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A Survey of the State of the Power Engineering Profession in the Pacific Northwest and what Working Professionals are Defining as Priorities for Preparing Students to Fill Present and Near-Future Vacancies

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Abstract

What is the state of the power engineering profession today and what advice can working professionals give to academia on what is important for an introductory course? These two fundamental questions were asked of 73 power professionals representing 42 electric power entities throughout the United States Pacific Northwest via an online survey during the summer of 2015. Covered were the states of Washington, Oregon, Idaho, and Alaska, as well as Western Montana and Northern California.

For years there have been reports on the growing need for young engineers to step into large numbers of expected job vacancies due to retirement. Paralleling that concern has been that of the availability of quality power programs. The general perception is that few universities offer strong power curricula despite efforts in this area, although some good progress has been made. Indicative of these challenges has been the expansion of special scholarships for students willing to target power engineering as their field of choice (like that offered through the IEEE Power Engineering Society), and the hiring of graduates with little formal power education but who are perceived as capable of being trained. The author of this paper, who is an electrical engineering professor, has seen a significant number of his graduates enter the power industry to essentially 'learn on the job.'

Subsequently there is a motive to learn firsthand the state of the profession in the Pacific Northwest in terms of demographics and also to get valuable current feedback from those in the field about topics they recommend as most important to cover in an introductory course. The author is in the process of developing such a course to complete a triad of power related courses offered as technical electives: Power Systems, Power Electronics, and Power Engineering.

The survey reveals interesting results. For example 86% of the respondents agreed or strongly agreed that they had concerns about being able to fill coming job vacancies. Fifteen percent of those sampled reported being within five or fewer years of retirement, with 27% within 10 or fewer years. On the course content question, respondents were asked to prioritize subtopics in order of importance. Power transmission was selected as first or second priority 82% of the time and power distribution was selected first or second 74% of the time. Power generation dominated the 'other' category as it was not explicitly offered in the survey, and in hindsight should have been. Answers to open-ended questions provide a wealth of valuable advice for academicians to heed when introducing students to power, ranging from the actual process of substation design to the admonition to 'make it fun!'

Introduction

Background:

The motivation for this survey was two-fold: (1) to gain insights into the state of the power engineering profession in the United States Pacific Northwest, and (2) to solicit feedback from working professionals in this region on what they believe are the most important elements to include as part of an introductory undergraduate power engineering course.

There have been various reports on the concern for replacing soon-to-be retiring engineers. Anecdotal and professional papers have echoed the idea that there may not be enough adequately trained new engineering graduates to replace those leaving the profession. This concern has been flagged for quite some time. As early as 1975 this concern was voiced.[1] This was also true in the 1980s and proposals for mitigation offered.[2] In the 1990s this continued. For example, The IEEE Power Engineering Society presented a current assessment and proposals for how to revive the field for the 21st century.[3] The military has recently also expressed this in terms of their future needs, as exemplified by the Navy's move to electric ships, yet the inadequacies in their own academies power curriculum.[4] One observation has been the availability of qualified faculty, with retirements not always being replaced or the level of expertise not perceived as being as strong.

In a 2007 PES experts panel discussion, it was noted that

- in the sequent 10 years power engineer needs would increase
- the number of power students was on the rise
- there was an aging workforce in industry and academia, and industry research funding for university power programs had fallen significantly over the previous decade and increased government funding was matching this decrease
- focus on the capacity of power engineering programs to educate students for future needs was needed
- there was a need to attract students to the power career option and the vital role played by faculty[5]

Out of this same concern, the power industry itself has taken steps to support and promote the development of young power engineers by recruiting interns and providing scholarships. One example of this is the IEEE Power Engineering Society Scholarship Plus Initiative which provide funds, help with internships, and mentorships.[6]

As these concerns have persisted they have spawned various studies of power engineering education and curricular reform. Among these the University of Minnesota has worked on developed an NSF funded comprehensive power curriculum where they put emphasis on the need for close cooperation with industrial professionals.[7, 8] The Colorado School of Mines has had a similar focus.[9] At Pennsylvania State University the affective aspects of power engineering education were addressed.[10] They put emphasis on the importance of understanding students and faculty perceptions of engineering education. It also mentions the importance of curriculum organization and impact of curriculum organization on instructors. Need for student reflection, exposure, and discussion. It also supported the theme of industry cooperation to help professors. In nearby Canada, McGill University, University of Sherbrooke, Hydro-Quebec, ALSTOM have partnered together to create a joint Institute of Electrical Power Engineering based on the perceived need for more power engineer who are optimally trained.[11]

Finally in recent years there are those who have addressed ways to optimize the introductory power engineering classes at the university. This can apply not only to those programs that have a fairly robust offering in power, but also to those who have a more limited scope in their curriculum yet want to be as judicious as possible in what is included am excluded from such a course.[12, 13]

Context of the Survey:

By gathering demographic information from a sampling of working professionals in the region I hoped to learn to what extent the perceptions of the power engineering workforce aligned with the cumulative responses to this survey. The second major focus of this survey was to garner input on what these working professionals consider to be the most important topics to cover for an introductory course. The idea here is that power providers hire electrical engineering graduates with fairly minimal explicit course work in power presumably because there are not enough for the need. I did an online review of the power engineering program offerings in my state of [omitted for double blind review] and found that only three institutions, one private and two public, have what could be called robust programs. Others have a limited suite of courses.

Even though my institution of Seattle Pacific University does not have an explicit power engineering track, a number of graduates have moved successfully into the field. A lot of the training for specific jobs takes place on the job. If a graduate has a solid background in the fundamentals, is motived and is teachable, they can, and do, move into power jobs. We have a course in power electronics and one in power systems (commercial buildings and marine electric applications), but not one in power engineering. They depend on these courses and the rudimentary content on three phase that they cover in their circuit analysis courses. Yet despite the apparent success of our graduates it is clear that the better prepared they are the better for everyone. I reviewed the university level power programs in my state of Washington and found that only three have what would be considered robust undergraduate programs. By adding our own introductory power engineering course to the two other power related courses, we feel that we can better prepare our students to help fill the need. By getting the best possible input from working professionals in our region we hope to make the best use of the time we invest.

Ideally the sample population for such a survey should be as random as possible to lend credence to the results. Within the scope of this work it was not possible to assure how well this was accomplished because of the challenging nature of contacting participants, getting assent, and actually having them complete the survey in a timely manner. For example, Figure 8 below shows that a bit more than 20% of all respondents held post graduate degrees, surely a higher percentage than for a truly random sampling of working professionals. This also does not address the career-extending effects that significant amounts of part time consulting has had on understanding the issue. However, given the demographic results of the respondents reported below, I believe the sample warrants credibility. Through diligence I was able to attain an 87% response rate in the allotted time (73/84), which was higher than expected and significantly higher than most surveys in general. My primary goal was to obtain enough responses to make the results arguably meaningful.

The demographic data gathered in this survey were the following: (1) age, (2) gender, (3) job description from the categories of Engineer, Senior/Lead Engineer, Engineering Manager, Senior Management, (4) years with present employer, (5) years in present job, (6) years in power industry, (7) estimated number of power engineers with employer, (8) number of employer customers, (9) highest level of education, (10) expected years before retirement. Another set of questions sought to obtain insight into the level of concern for filling anticipated vacating positions in the industry in general, and the specific needs to fill positions where they worked in terms of immediate needs and anticipated needs within the next five years.

