Enhanced Workforce Development via the 2017 FEEDER Student Summer Program

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The FEEDER Consortium which consists of twelve universities, seventeen industry partners and two national labs has the goal to enhance curriculum development and education in the study of distributed energy resources. Every summer the consortium offers a program in which students meet at a specific location in the United States and participate in a week-long event, which consists of networking events, technical workshops, industry tours, laboratory experiments and leisure activities. This program works to enhance the workforce development of undergraduate and graduate power engineering students.

In the summer of 2017, the summer program was hosted by the University of Pittsburgh. During the week-long program, students were given two different technical presentations, including a presentation on multi-physics analysis of adjustable speed motor drives, and a presentation on developing demand response programs. Students also participated in interactive workshops on defining the smart grid, distribution line modeling, and researching vehicle-to-grid technology.

The program also had three tours to local utilities. The first tour was a tour of Duquesne Light Company's operations and training centers. During this tour, students learned about DLC's new microgrid developments. The second tour was of Mitsubishi Electric, where students toured the high-voltage switchgear manufacturing facility. The last tour was to Eaton's Power Systems Experience Center, where students participated in an interactive tour of pole mounted equipment, a data center and a power quality laboratory.

One day of the summer program consisted of student experiments in an electric power student laboratory at the University of Pittsburgh. In this laboratory, students learned how to use Dranetz meters and take measurements of different three-phase load configurations. This exposed the students to real world phenomena such as resonance of capacitive loads due to transformer inductance.

Concluding the program, the students filled out reports which collected information on their background in electric power and measured their overall evaluation of the program. The data from these questions were used to perform a statistical analysis of the perceived quality of the program and to determine what improvements would be needed for future programs. These reports also had a series open-ended questions addressing the program's impact. A qualitative analysis was performed based on these open-ended questions.

This article describes the summer program in detail and gives a summary of the student reports. The summary suggests, that this summer program will be one of the most memorable and fruitful experiences of the students' academic careers.

Introduction

There are several studies which detail the benefit of student collaboration and networking [1], [2]. However, there are not always adequate opportunities for students to network and collaborate with other students and faculty outside of their home institution. Therefore a summer

program was developed by the FEEDER (Foundations in Engineering Education for Distributed Energy Resources) Consortium, in hopes to not only increase the ability for students to network and collaborate, but to expose the students to a wide variety of technologies that they could not see otherwise. This strengthens several of the soft skills that are very important in the development of a young engineer's career, but are often times overlooked [3].

The summer program for 2017 was hosted by the University of Pittsburgh. This program took place over a period of one week from June 5th to June 9th, and consisted of academic lectures, workshops, laboratory exercises, tours of local industrial sites, networking events, and extracurricular activities. This summer program was the 4th annual summer program as part of the FEEDER Consortium. While the summer program is just one of the many thrusts of the FEEDER Consortium, it is one of the most well-received and appreciated by the students who participate. This paper gives a short background of the consortium, the history of the summer program including the location, schedule, and highlights for each year's program, a detailed description of the 2017 summer program at the University of Pittsburgh, and both a quantitative and qualitative assessment of the program's effectiveness as it was perceived by the attending students.

History of the FEEDER Consotium

The FEEDER Consortium is one of three national DTTCs (Distributed Technology Training Centers) funded by Department of Energy, and it consists of twelve universities, eighteen utilities, seventeen industry partners and two national labs. Its mission is to significantly advance engineering capability to accelerate the deployment of distributed power systems technologies through well-designed and complementary research, development, testing, analysis, and evaluation, supporting innovative and highly collaborative education of the current and future workforce.

Through innovations in contents, pedagogy and delivery, FEEDER has significantly elevated power systems engineering workforce development, with direct impacts on thousands of undergraduate students and hundreds of graduate students since its inception in 2013. The intercollegiate center has developed sixteen new cross-disciplinary courses, covering such topics as renewable energy sources and public policy, smart grid communication, distributed optimization and control, distributed energy resources, microgrid operation, electricity distribution networks with 100% solar penetration, energy data analytics, cyber security and grid resilience. A novel multi-institutional course sharing agreement is developed and implemented. This agreement enables students to enroll various courses from consortium universities in the same manner as local courses in their home institutions, and it allows faculty members to deploy modern educational technology and course delivery options, to substantially expand the spectrum of course offerings while reducing course redundancy among the campuses. As a result, a much larger group of graduates are better trained and then fed into the workforce, existing practitioners gain up-to-date expertise of distributed energy systems through professional training, and these new and existing engineers are working to transform our existing electric grid infrastructure into a more reliable, intelligent, digital grid.

