric Transmission and Distribution.** *“Grid 2030” — A National Vision for Electricity’s Second 100 Years.* 2003.

6. Chester, M.D. Massachusetts Department of Elementary and Secondary Education. [Online]. *TechBoston.* [Online] [Cited: March 30, 2015.] http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=00350657&orgtypecode=6&.

7. Chester, M.D. Massachusetts Department of Elementary and Secondary Education. [Online]. *Dorchester Academy.* [Online] [Cited: March 30, 2015.] http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=00350651&orgtypecode=6&.

8. Chester, M.D. Massachusetts Department of Elementary and Secondary Education. [Online]. *O'Bryant School of Math and Science.* [Online] [Cited: March 30, 2015.] http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=00350575&orgtypecode=6&.

9. **NSF.** *Women, Minorities, and Persons with Disabilities in Science and Engineering.* 2011.

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