Regarding course content they were first asked to priority rank the top five power engineering topics from the following list:

A. Power Transmission
B. Power Distribution
C. Smart Grid
D. Loads
E. Human Factors
F. Future Issues
G. Grid Security
H. Grid Simulation and Analysis
I. Professional Ethics
J. Other

In addition there was a question on naming two practical power engineering skills that may not traditionally be found in an introductory course but should be considered. Others asked what topics they would recommend de-emphasizing and what soft skills were most important. Finally, they were asked to provide any other relevant comments they wished to share, which provided a rich collection of practical wisdom.

Demographic Results

I contacted a sampling of 84 power engineering professionals in the greater Pacific Northwest including Washington, Oregon, Idaho, Western Montana, Northern California, and Alaska who agreed to participate in the online survey. Of these, 73 completed the survey during the month of June 2015, which is an 87% response rate. Of these 92% were male and 8% female. The distribution of respondents per state is the following:

Table 1 Number Agreeing to Survey

State	Number Agreeing to Survey	Number Power Service Companies
Washington	45	15
Oregon	10	8
Idaho	9	6
Western Montana	6	5

Northern California	8	3
Alaska	6	5
Total	**84**	**42**

The individuals who did not complete the survey were evening distributed among these states.

Age: This reflected a fairly uniform distribution with the possible exception of the 51-60 years of age group, which comprised 30% of the total (see Figure 1 below). This may hint at expressed concerns regarding replacing those soon to be retiring.

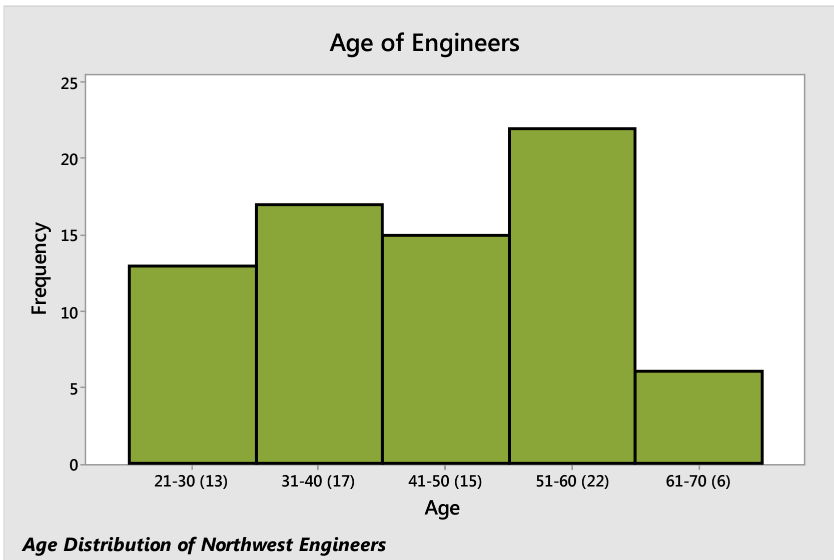

Figure 1 Age Distribution

Job Category: These were limited to four basic categories: (1) engineer, (2) Senior/Lead Engineer, (3) Engineering Manager, and (4) Senior Management. See Figure 2.

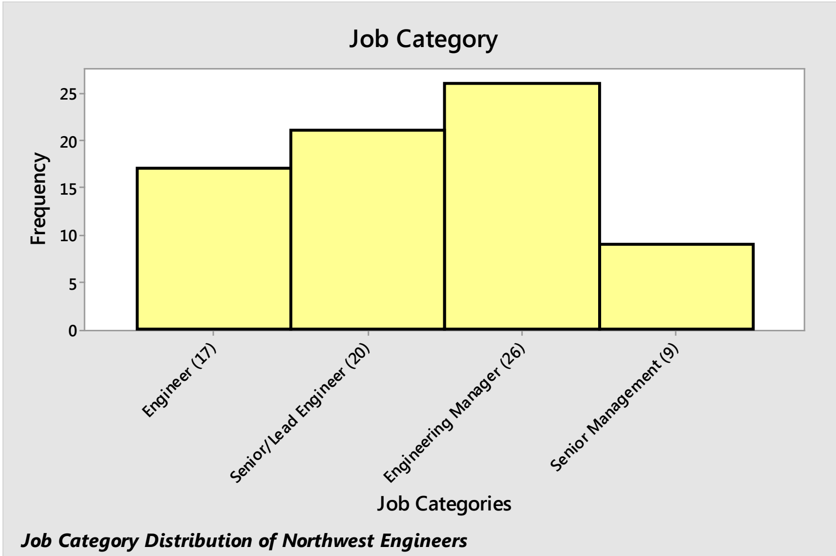

Figure 2 Job Category Distribution

Noteworthy here is that the largest group at about 36% were engineering managers, with senior/lead personnel close at 29%. Even though all levels were recruited, at larger entities I recruited through managers and senior staff to better get the word out to all in their organizations. However, the percentages of the two middle groups indicates that the respondents tended to remain there. It could be argued that one positive of this is that these people may be the best ones at providing the most valuable answers. On the other hand it could be considered problematic in not providing a sample distribution that is more reflective of the actual percentages of engineers in each of these categories, with management seemingly overrepresented.

Years in Power Industry: When broken into intervals of five years we see in Figure 3 what appears to be a fairly uniform spread except for the 40-50 years category. It may be that after that many years in this business substantial numbers leave the profession for any number of reasons, or they were simply fewer engineers in earlier days. Early retirement could also play a part due to past generous retirement plans.

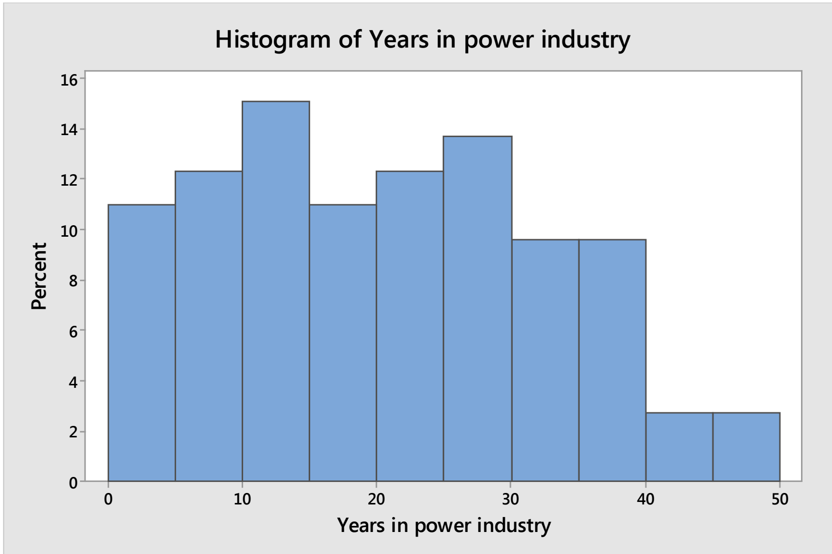

Figure 3 Years in Power Industry

Years with Present Employer: The distribution shown in Figure 4 could be a bit surprising to some, as the power industry traditionally has been viewed as one of the most stable careers. Even though there are notable numbers with extended years of service, we see the predominant number being in the ballpark of ten years of less. This seems to indicate more mobility.