Interdisciplinary research at the FEEDER Consortium focuses upon addressing intermittencies, uncertainties and other technical challenges in integrating renewables of extreme high penetration. Through DOE's ENERGISE program, FEEDER leads a research team of university, industry and utility and national lab to prepare our nation for 100% PV penetration in the national electricity grid by 2030. A new, scalable, plug-and-play and secure grid operation paradigm has been developed by infusing information and data-driven technologies, autonomous controls, self-organizing microgrids, distributed optimization, distributed energy resources and storage technologies. Research results are disseminated through several channels: FEEDER monthly seminar series to graduate students, undergraduate students, industry and utility engineers, themed sessions at professional conferences, scholarly publications in top journals, and integration into power systems curricula and professional training materials.

The FEEDER Industry Advisory Board regularly provides invaluable inputs which enable us to address the evolving needs of workforce training, research, and development. During regular semesters, FEEDER partners routinely sponsor and co-supervise senior undergraduate capstone design projects. Several FEEDER partners, including Siemens, Leidos, Texas Instruments, and Duke Energy have funded and supported R&D projects, in addition to their support of student activities and projects. The extensive engagements among FEEDER faculty, students and their partners from industry and utility provide a solid foundation for FEEDER to fulfill its mission. The last four years have been a resounding success, and together with DOE are working to sustain and expand this successes.

History of the FEEDER Summer Program

The 2017 summer program was the fourth annual offering of the summer program. A brief history of each of the other three summer programs is detailed in this section

2014 Summer Program:

The first summer program, hosted by the University of Central Florida was a strong success, with thirty students participating from six of the seven then current FEEDER universities (Arkansas, Auburn, Central Florida, Florida State, Kentucky, and South Carolina) and fifteen faculty members from all seven. Additionally, the team formally welcomed the University of Pittsburgh (former lead faculty was Tom McDermott, who also attended) to the consortium.

Some of the highlights for the 2014 summer program included:

- Lecture on energy management, distribution management system, SCADA, power market modeling, transmission system monitoring, and volt/var optimization given by Dr. Yuan Liao of the University of Kentucky
- Tour of a 6 MW one-axis tracking PV system provided by Duke Energy and Orlando Utilities Commision. Shown in Figure 1 below
- Lecture on smart grid stability, time domain transient analysis, and the impact of distributed generation integration on protective schemes of power systems given by Dr. Saeed Lotfifard of the Univeristy of Central Florida

- Lecture on basic graph theory, random graph theory, Erdos-Renyi networks, small-world and scale-free networks, properties and consequences, models for electricity grids given by Dr. Alireza Seyedi of the University of Central Florida
- Plenary talk given by Dr. Johan Enslin of University of North Carolina - Charlotte (a member of the EPRI-led DTTC) who discussed the infrastructure and strengths of "EPIC," the Energy Production and Infrastructure Center at UNCC
- Research sessions on integration of distributed generation devices and system-level issues due to this integration
- Presentation on a smart grid laboratory test bed given by Texas Instruments

Figure 1: Students at 6 MW one-axis tracking PV system

2015 Summer Program:

The second summer program was hosted in conjunction with the the University of Kentucky's, Power and Energy Institute of Kentucky (PEIK). During this summer program, students traveled to multiple energy sites over the course of a week. Prior to this summer program, this program was run as a semester long course at UK.

