A New P. E./EE Exam Model Of The Future

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ABSTRACT: *The vast majority of unregistered engineers of a single discipline in the U.S. are Electrical and Electronics Engineers working in industry, the paper shows how the current NCEE administered P.E. exam favors engineers working in the power industry. The paper points this discrepancy out factually and establishes a New PE exam model of the future, based upon the 1972 IEEE National membership disciplines of major technical specialties.*

COMPOSITION OF ELECTRICAL ENGINEERS IN THE UNITED STATES

Of some 1,208,000 engineers [1] in the United States, there are approximately 400,000 who are registered Professional Engineers, [2] while the remaining 808,000 are not registered. According to the NCEE 1972-73 yearbook, only about 10% or 121,000 engineers are actually required to be licensed, the remaining 1,087,000 being exempted under provisions of the law based on certain restrictions [3]. Nevertheless some 279,000 engineers have taken it upon themselves for a number of reasons to become registered over and above the 10% who are required by law to do so.

With the advent of new Federal laws which created the Occupational Safety and Health Act (OSHA) [4] and the Consumer Product Safety Act (CPSA) [5], among others, it is the author's thesis [6, 7, 8, 9] that any engineer in any phase of employment where he functions as an engineer under either OSHA or CPSA, should be required to be a resistered PE.

Only by the utilization of qualified licensed PE's in these positions bound to a code of ethics by law can the real purpose of engineering registration and that of OSHA/CPSA be effectively achieved through enforcement, that being "the protection and safeguarding of the health, welfare and safety of the general public by preventing the introduction into working environment and the general stream of commerce of equipments and products improperly designed, or manufactured."

Composition of Electrical Engineers in Florida: Here in the State of Florida in 1970 there were 30,692 engineers [10], 2.5% of the total 1,208,000 engineers in the U.S. Of this amount, 9,093 [10] or 30% are classified Electrical/Electronic Engineers of which some 4,100 are members of the Institute of Electrical and Electronics Engineers (IEEE) in 11 Florida Chapters. The IEEE, by the way, is the largest engineering society in the world having over 120,000 members in the U.S. alone. Using the Florida data on IEEE members as a sample of all Florida Electrical Engineers would approximate the United States EE:s at more than 300,000 roughly 25% of all the engineers in the U.S.

The Electrical Engineering discipline represents the single largest size group from which new prospective registered Engineers might be recruited. Based upon an IEEE national membership survey [11] which showed that roughly 25% of all IEEE national members were registered P.E.'s, this would size the unregistered PE's to be 225,000 nationally. In the State of Florida, the registered PE's who are IEEE members was verified to be about 20% in Central Florida [12]. Therefore, in this state there are roughly 7,250 EE's NOT registered, while some 2,843 are. Comparing this 7,250, unregistered EE's to the total membership of the Florida Engineering Society's 2,688 members [13], shows them to be 2.7 times the size of the entire FES. Refer to Table 1 for a summary of above data.

It is further important to recognize that while FES traditionally has been associated principally as servicing the consulting Engineers in Private Practice, of which there are 1081 of the 2688 FES members or 40%, nevertheless the number of FES member engineers in indistry surprisingly total 973 of the 2688 or 36% of the total FES membership. Now, if one were to assume that the private practice consulting engineers in FES represent the vast majority of those in Florida, since registration is of a greater necessity to a consulting rather than an industry engineer at present, then FES and the SBPELS [14] must look to other than the consulting engineers for realizing any substantial growth of the P.E. ranks.

It is the author's subjective conclusion that FES and SBPELS must look to the engineers in industry for new member growth and specifically must look to the largest block of non PE engineers in the state of Florida, sized previously at being 2.7 times the present entire FES membership, or 7,250 unregistered EE's tha vast majority of which are in industry. Bear in mind that both FES and SBPELS have a public service duty to seek out these unregistered PE's and to motivate them to become registered in order that the OSHA and CPSA safety objectives can be realized.