Figure 4 Years with Present Employer

Years in Present Job: Figure 5 seems to show that there are generally opportunities for professional growth in this population, with just a handful staying put jobwise past 10 years.

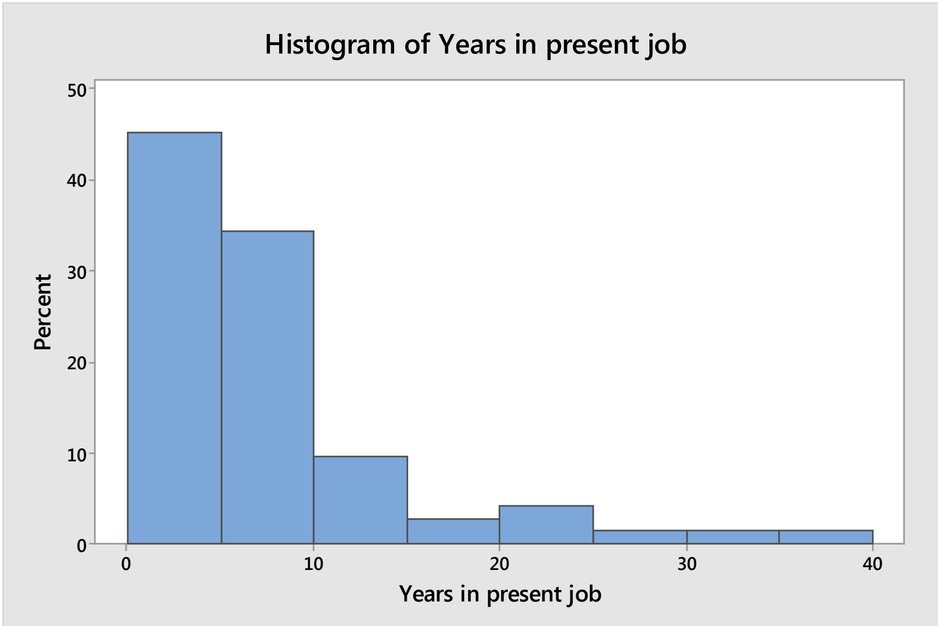

Figure 5 Years with Present Job

Estimated Number of Power Engineers with Employer: Figure 6 shows a large number who work in small entities of just a few engineers. These are the small rural providers that provide electrical service only and buy their power from (generally) the BPA. The next largest categories were 36-100 and over 200 power engineers entities.

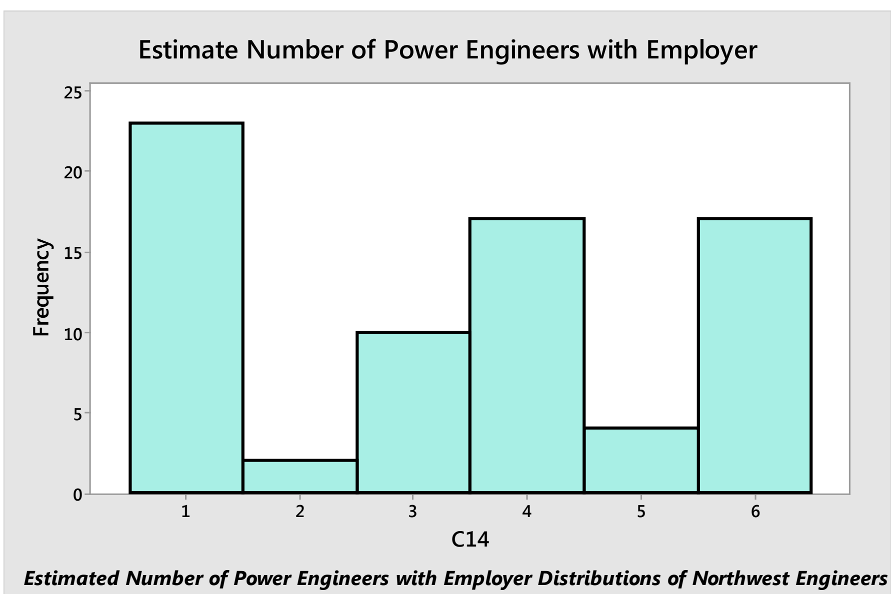

Figure 6 Estimated # of Power Engineers with Employer

Number of Employer Customers: Figure 7 shows a larger block of those working for companies that serve large populations (300,000 – over 1,000,000) and then another larger block at what might be called moderate sized populations (15,000-45,000).

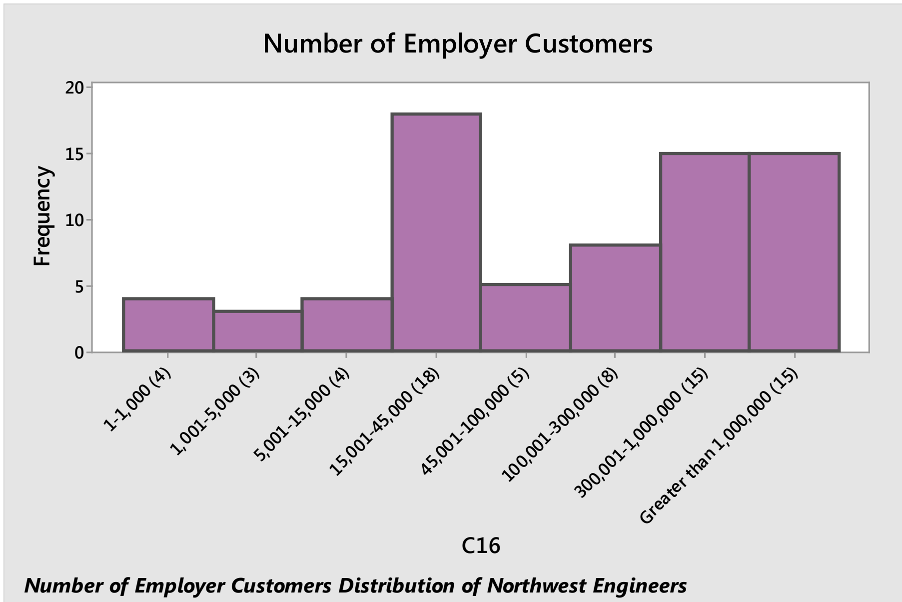

Figure 7 Number of Employer Customers

Highest Level of Education: Not surprisingly, Figure 8 shows the dominance of the bachelor's degree, with 52, or 71% attaining that level. This seemed to reflect that this is adequate for most jobs/careers in the industry. However, anecdotally there is a high level of on-the-job training/mentorship as well as short courses and seminars among the population, so continuing education/training is essential for professional sustainability.