Some of the highlights from the 2015 summer program included:

- Tour of a solar farm, efficient house retrofit, biogenic natural gas wells provided by Blue Grass Energy
- Tour of a hydroelectric plant given by LG&E
- Tour of a coal plant, supercritical coal combustion process, pollution control and more given by LG&E Trimble Plant

- Tour of a wind farm given by Chalmers Wind Farm
- Tour of a smart grid education center given by Duke Envision Center
- Tour of a nuclear site given by TVA Bellafonte
- Tour of a pumped hydro facility given by Raccoon Mountain Pumped Storage

Figure 2: Students talking with an LG&E Operator

2016 Summer Program:

The 2016 summer program was unique in the sense that it was the first summer program not hosted by a university, but rather hosted by a national laboratory. This summer program was hosted by National Renewable Energy Laboratory (NREL), but included participation from all twelve of the now current universities of the FEEDER Consortium. This program included thirty students, twelve faculty and NREL staff.

Some of the highlights for the 2016 summer program included:

- Visit to hiking locations near national lab.
- Lecture on distributed energy resources and inverter technologies, and the basics of power systems operations given by Dr. Fahimi Babak of the University of Texas - Dallas
- Testing and evaluation of inverters
- Tour of an energy systems integration facility
- Lecture on high PV distribution planning given by Roy McCann of the University of Arkansas
- Lecture on modeling and simulation of a distribution system given by Bryan Palmintier of NREL
- Tour of a wind technology center at NREL

- Lectures on distributed control and optimization, and distribution management systems given by Zhihua Qu of the University of Central Florida

2017 Program Agenda

The 2017 Summer Program was held from June 5th through June 9th at the University of Pittsburgh. The program consisted of five days which each had their own unique theme. The agenda for the five-day program is given in below:

- Day 1, Monday, June 5th: University of Pittsburgh
  - Welcome to the University of Pittsburgh speech given by Dr. Greggory Reed of the University of Pittsburgh
  - Multi-physics analysis of adjustable speed motor drives workshop given by Dr. Fahimi Babak of University of Texas - Dallas
  - Introduction to smart grid workshop given by Dr. Robert Kerestes of the University of Pittsburgh
  - Introduction to distribution line modeling workshop given by Dr. Robert Kerestes of the University of Pittsburgh
  - Developing demand response programs and markets workshop given by Dr. Reza Ghorbani of the University of Hawaii at Manoa
- Day 2, Tuesday, June 6th: Tour of Duquesne Light Company (DLC) and Mitsubishi Electric (MEPPI)
  - Duquesne Light visit:
    - Introduction and overview of DLC
    - Overview of the operations center
    - Tour of DLC's operations center
    - Tour of DLC's training center and "juicer" demonstration
    - Presentation on the microgrid
  - Mitsubishi Electric visit:
    - Tour of the high-voltage switchgear
    - Tour of the electric distribution division (EDD)
    - Presentation by power systems engineering services (PSES)
  - FEEDER banquet dinner at the University of Pittsburgh
- Day 3, Wednesday, June 7th: Eaton Power Systems Experience Center (PSEC)
  - Tour of power distribution equipment
    - Pole mounted equipment
    - Data center
    - Switchgear
    - Residential
  - Power quality lab
    - Voltage sags
    - Transients
    - Harmonics
    - Power factor correction

- Day 4, Thursday, June 8th: University of Pittsburgh
  - Welcome to Electric Power Student Laboratory
  - Workshop at Electric Power Student Laboratory
    - Lab safety
    - Loads and data collection
    - Harmonic analysis
  - Power systems workshop
    - Vehicle to grid research session
    - Background of electric power program and research thrusts at the Univeristy of Pittsburgh
- Day 5, Friday, June 9th: Energy Innovation Institute
  - Tour of the Energy Innovation Institute
  - Final reports
  - Adjourn

Description of Activities

Students flew into the City of Pittsburgh on Sunday, June 4th, one day before the start of the summer program. Upon their arrival, they took public transportation, which was prepaid as a part of the program, to the University's student dormitories. These dormitories were vacant due the summer semester's light registration, and were paid for as part of the summer program. All students stayed in the student dormitories for the entire week, while the faculty members who attended stayed in a nearby hotel. All students were present and accounted for by Monday morning when the program officially commenced.

A description of each of the activities is given in the section below:

Day 1: The first day of the program was held entirely at the University of Pittsburgh. This day consisted of a networking breakfast, a welcoming speech, and various student workshops.