1973 NCEE PE/EE OVERLY EMPHASIZED POWER

It is the author's contention that while the current registration of Professional Engineers is a necessity, and that the standardization of registration laws, reciprocity, and 100% use of the NCEE administered PE exams are to be supported, nevertheless constructive criticism of the NCEE PE exam for electrical/electronics engineers in particular is warranted.

As a brief prelude, the author took the steps 10 years ago toward becoming licensed upon accumulating the required 4 years post EIT experience; at that time, a review text was purchased and upon seeing its over emphasis of the power "electrical" discipline, he was turned-off from going further because his practice was in electronics and not power. Interestingly enough, the author was examined on November 2, 1973 by the State of Florida SBPELS for the PE license after gaining additional maturity and having an expectation that 10 years later the PE exam would be representative to all EE disciplines as the newest review texts [16, 17, 18] advertised it would be.

The exam given on November 2, 1973 was the NCEE exam, now used almost universally throughout the US. Based upon that exam, the author and a close working associate, who also took the same exam, have concluded that nothing really had changed over the 10-year period since 1963, and that if future NCEE PE exams for EE's in industry continued to be the same heavy weighted "power" type problems, the vast majority of the 7,250 unregistered EE's in industry will continue to be turned off.

SBPELS and FES will not grow in PE members and service to the public and support for implementing objectives of OSHA and CPSA will be retarded. Now, let's look closer at the NCEE exam and how it must be changed to be made more relevant to the vast majority of unregistered electronics engineers, not only in the State of Florida, but across the U.S. as a whole, if we are to succeed in motivating them to become registered for protecting the public safety.

IEEE Member Disciplines Versus NCEE P.E./EE Exam Questions: Analysis of IEEE's national membership discipline profile, the 1973 NCEE/PE/EE exam, and several PE/EE review texts reveals the discrepancies which still exist in the PE examination of electrical and

electronics engineers in industry. The author analyzed these data and compiled them in Table 2 for easy comparison.

First, let's look at the composition of the IEEE membership of over 120,000 engineers in the United States. According to the IEEE 1972 membership survey [19], which was computed to be 95% accurate based upon a 35.8% sample size of 43,471 respondants, the proportion engineers who classified their major discipline in electrical engineering is as shown in Table 2 Column 1. This is arranged in decreasing order by size. The percentage size of each discipline is shown in Column 2. This says that 24% are engaged in power, 15% in Aersopace and Electronics Systems, and so on. By distributing ¼ of those in Engineering Management to Power, making it say 30%, then the balance, or 70% classified themselves are not working in power as their prime discipline. Also, it says that roughly 30% are engaged in communications and computers combined (16 and 13% respectively), which are the *fastest growing disciplines.*

Now, on the other hand, if you look at Column 3, this shows the distribution by percentage of the problems contained in the November 2, 1973 NCEE PE/EE exam by discipline. This graphically illustrates the imbalance which the present PE exam possesses. Power problems represented 53.3% of the total test (compared with a 24% IEEE member distribution working in that field). There were no problems in the Aerospace and Electronic Systems discipline (IEEE members account for 15%). Engineering management ahd 6,7% problems (IEEE is 15%). Communications contained no problems (IEEE members are 14%). Circuits had 26.6% (IEEE at 11%). Computers had no problems (IEEE at 11%). Finally, controls had 13.4% (IEEE at 10%). It is interesting to note that at this test in November, while there were no computer questions given, nearly 90% of all candidates being tested were using the latest electronic digital calculators instead of slide rules, all plugged into power drop cords along the aisles. (While the test wasn't representative of the state of the art, the candidates' equipment being used in the exam was; this was somewhat humorous to the author to observe.)