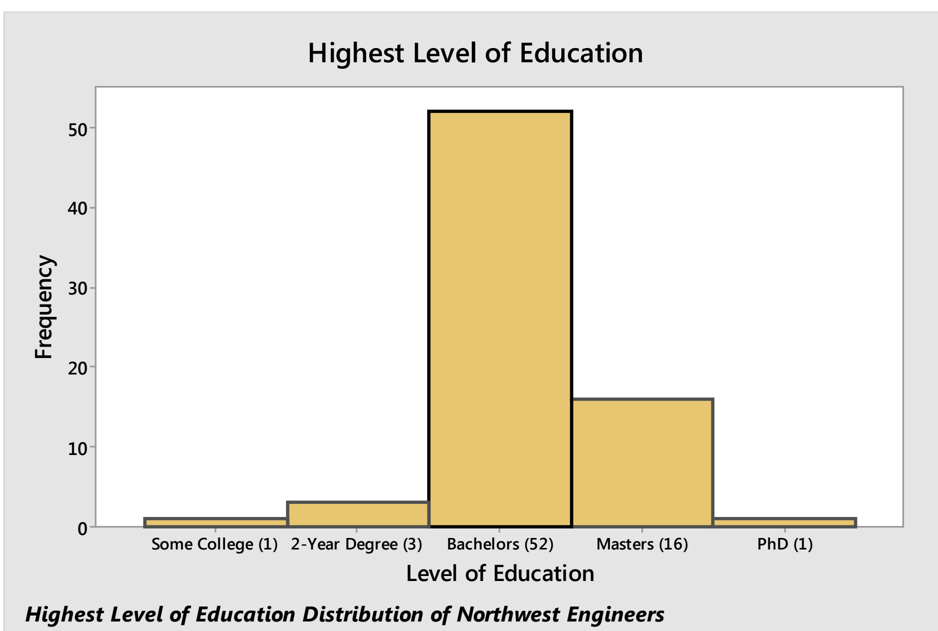

Figure 8 Highest Level of Education

Expected Years Until Retirement: This was intended to get some insight with respect to the belief by some that there is a growing need of new engineers to fill the ranks of those departing via retirement. Yet the number of 27% being within 10 years of retirement, as seen in Figure 9, does not indicate this, but seems more reflective of a fairly uniform distribution of engineers throughout the age and experience spectrums. If one assumes a roughly 40 year career, you would expected about one quarter of those to be retiring within the next 10 years, which is essentially what I found. The results shown on the age distribution of Figure 1 and that of the number of years in the industry shown in Figure 3, coupled the results on the expected years until retirement in Figure 9 was not what I was expecting. I expected a stronger weighting at the higher age and shorter years until retirement.

Figure 9 Expected Years Before Retirement

Some have expressed the perception that power engineers seem to leave the industry after a few years, yet this survey does not seems to support that. Not only in the numbers reflected in the figures, but also anecdotally in my phone conversations with the respondents, I have gotten the impression that they are finding ample challenge, career opportunities, and ongoing training venues that keeps them in the power career path. It is true that some positions, especially those in small power providers, are limited in growth opportunities, but based on the comparison of the years in industry distribution in Figure 4 and the years in present job in Figure 5, it seems that the mobility within the industry is adequate in meeting the need for career advancement.

I Results and Discussion Regarding Industry Perspectives on Course Content

Rather than write separate results and discussion sections for this paper, I have opted to include discussion along with each portion of the results. The motivation here is that there are so many parts to the results that the reader can better digest the information by not having to wade through many pages of purely results before be exposed to discussion/commentary on the results.

The core of the part of this survey whose purpose was gaining advice from working professionals on the content of an introductory course in power engineering was based on the following question.

“Rank in priority order the five power engineering topics listed above that you feel should receive the most detailed emphasis, with 1 being the most important and 5 being the least important.”

These topics, or categories are listed here again.

A. Power Transmission
B. Power Distribution
C. Smart Grid
D. Loads
E. Human Factors
F. Future Issues
G. Grid Security
H. Grid Simulation and Analysis
I. Professional Ethics
J. Other

In hindsight this list should have included Generation as one of the explicit topics, but it was not caught in time to be able to change it. However, indicators below regarding how often Generation showed up in the “Other” category and other comments I believe confirms that this is important.

Since the topic chosen to be first priority, or second is foremost in the minds of those who chose them, it was decided to utilize a modified Borda Count[14] ranking method as a better indicator of importance as opposed to a simple count. For this a first priority was assigned a weighting of 5 points, a second priority a weighting of 4, a third a weighting of 3, fourth a weighting of 2, and 5^{th} a weighting of 1.

Figure 10 below shows the results of this analysis for the nine explicit topics plus “Other” for all respondents. Clearly Distribution and Transmission are winners,

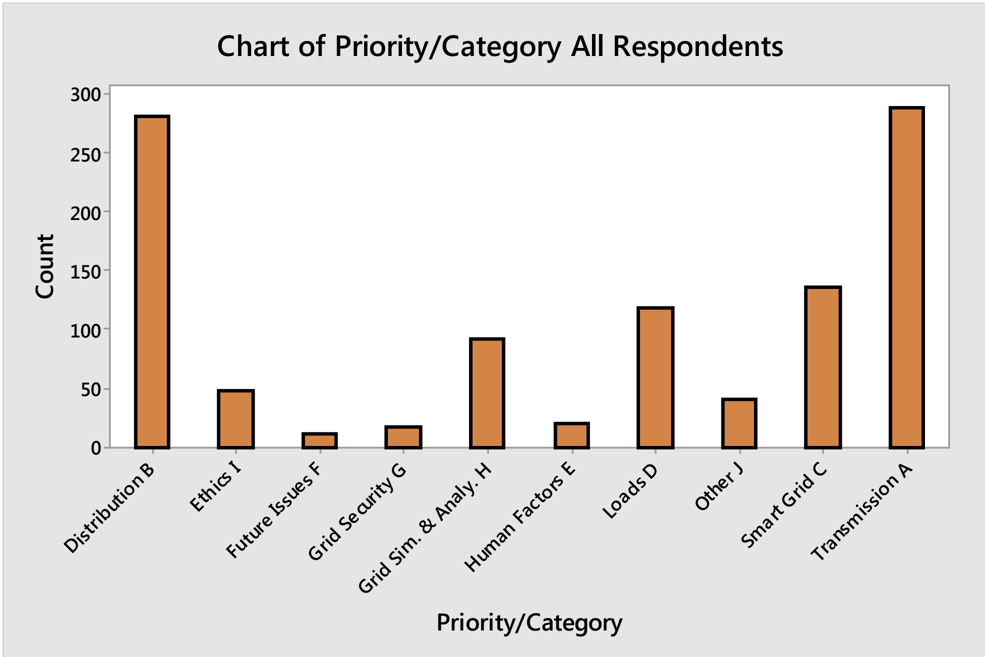

Figure 10 Modified Borda Count of Category Priorities – All Respondents

With this analysis a natural question arises about whether or not different subgroups of the sample set had demonstratively distinct results. To test this, I decided to run Barda counts based on two different criteria: (1) education level, and (2) years in the profession. It turned out that the majority hold bachelor's degrees as their highest level, the next highest group with Master's degrees, and just one PhD, two with two-year degrees and one with "some college." Consequently I divided them into two groups: (1) Bachelors and Some College, and (2) Masters and PhD. This seemed like the most likely division to expose differences. Figure 11 below shows the results for Bachelors and Some College and Figure 12 the same for Masters and PhD.