The breakfast took place at 8:00 a.m. in the lobby of the University of Pittsburgh. During this breakfast, the students and faculty from the different institutions were given a chance to network with each other.

Following the networking breakfast, the students gathered for the first workshop of the day. This workshop was a research presentation on multi-physics analysis of adjustable speed motor drives given by Dr. Fahimi Babak of University of Texas - Dallas. This presentation covered the process of multi-physics modeling of motor drives, and some of the benefits performing such an analysis can provide. There was a great deal of interest in this presentation, especially from the graduate student population.

Next was an introduction to the summer program given by Dr. Robert Kerestes of the University of Pittsbugh. This introduction provided students with information and logistics about the week to come. Directly after this introduction was a welcoming speech given by by Dr. Greggory Reed of the University of Pittsbugh.

The second workshop of the day which took place after the introduction, was a workshop on defining the smart grid. In this exercise, students were assembled into small groups and discussed what the smart grid really is. After the group discussions, the whole student body discussed what their definition of a smart grid is and came up with a collaborative definition. This definition was:

"The smart grid is a collection of devices which provide two-way communication with the main power grid, and can be used to automate processes resulting in more efficient power systems technology"

The next workshop of the day was conducted in the electrical and computer engineering labs at the University of Pittsburgh. In this workshop, a brief lecture on power distribution line modeling was given.

Figure 3: Distribution lines in Kennerdell, PA used for MATLAB modeling exercise

In this lecture, Kersting's method [4] of line modeling was described in detail. Students were then asked to then choose one of the two distribution lines shown in Figure 3, and create a model using MATLAB, which was installed on all of the lab computers. To create this model, the students were given some data about the type of conductor used for each cable, but the students had to estimate the geometry of the line from the photos. This gave each student a unique answer, and allowed students to compare solutions and point out possible discrepancies. Based on their model they were able to determine the impedance per mile of the line that they selected.

The final workshop of the day was a research presentation on developing demand response programs and markets given by Dr. Reza Ghorbani of the University of Hawaii at Manoa. In this

presentation, a strategy for the integration of renewable energy resources was presented. This covered many of the challenges that are seen with regards to demand response and the stochastic nature of renewable energy resources.

Day 2: The second day of the summer program consisted of two industry tours. The first of which was to DLC which is a local electric power utility, and the second of which was a tour to MEPPI, which is Mitsubishi's power products facility.

During the tour to DLC, students were exposed to what goes on daily at an electric power utility. For this tour, students were broken up into three groups and participated in three different activities. The first activity was an overview of the utility's operation center and a presentation on microgrid projects that were to commence in the near future. The second activity was a tour of the utility's operation center. During this tour, students were able to see the operators in action and ask questions about what abnormalities can occur on a day to day basis. The final activity of the tour was a tour of the utility's training center. During this tour, students were able to see all of the equipment that linemen used on a daily basis. Students were also given a demonstration of how a generator can back feed power through a transformer putting linemen in danger. This was referred to as the "juicer" demonstration.

Figure 4: Students at DLC on June 6th, 2017

Following the tour of DLC, students were transported to MEPPI. The MEPPI tour was composed of three different activities as well. The first activity was a tour of MEPPI's medium voltage circuit breaker production floor. During this tour, students were able to see how medium voltage

circuit breakers were constructed and ask question of the engineers constructing them. Directly following that tour, students then took a tour of MEPPI's high voltage circuit breaker production floor. During this tour, students were able to watch the construction of massive high voltage circuit breakers take place. The last leg of the MEPPI tour was a presentation given by senior engineers from MEPPI. This presentation consisted of some of the challenging engineering problems that engineers have encountered at MEPPI.

After the two tours the students returned to the campus where a welcoming banquet was held. The welcoming banquet was initiated with a speech from Dr. Zhihua Qu, Director of the FEEDER Center. After the speech, students were served some local cuisine from City of Pittsburgh. During this dinner, students were given another opportunity to network and meet different people in the FEEDER Consortium.