Now, let's go a little further. Column 4 is a profile of what an NCEE pamphlet [20] explained would be the profile and size of the typical questions to be expected. Here, the main discrepancies are in power (53.3% to 35%), Communications (5% to 20%), Circuits (26.6% to 15%). Even here too, the NCEE typical questions profile does not correlate well with the IEEE membership profile, especially in Power (24% to 35%), Aerospace (15% to 0%) and Computers (11% to 0%).

Now let's look at Column 5, which is the profile of the PE/EE questions compiled in California for the period 1960-71 [21]. Comparing the actual exam to Column 5 shows a discrepancy in Power (53.5% to 40%), Communications (0% to 20%), Circuits (26.6% to 10%) and computers (0% to 10%). Here again, comparing IEEE to Column 5 shows these discrepancies; Power (24 % to 40%), and Aerospace (15% to 0%). Actually, the California profile is the only one to include computers, and matches fairly close for 5 disciplines comparing to IEEE.

The last comparison is based on Column 6. This is taken from a new text [22]. Here, generally, discrepancies are found in Power, Aerospace, Communications, Computers and Controls. This data was a compilation of 200 recent PE/EE problems. The NCEE exam did overemphasize power, did not address Aerospace, Communications or Computers, and overemphasized circuits.

It was interesting to observe in the NCEE 1972-73 Yearbook page 197, the following remarks: *"The apparent poor performance of electrical engineers in the Principles and Practice examination was investigated and believed resolved with a change in scoring practices."*

This is treating the symptoms and not the cause. The test questions themselves are the problem, and until they are updated to reflect the disciplines which the vast majority of engineers are found working in, not only will the scores be low but the number of candidates applying to become registered will continue to be turned off.

A RELEVANT PE/EE EXAM MODEL OF THE FUTURE

Now, let's construct a model of the future for guiding the selection distribution of exam questions. Let us agree that we should use the profile of the IEEE national membership of disciplines as the base. Therefore, making use of the percentage figures given in Table 2, Column 2, as that profile, and using 20 questions to be the maximum contained on a NCEE PE/EE exam, the breakdown would be given in Table 3.

Here, in the Model of the Future, the prospective candidate for registration would expect to see no more than 5 Power questions, exactly 3 questions each in Aerospace, Engineering Management and Communications and 2 questions each in Circuits, Computers and Controls, for a total of 20 to choose 8 from.

Now, let's see how this might work. First, let's assume we're considering the non-supervisory level engineer; one with between 4 and 10 years experience. He would be expected to work the problems contained in his discipline's speciality as stated on his PE application form. This would range between 2 to 5 questions. Then while he might be capable of working some of the management problems, he more likely will be proficient in an allied technical area, such as controls, circuits, communications or even power. From this range, he would be expected to pick 8 total problems and work them.

On the other hand, let's say the candidate has over 10 years experience, is working in a supervisory or middle management level position, and he approaches the PE exam. He would be expected to work the Engineering Management problems of 3 each, plus be proficient enough to work 5 more from the related technical disciplines.

Now, let's look at the Power discipline itself. One might argue, Power is Power and has nothing in common with Communications, Computers, or Controls. From first hand experience [23] the author will vigorously argue "No! You are wrong." From familiarity with the Bonneville Power Administration and the Florida Power Corporation's generation, distribution and control network systems, the author can state factually the following:

1. Generation and long line distribution is still a fundamental power discipline.
2. Control today is based upon computerized remote sensing, telemetering via microwave communications links, local display loop remote control via manual/semi-automated computerized control, telemetry and loopback verification.
3. The total power engineers need to be knowledgeable in all of these disciplines as well.
4. Conversely, the other disciplines today must be knowledgeable in each other's disciplines as we move towards tying more and more equipments together to make ever increasingly complex systems.
5. In the end, the power and communications/computer disciplines end up approaching the total systems disciplines found in category 2, that being Aerospace and Electronic Systems.

CONCLUSION

Today's power weighted NCEE PE/EE exam is proposed to be replaced by a Model of the Future. This provides a better balance of questions keyed to the major technical disciplines of the 1972 IEEE National membership survey.

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