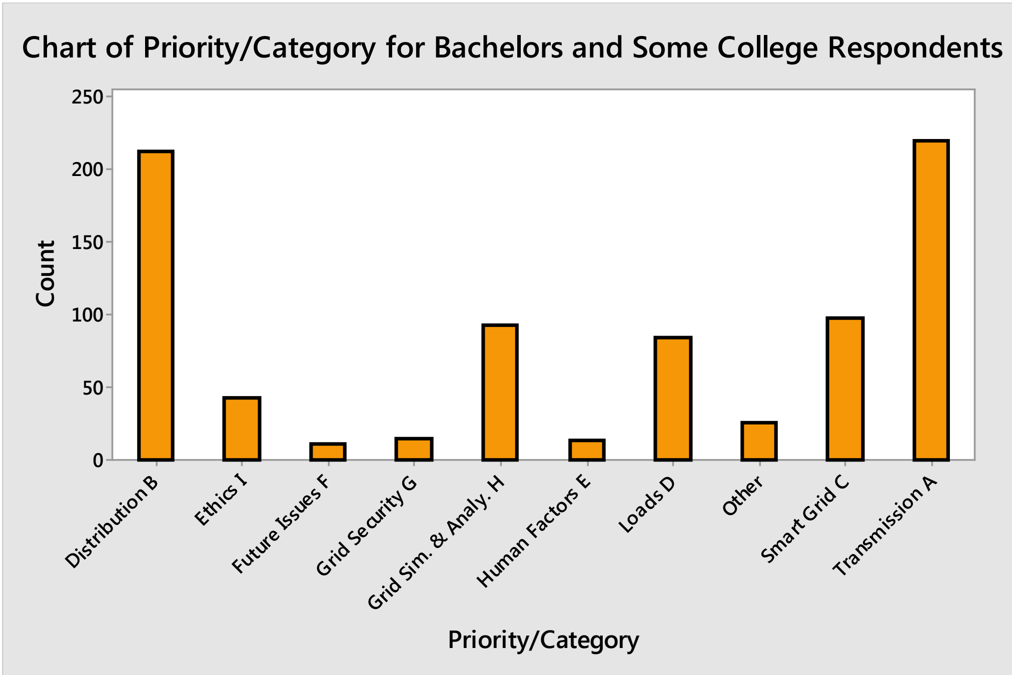

Figure 11 Modified Borda Count of Category Priorities – Bachelors and Some College

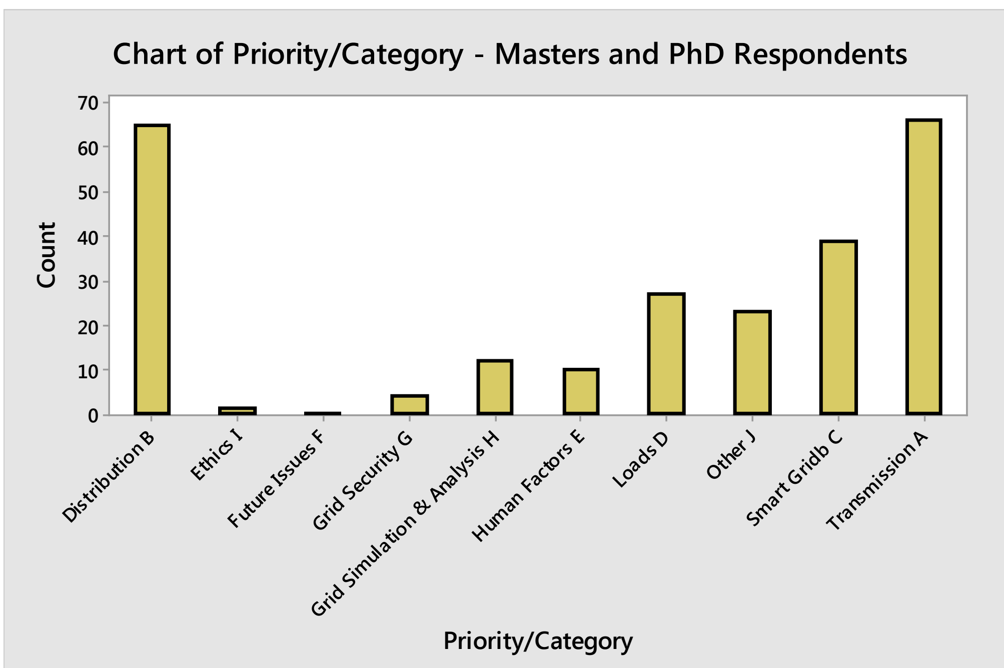

Figure 12 Modified Borda Count of Category Priorities – Masters and PhD Respondents

As mentioned before, I believe the survey had a strategic error of not including generation as a named topic. If it had been included it is likely it would have shown up prominently in the equivalent of Figure 8. Support for this notion was found in voluntary commentary offered by some when they chose 'J' (Other) for one of their priorities. Below are the comments provided. All but one does not have to do with generation!

1. Economics, Asset Management (Standards/Reliability/Maintenance/Operations)
2. power basics and machines
3. conventional and renewable generation
4. Generation, Relay Protection
5. Gen, Gens, Exciters, PTs, CTs, Protective Relaying, etc.
6. Generation
7. Generation, Standards/Practices
8. Machine theory/modeling
9. Generators

With these results we can see that in the main they are the same. However, the "Other" category shows a noteworthy difference. This difference can be accounted for by the category of power generation being more cited by the Masters and PhD group. Grid Simulation and Analysis is more prominent among the Bachelors and Some College group, as well as noticeably more citing for Ethics and future issues. Human factors seem a little more significant to the Masters and PhD group, although both are low. The differences between these two education level groups most likely are the result of what the focus of their day to day jobs.

Now we look at what differences may emerge based on years in the profession. The idea here is that length of job experience could color what individual believe about priorities of course content. Figures 13, 14, and 15 present the results of dividing up the respondents according to length of years in the profession of 0-15, 16-30, and 31-50 years, with the latter category time span being larger due to the smaller population in that subgroup.

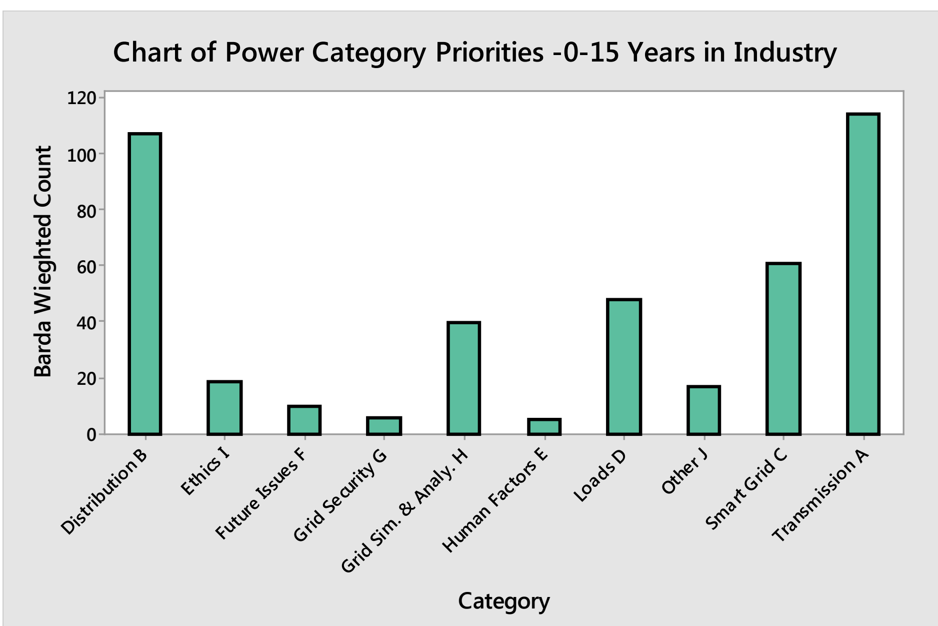

Figure 13 Modified Borda Count of Category Priorities - 0-15 Years in Industry Respondents