Day 3: The third day of the program consisted of a student tour of Eaton's PSEC. This tour started off with a breakfast provided by Eaton. During this breakfast Dan Carnovale of Eaton gave a presentation on some of the work that Eaton does and some of the consultation they provide. Students thoroughly enjoyed this presentation as it was both very informative and entertaining. The remainder of the morning session of the PSEC tour consisted of a tour of many of the different power distribution equipment. This equipment included pole mounted equipment, data center equipment, low to medium voltage switchgear, and residential power equipment. Students then broke for the lunch session. During the lunch session, the students and faculty networked with engineers from Eaton.

Figure 5: Dan Carnovale of Eaton speaking to students and faculty

After the lunch session, Eaton hosted a set of lectures and demonstrations in their power quality laboratory. These lectures and demonstration consisted of voltage sags due to induction motor inrush, soft starting induction motors, harmonics, and power factor correction. These lectures and demonstrations were very interactive. Students were asking questions and discussing with Eaton engineers during the entire session.

Day 4: The fourth day of the summer program was held at the Univeristy of Pittsburgh. The events for the day were put on by the University of Pittsburgh in collaboration with Eaton. Students were broken up into two separate groups. The first group stayed in the lecture room at

the University of Pittsburgh for lectures and workshops. This lecture and workshop session started with an overview of the research activities going on at the University of Pittsburgh's Center for Energy. Following this lecture, the students were organized into small groups and given a research paper [5] on vehicle to grid (V2G) technology. Students were organized into groups of two or three students, each group consisting of a mix of graduate and undergraduate students, and asked to read the research paper and give a brief summary on their findings. This proved valuable because it gave graduate students a chance to briefly mentor undergraduate students in the ways of research, and it exposed undergraduate students to research in general.

The second group for the day worked in the Electric Power Student Laboratory at the University of Pittsburgh. During this session, students studied laboratory safety, performed a lab on instrumentation and measurements, then used that data to perform a harmonic analysis. What was particularly helpful was for students to see the effect of switching in a purely capacitive load. Most students thought that switching a capacitive load in would simply cause current to lead the voltage, but instead saw a great deal of resonance. This showed that that most sources in real power systems have an inductive component that should be considered.

Day 5: The final day of the program started with a tour of the Energy Innovation Center in downtown Pittsburgh. After the tour, students gather to fill out their final surveys about the program. These surveys provided a great deal of quantitative and qualitative data about the program. After the surveys were filled out, Dr. Robert Kerestes of the Univeristy of Pittsburgh provided some parting words and the students adjourned.

Assessment of the Program

The surveys that were given at the end of the program served as a means to assess the program. Some of the data gathered on the students and a summarization of the data is given below, for the (N=30) students who were polled.

The program offered a balanced mix of degree programs for the students; 53.3% of the students were working on their Bachelor of Science, 13.3% of the students were working on their Master of Science, and 33.3% of the students were working on their Doctorate of Philosophy. The majors of the students were 90% electrical engineering and 10% mechanical engineering. The academic experience of the students was distributed such that half of the students had taken four or more power classes, about one quarter had taken two or three classes, and another quarter had taken one course.

Some of the feedback indicated that the material was too generalized, or that material was either too complex or too simple for certain students. One possible ramification to this problem would be to survey the students ahead of time. For example, if the three questions

1.) What is your current degree program?
2.) What is your major?
3.) How many power-related course have you had prior to participation in this workshop?

were asked ahead of time, breakout sessions could be developed which would be more targeted towards certain audiences. For instance, a short technical session on current challenges in the modern-day power system, where the lecturer could explain some of the basic challenges that engineers are working on, would be perfect for an BS level student with one power class, but it would likely be too simple for a PhD student with more than four classes. However, while that session is running, a more complex session geared toward the advanced students could be running. This would give the students some autonomy, and in turn would provide them with a better summer program.

The students were asked which topics they would like to hear more about in the future. This question allowed the students to give more than one answer. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Smart Grid/Data Analytics (9)
- Renewable/Storage Integration (8)
- Control and Automation (4)
- Finite element analysis of machines (2)
- Cyber security (2)
- Power electronics (2)
- Vehicle to grid technology (2)
- Protection (1)
- Superconductors (1)
- Hardware (1)
- How to research (1)
- Economics (1)
- Machines and drives (1)
- Simulation (1)
- Optimization and economic dispatch (1)

The students were asked which topics they would not like to hear more about in the future. This question allowed the students to give more than one answer. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Anything (7)
- Hardware (2)
- Protection (1)
- Economics (1)
- Solar power (1)

The students were asked if there was a particular tour or other technical content outside of the classroom that was particular good. This answer showed a consensus answer. Every student answered that the Eaton tour.

