

Characteristics of Training in Civil Engineering Firms

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Abstract

Experiential learning is an imperative process in the professional development of recent civil engineering graduates. Over the past 50 years there has been a reduction in the number of college credit hours required to receive a bachelor of science degree in civil engineering. The reduction in credit hours causes a reduction in Civil Engineering based courses which requires employers to provide additional training. Increasing complexity and specialization of civil engineering work also adds to the urgency of on the job training. An online survey was conducted to explore the processes used by employers to educate recent civil engineering graduates and to determine the length of the training process. The survey looked at formal (classes and seminars) and informal (mentoring or coaching) training methods. The survey shows that 51% of the respondents received only one year or less of post graduate training. The plurality of the training, approximately 39%, is strictly informal. Results from the survey shows that 55% of respondents believe that on-the-job training somewhat or very much helped with passing the Professional Engineer's (PE) or Structural Engineer's (SE) exam. One surprising fact of the survey is that 16% of the respondents did not receive any informal or formal training. The top three areas where graduates are receiving training is structural analysis and design software, learning to read and interpret design drawings, and the use of BIM software. The areas receiving the least training is CAD software, developing writing skills, and oral presentation (communication) development. The results of the survey indicate that many companies need to evaluate their training program and make the necessary improvements to increase the recent civil engineer's potential for professional development.

Keywords

Mentoring, coaching, training, civil engineering

Introduction

When does the education process stop, or better yet, when does learning stop? Most engineering students believe their education stops the day they walk across the stage and receive their diploma from the prestigious university. Then reality sets in when they start their first job after graduation. They quickly learn about the concept of on-the-job training. Perhaps Jeffery Russell states it best: "Engineering is a profession in which learning occurs continuously."¹

In the past 50 years college credit hours that are required to graduate with a bachelor's of science degree in civil engineering (BSCE) have been decreased. The total credit hours in the 1960's were approximately 150 hours while today the average is around 125 credit hours². This reduction in credit hours forced most civil engineering programs to cut engineering courses: additional on-the-job training is required to fill in the areas that were not covered in college. The

students graduating from college still need to learn until they will be ready to work without significant guidance.

Numerous studies and articles suggested the changes that college engineering programs need and what these changes brought. Few studies have focused on training entry-level engineers. The most useful research (conducted in the mid-1990's with a paper survey mailed to approximately 80 engineering firms in Anchorage, Fairbanks, and Juneau in Alaska³) only had 39 responses but was able to show that entry level engineers need improvement in communication skills, construction practice, project management and attainment of internships. Another study⁴, which looked at training of entry-level engineers, based all of their conclusions on the data collected by Kinney & Ra and focused on teaching styles used to train entry-level engineers.

This paper summarizes the training which engineering graduates take to make the transition from college to industry, whether formal or informal, how this training helps them with passing the PE and SE exams, and whether companies provided different training based on their size. The purpose of this survey was to determine if recent graduates are receiving the necessary training and if they are not what can be done to correct this issue.

Survey

An online survey consisted of twelve simple questions to learn more about the training that recent engineering graduates received during their first four years after graduating from college. Each question was designed to extract specific information on the training that was provided or not provided.

The survey was e-mailed to over one hundred colleagues as well as being posted on professional social media websites (1,200 to 83,000 members) for ten weeks. Based on the limited responses that Kinney & Ra received for their research, the authors believe that using an online survey is a method to reach a broader audience and increase the number of responses.

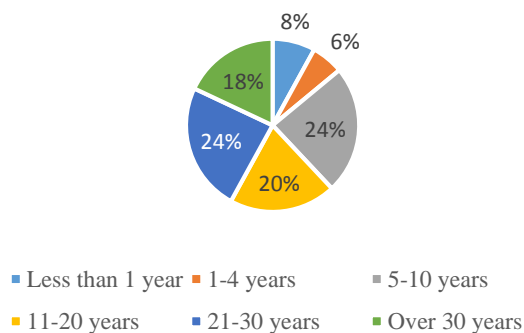
The respondents to the survey covered most of the United States from the East Coast to the West Coast and from the North to the South.

Results and Analysis

The survey received a total of 52 respondents. While the number of responses was less than initial expectations, the data provides enough information to show a trend in training.

Figure 1 shows the years of experience of the respondents to this survey. The majority of the respondents (62%) had over 10 years of experience while only 14% had 4 years or less experience. Most the respondents had bachelor

Figure 1 - Years of Experience

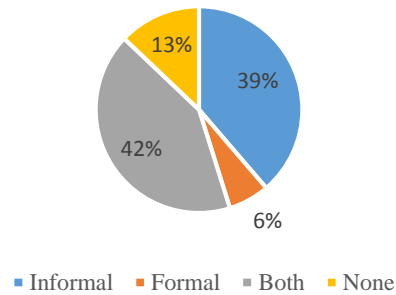


of science degrees (58%) while the remainder of the respondents had master of science degrees. None of the respondents had a master's of business administration or a doctoral degree.