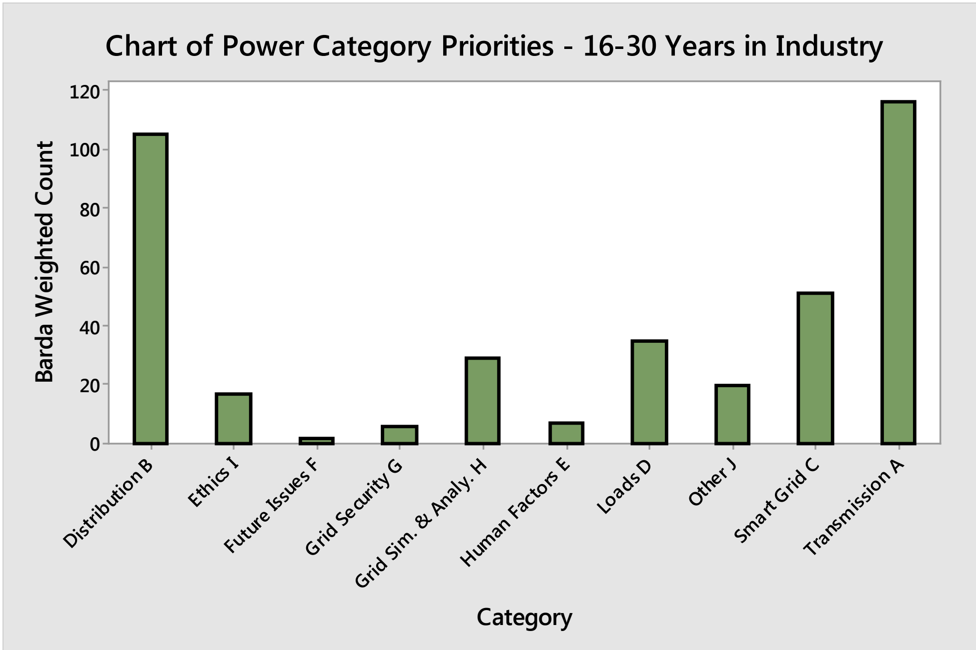

Figure 14 Modified Borda Count of Category Priorities - 16-30 Years in Industry Respondents

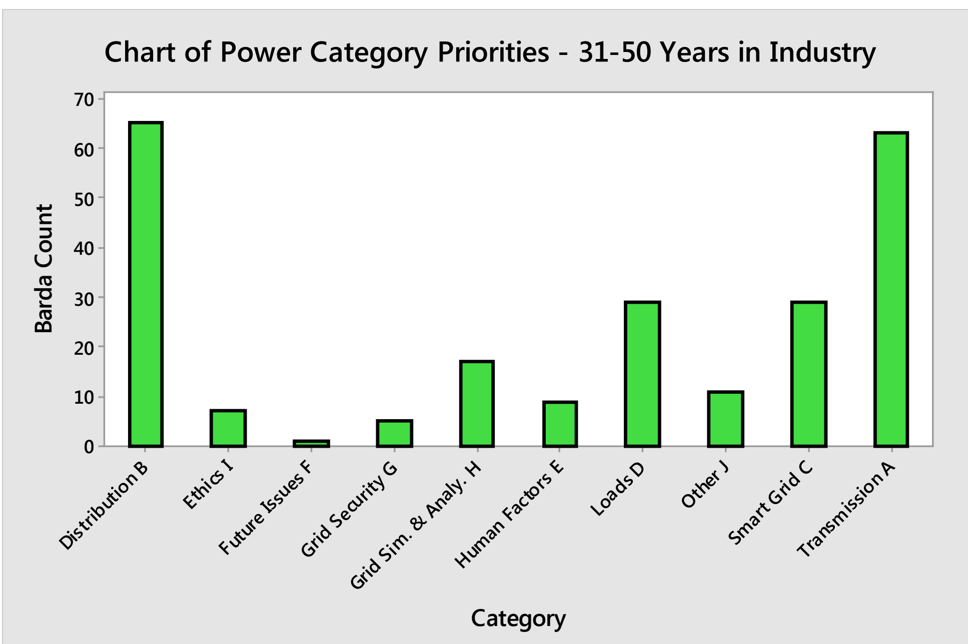

Figure 15 Modified Borda Count of Category Priorities - 31-50 Years in Industry Respondents

Inspection of these results show few differences. All relative priorities are very close except Smart Grid is not higher than Loads for the 31-50 Years subgroup. In addition there is a noticeable difference on Future Issues among those of the 0-15 Years subgroup, which could be expected since they comprise the group with the potentially longest professional future! Overall, however, consistency among these three subgroups is the most remarkable trait. At least among this sampling, years in industry is not a significant factor.

Open Ended Questions

I asked a set of open ended questions to further glean from the accumulated wealth of wisdom and experience represented by these participants. I hoped to obtain practical advice that could be used to enhance an introductory power engineering class. I was seeking to gain further insight into how to optimally structure the content of such a course. Following are the questions posed.

1. **Name two practical power engineering skills you feel should be taught in an introductory course by receiving instruction from practicing engineers or at least by thorough class instructor coverage. These skills may not be traditionally taught in an introductory course, but nevertheless in your view are important, especially if the introductory course may be the only explicit power engineering course they take. Also please explain why you view them as important. Examples may be: substation design, transformer design, customer installation procedures, grid control and management, generator maintenance, etc.**
2. **What topics should be de-emphasized in an introductory course?**
3. **Describe what 'soft skills' related to power engineering are most important. The definition of a soft skill is one used on the job that does not primarily involve the application of technical knowledge and skill. Examples could be written communication, oral communication, teamwork, time management, reliability, innovation, creativity, initiative.**
4. **Please provide any other comments you would like to make regarding the content and management of an introductory undergraduate power engineering course**

Responses to questions

Following is a synopsis of the answers to these questions.

1. <u>Practical Skills</u>: Virtually all respondents made contributions this question and the answers were quite diverse, yet some trends could be discerned and distilled to several themes: (1) Substation design, (2) Protection, (3) Three-phase basics, (4) Transformers design and analysis, (5) Codes and Standards, (6) Grid control and Analysis, (7) "Big picture" understanding of the overall power provider system from start to finish. These reflected the sentiment that at least somewhere in a course students could be led to dig below the theoretical/general concepts levels and be exposed the actual details of how practicing engineers address these topics. This list provides a rich list to choose from when designing a course. The three most cited skills were: (1) Protection and Protection Modeling, (2) Substation Design, (3) Grid Control, Modelling, and Analysis. In response to this question there were 51 separate skill suggestions via 138 total skill citations. This was very valuable input. I ordered a resource book and looked more into NEC/NESC as a result.