The students where asked if there was a particular tour or technical content outside of the classroom that was their least favorite. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Nothing (14)
- Duquesne Light Company (5)
- Mitsubishi (3)
- Presentations during tours (1)

The students were asked what part of the program did they find most worthwhile. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Tours/Industry Exposure (23)
- Networking (5)
- Visiting the University of Pittsburgh (1)

The students were asked what part of the program they felt needed the most improvement. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Technical sessions (8)
  - Comments were:
    - Need more active learning/hands on component to these technical sessions.
    - Too complicated for some
    - Would rather see implementation rather than theory
    - Too long
- Nothing (4)
- Logistics (3)
- More networking (2)
- Organization (2)
- More focus on research (2)
- More lab work (1)
- More autonomy (1)
- Reduce amount of activities per day (1)
- More hands on technical sessions (1)
- More policy (1)
- More technical material (1)

The students where asked if they have any suggestions for future programs, either at this site or elsewhere. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Introduction/Meet and greet session should be added (4)
- More active learning/hands on sessions (3)
- Better variety of food/Dietary restriction accommodation (2)
- Have next session in Hawai'i (2)
- Have a tour of the city (2)
- Better directions for lodging (1)
- Have prerequisites defined for tech sessions (1)

- More examples of implementation (1)
- A microgrid tour (1)
- Less technical lectures (1)
- Have next session in California (1)

The students were asked to provide additional comments. A summary of their answers is (note that the number in parenthesis is the number of times this answer was given):

- Thank you (5)
- Good job (5)
- Program broadened their horizon (1)
- More economics needed (1)
- Share contact info prior to session (1)
- More of a research focus would be helpful (1)

In summary, the 2017 Summer Program at the University of Pittsburgh was a success. When the students were asked to rate the overall quality of the program, 86.7% of the students rated the program as "excellent", while 10% of the student ranked the program as "good" and one student left the question blank making up the remaining 3.3%. Based on feedback, there were two areas which the students found particularly valuable. Those two areas were industry tours and networking. From the student report comments, a good way to improve the program would be to add a meet and greet session on the first day before any events or activities take place. During this session students could introduce themselves to the group, declare their degree program, areas of interest…etc. After the introductions, perhaps a networking session in which students could familiarize themselves with each other would be very beneficial.

Secondly, some students had brought up the great idea in which lectures could be given in advance to the industry tours, so that the students could get the most out of the tours. For instance, this year one of the industry tours was Mitsubishi Electric where the students took a tour of the switchgear manufacturing facility. It would have been helpful to have a brief lecture on medium and high voltage circuit breaker technology in advance to the tour.

Lastly, a good recommendation would be to have concurrent breakout sessions which spanned many levels of technical know-how. This way, the technical lectures could adhere to the right demographic benefiting the students as much as possible. This is the only way in which the total spectrum of BS, MS and PhD student can be accommodated.

Summary of Program Assessment

The table shown below shows the quantitative questions that were asked to gather some data on the programs effectiveness. This assessment provided a great deal of insight on how the program was receieved.

	Multiple choice questions (N = 30 responses)	**(response) %**	**(response) %**	**(response) %**			
Demographics	1. What is your current degree program?	BS (16) 53.3%	MS (4) 13.3%	PhD (10) 33.3%			
	2. What is your major?	EE (27) 90%	MAE (3) 10%				
	3. How many power related courses have you had prior to participation in this workshop?	1 (7) 23.3%	2 or 3 courses (8) 26.7%	4 or more courses (15) 50%			
	4. Please tell us your university. (If you wish to remain anonymous, then please just indicate "anonymous" in the blank.	UCSD (5), UCF (6), Auburn (1), FSU (2), UArk (3), USC (1), UF (1), UK (3), UTD (3), SDSU (1), UH (2), Anonymous (1)					
Technical classroom content	5. The technical level of presentations (in general) was appropriate:	too simple (2) 6.67%	just right (12) 40%	somewhat challenging but understandable (14) 46.7%	too challenging (in general), and beyond my ability to understand (2) 6.67%		
	6. How would you rate your learning from the technical presentations (in general):	very worthwhile learning (16) 53.3%	worthwhile learning (10) 33.3%	some learning (4) 13.3%	little learning 0%	no learning 0%	
Non-classroom content	8. Overall, how would you rate the tours and other technical content outside of the classroom?	very good (27) 90%	good (3) 10%	ok	not useful	poor	
General	11. The program included lecture content, tour content, and also networking/social						

	Multiple choice questions (N = 30 responses)	**(response) %**	**(response) %**	**(response) %**			
	opportunities. How would you rate the balance of the content?						
	11 a. technical lecture content	need more (4) 13.3%	just right (19) 63.3%	need less (7) 23.3%			
	11 b. technical tour content	need more (9) 30%	just right (20) 66.7%	need less (1) 3.3%			
	11 c. project work	need more (5) 16.7%	just right (24) 80%	need less (1) 3.3%			
	11 d. computer programming and tools	need more (19) 63.3%	just right (11) 36.7%	need less 0%			
	11 e. non-technical content (sightseeing, networking with fellow students, etc)	need more (14) 46.7%	just right (15) 50%	need less (1) 3.3%			
	12. Length of program and format. Please let us know what you think regarding the length of the program.	extend program 2 more days (6) 20%	extend program 1 more day (4) 13.3%	the program is the right length (20) 66.7%	shorten the program by a day 0%	shorten the program by 2 days 0%	
	13. What is your overall evaluation of this summer institute 2017 program?	excellent (26) 86.7%	good (3) 10%	fair 0%	weak 0%	poor 0%	Blank (1) 3.3 %

Conclusion:

The 2017 Summer Program provided students with an opportunity to meet students and faculty from other institutions with an interest in power. The concept that building a network of professionals in your field leads to success is well known [6], and this program provided that opportunity for students to network early in their careers. This should most certainly have a positive impact on the group as a whole. On top of making professional connections, students also formed friendships which have the potential to last a very long time. A student quote which reflects this, from the final reports is given below:

“Aside from the great amount of learning and industry application of theoretical knowledge, meeting people was the most worthwhile. Not only because of the diversity in age, gender, ethnicity and nationality, but in academic years and degrees as well. While networking and

getting to know each other, there were a lot of academic research discussions that were very constructive and enlightening."

Along with networking, real world engineering exposure was one of the real advantages to having the summer program. During discussions with students, we realized that many of them had never seen some of the technology that they were studying. Dan Carnovale of Eaton joked that many students think that a transformer is just a bunch of squiggly lines on a piece of paper before they see an actual transformer at the PSEC. This exposure to real world equipment was certainly worthwhile to the student who wrote the comment below:

"The FEEDER summer program really broadened my horizons in terms of research and industry exposure. Electrical engineering is often very abstract, so it was extremely beneficial to see real world engineering."

The last major benefit of the program that we observed was that the students were able to travel and see the world. Studying at a university is supposed to not only educate our students, but to give them a worthwhile experience. Many of the students who attended the program had never travelled before. When one student was asked what the most worthwhile part of the program was, they answered simply to see City of Pittsburgh. There was such positive feedback when it came to the students' almost unanimous first visit to the City of Pittsburgh. A fun picture that the students took in front of the fountain at Point State Park in Pittsburgh, shows them having fun and being creative with photography.

Figure 6: Students having fun with photography at the fountain at Point State Park in downtown Pittsburgh

In conclusion, this summer program was a great success but there is still room to improve. Students really enjoy and find networking worthwhile, but the networking sessions could be improved. In future years, it may be helpful to have a specific meet and greet session where students could present themselves and the universities they come from in groups. Also, the

industry tours continue to be one of the major points of success for the program, so while they will certainly continue, tying the lectures to the industry tours together may have a greater impact. We are happy that we can provide this opportunity to our students and look forward to doing so for years to come.

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