2. Topics to Deemphasize: This was another rich resource, although with fewer responses – a total of 51 citations. The most cited topics were: (1) Smart Grid and Renewables, (2) Smart Grid driven demand side management, (3) Grid Security, (4) Generator Maintenance, (5) over emphasis on theory versus rule-of-thumb practices. Some significant messages via the comments are worth mentioning. The was a sentiment expressed that the course should not be so heavy on theory and technical detail (e.g. harmonic analysis, relay settings,) that students get turned off to the topic. Coupled with this was the idea that there are numerous practical and interesting things to learn that are not as mentally taxing yet are imminently valuable for the practicing engineer and would better maintain student interest. As one person said "KEEP IT FUN!"
3. Soft Skills: This question garnered much interest, with a total of 176 citations. Forty six percent of these dealt with communication skills, 29% with teamwork skills, and 25% with time/organizational/project management skill. It was clear that soft skills are viewed as highly important and somehow should get emphasis as part of student education. This is not necessarily a new revelation, but does confirm how strongly this thought is carried by those in the profession. However, these skills are best developed as part of an overall departmental and curricular priority rather than in a specific class or two. In this sense, crafting an academic culture that values and provides a rich experience set for developing such skills is warranted.

4. Any Other Comments: There were a total of 61 comments in answer to this question, more than is practical in this paper. With the exception of two that were multiples of the same thing, all were unique among the results. With ten citations was a comment recommending that students be exposed to the practical applications power engineers typically do in the field and the shop, spanning T & D, Generation, Rotating machines, transformers, wind and solar. The second multiple mention with three was advice to make sure students are exposed the overall aspects of the entire energy system, as has been mentioned previously (item (7) in Question 1). There are too many to list all here.

Following is a sampling of what respondents contributed: simple protection overview, student interaction with industry professionals, substation design, distributed generation, per unit calculations, minimize renewables emphasis but have some to create interest, awareness of codes, appreciation for the vital important reliable power is to society, be solid in basics, benefits of the PE licensure, key power simulation software, deeper understanding of real and reactive power, understanding how outages work and how they are handled, integration of generation and transmission knowledge, system planning and design, use intro course as 'marketing tool' for subsequent classes, business case exposure, limit detailed theoretical analyses, construction standards and standard conductors, dealing with a wide spectrum of difference people, team skills, career guidance, use research and design projects as part of class. Taken as a whole, this collection offers much food for thought! Open-ended comments can give valuable indications of the state of the system and what professionals may be thinking. It can serve as a reality check for those in academics.

Power Engineering Personnel Needs

Next questions regarding their viewpoints on what the immediate need and near term (with five years) needs were for filling power engineering positions.

1. **Please respond to the following: I am concerned about the power industry's ability to replace those leaving the profession through retirement and other reasons.**
2. **Presently we need to fill _____ power engineering job positions**
3. **Within the next five years, we expect we will need to fill ____ power engineering job positions**

Below are charts showing the results from these questions. Figure 16 reflects the results of Question 1. Eighty-six percent marked either "Concerned" or "Very Concerned." This is curious in light of the demographic data collected here. Yet, in reading additional anecdotal reports from this sampling group, and counting the reported needs, it indeed looks like a large need. Figures 17 and 18 show the immediate and within five years reported power engineering personnel needs. The answers to the jobs openings questions (immediate and within five years) varied quite a bit and some were not precisely quantitative (e.g., "dozens"); however, my review reveals an estimate of about 185 immediate needs and approximately 450 within the next five years. This comes from 42 individual power supplies our region. According to the United States Department of Labor Bureau of Labor and Statistics, as of 2014, there are an estimated 9,000 power engineers employed in the states of Washington, Oregon, Idaho, and Alaska[15]. I cannot provide a similar number since I only tapped portions of Montana and California. How many may be represented in these portions is difficult to determine.

Nationwide, about 10% of all electrical engineers work in the power industry. If the same ratio holds true for the Pacific Northwest, then we should have about 900-1000 power engineers. The reported estimated number of power engineers among the 42 queried power entities seems to be comparable. That would mean that I got responses back from approximately 7-8% of this population. Yet in light of this, the 450 estimate for positions to be filled in the next five years may seem unrealistic. However, this may reflect that future positions are not just replacements but indicate a growing need.

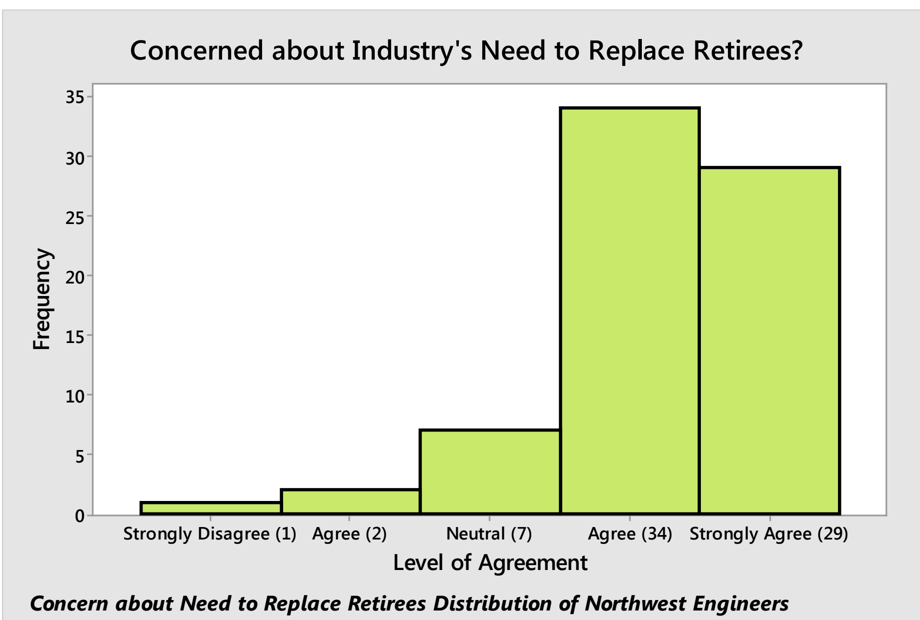

Figure 16 Concern about Need to Replace Retirees

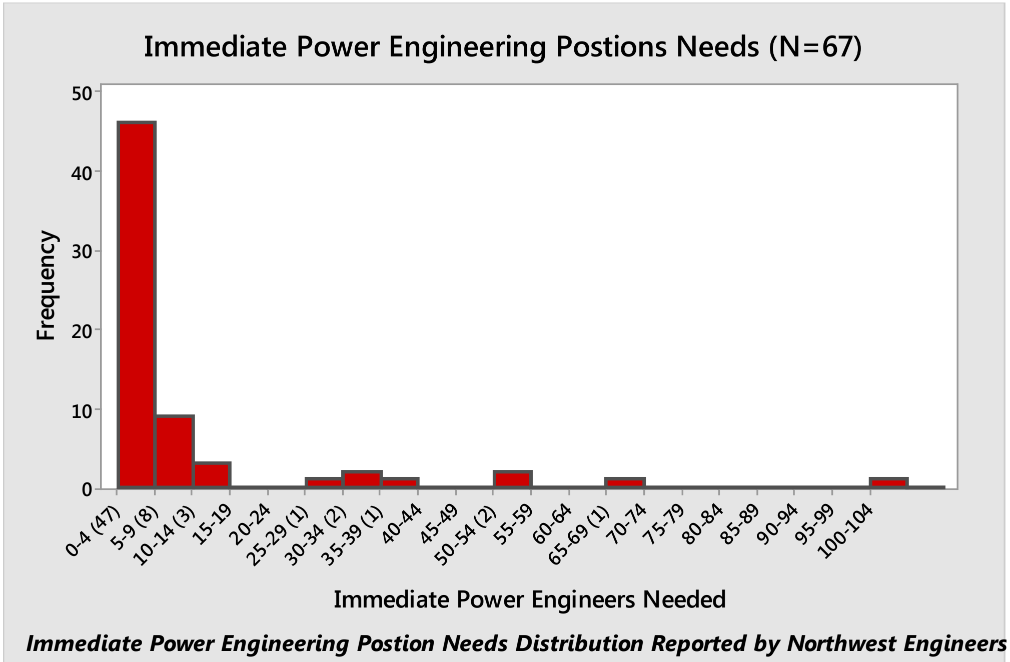

Figure 17 – Immediate Power Engineering Positions Needs

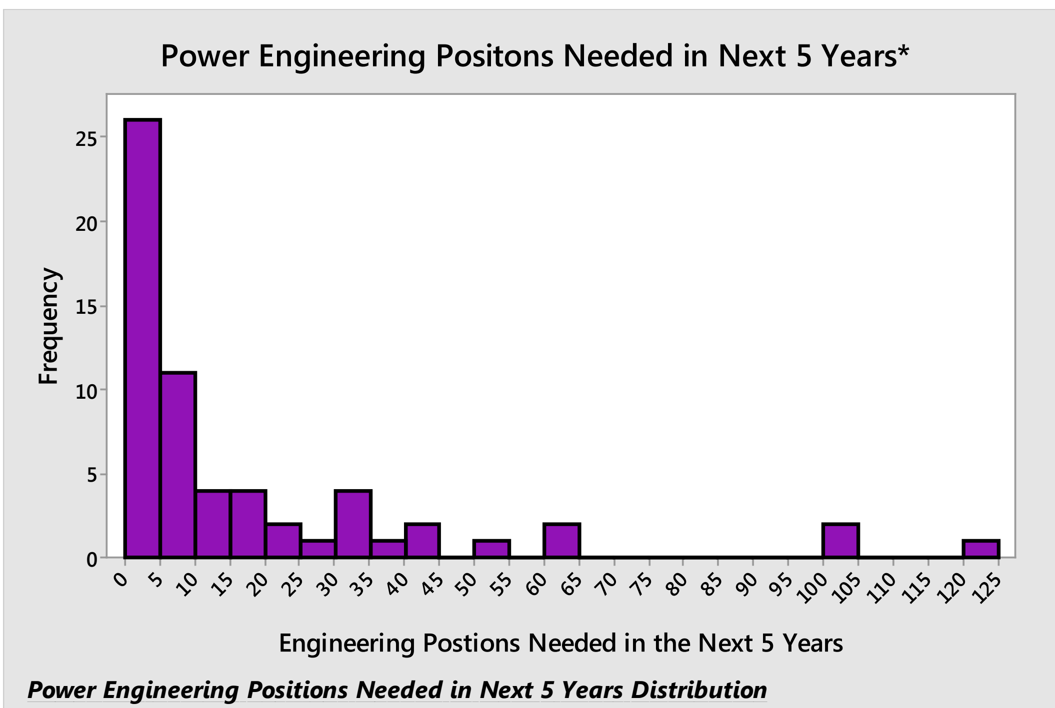

Figure 18 – Power Engineering Positions Needed within Five Years

Smart Grid

There is much discussion and work being done in recent years regarding the electric power infrastructure changes needed to make the power grid more efficient, reliable, and secure. Academic, industrial, and government entities are all addressing this in various degrees. Consequently, I was interested in seeing what level of interest there might be in a follow up survey that could address this topic on its own. Below is an inquiry I included in the survey to gauge that interest.

The so called 'Smart Grid' has in recent years been receiving growing attention among stakeholders in the power industry, both domestically and globally. This has been manifested in such areas as transmission, distribution, monitoring, control, standards, and regulation. The level of power supplier activities related to Smart Grid applications appears to vary widely across the Pacific Northwest. In order to obtain a more precise understanding of the status of these Smart Grid activities, would you be willing to participate in a follow-on survey that would explore the extent of Smart Grid activities in this geographic area?

The 'Yes' response rate was 42 / 73, or 58%. This indicates that such an endeavor could be worthwhile. Feedback on this topic could not only be useful for getting a sense for what is happening now to garnering practical advice on how to introduce it in academics.

I asked who would be willing to receive follow up contact on content of this survey, and in this case received about a 60% response rate.

Conclusion

What worthwhile knowledge can we take away from this survey? The two fundamental goals of this survey was to get a sense of the state of the power engineering field in the Pacific Northwest region of the United States and to solicit valuable feedback from a sampling of these people on what they deem most important to include in an introductory course in power engineering. Even with the limited scope of the sample, I believe that these two goals have been met.

The combination of the written survey results, as well as numerous phone conversations have given me confidence that these findings have credibility as to the state of the profession and the type of things that can be of significant value to those like myself who hold up the academic end of this vital partnership in preparing young professionals an industry so vital for the health of our society.

Certainly this is not the end of the story. This study has raised questions regarding the alleged expected shortfall in qualified younger professionals to fill the ranks of those who are retiring or moving on to other careers. Is the need really as acute as some believe? The data collected in this survey is inconclusive. There are more younger and middle-career power engineers among my sample than I was expecting. Even though this survey showed a notable concern about being able to fulfill the need for new engineers in the next few years (Figure 16), the rest of the results are not necessarily consistent with that. No doubt some of the respondents have an accurate understanding of the real needs, it is also possible that some responses were offering an educated guess.

Regarding course content, this work has provided what I believe is invaluable perspectives on how an academic course, limited as it is, can best serve the needs of students and industry alike.

Emphasis on fundamentals is paramount as well as exposure to some of the less theoretical, practical skills that are required every day. For example, what really are the specific tasks, skills, and management practices need in substation design? In other words, what do engineers really do, and in what order, etc.? The need to equip students with the 'big picture' is important. We also should not kill their enthusiasm for the profession with too much emphasis on theory over against rules-of-thumb and practical knowledge of Codes and Standards, because everything is built to code in this business.

We should make it our goal to inspire as well as inform. We also need to keep in view the reality that 'soft skills' related to the non-technical dimensions of the profession can be just as vital to success. This includes the people skills of communication and cooperation (teamwork). Much valuable advice was uncovered in this study and I am very grateful for the generous contributions all of the busy, dedicated, and hardworking power engineers of our region who have shared their wisdom with me. Some who did not end up participating did not do so through lack of interest, but due to very heavy work responsibilities at the time the survey was available. Many have expressed the willingness to be engaged further in this partnership by more conversation, which I hope to do.

Acknowledgement

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