What type of training are recent graduates receiving? Is it formal, informal, both or no training at all? Formal training would be a defined training curriculum such as attending a seminar or online course. Informal training would be the training received from asking questions or instructions provided by a senior engineer at the beginning of a task or project that one is not familiar with. Informal training is most closely described as mentoring (or coaching).

Figure 2 shows the majority of the training (81%) that respondents received is strictly informal or both informal and formal. Formal only training only accounted for 6% of all the training types. One surprising fact is that 13% of the respondents did not receive any form of training. This seemingly goes completely against the basic tenants of a successful business.

Figure 2 - Types of Training

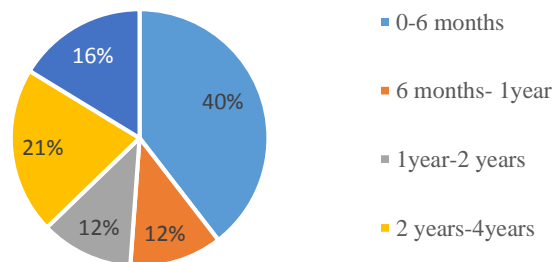


Informal training, as shown in Figure 2, is a key component of one's engineering training after graduation. Mentoring or coaching allows a recent graduate to work one-on-one with an experienced engineer⁵. In the mentoring relationship, the recent graduate is exposed to new concepts and ideas. They are also able to ask questions and learn to develop brainstorming techniques as well as be part of a team¹.

During mentoring or coaching, it is critical for the senior engineer to have great listening skills, give praise, make recommendations for improvements in a non-condescending manner, lead by example, and clearly communicate. Unfortunately recent studies show that this is not the case for companies in the United States. The surveys show that most (60%) managers/mentors⁶ did not have the skill set required to be an effective coach. If coaching is one of the most widely used methods of training recent graduates but the coaches are not equipped to be a mentor; then how effective is the informal training?

The survey shows that no matter the type of training received, 52% of the training lasted one year or less (see Figure 3). Is one year or less of training adequate for a recent graduate? Ideally mentoring should be a process that lasts more than one year. In fact, it would be wise to have a mentor who can provide wisdom and a second opinion throughout one's career.

Figure 3 - Years of Training



The length of training, whether formal, informal or both, is shown in Figure 3. The length of training data for respondents with 4 years or less of work experience was removed so as not to skew the data. The data shows that 21% of the respondents received training for up to 4 years. The biggest surprise is that 16% of the respondents with more than 4 years of work experience stated that they did not receive any training.

The top three areas where graduates are receiving training is structural analysis and design software, learning to read and interpret design drawings, and the use of BIM software. The three areas where training was least provided is CAD software, developing writing skills, and oral presentation development. A study of managers/mentors showed that 60% were not effective communicators (written and verbal)⁶. This could explain why an emphasis is not placed on written and oral communication.

The focus on communication skills is important in the business world; however, it appears that recent graduates are lacking this skill. More than 60% of employers note that recent graduates are lacking in soft skills such as communication⁷. The problem is perpetuated with mentors/coaches who are also lacking in this skill. How can a skill be taught when the one doing the mentoring does not possess this skill set?

The next question to ask is, did the training that recent graduate receive help them with the passing of the Professional Engineers (PE) or Structural Engineers (SE) Exams. The results from the survey shows that only 55% of respondents believe that the on-the-job training somewhat or very much helped with passing the exam. Per NCEES website “The PE exam tests your ability to practice competently in a particular engineering discipline. It is designed for engineers who have gained at least four years’ post-college work experience in their chosen engineering discipline.”⁸

The type of training, whether formal or informal, was found to depend on when the respondent graduated. Informal only training was much more likely to be provided to civil engineers who graduated more than 5 years previous (94% versus 6% for recent graduates). Formal only training was evenly provided to recent graduates and graduates who have been graduated more than 5 years. Only 16% of those who received both informal and formal training were recent graduates. It appears that recent graduates are receiving more formal training (combined with some informal training) as compared to those who have been graduated more than 5 years. It is clear that informal training has been the chosen method of training in the past.

The size of the firm does shape the type of training received. Some 80% of the formal only training was with firms that had more than 250 employees. It is probably easier for a larger company to develop a formal training program or to pay for external training than a small firm. The American Council of Engineering Companies defines the sizes of engineering firms based on the number of employees⁹, and a small firm is defined as a firm that has 1 to 50 employees. Small firms also make up 66% of the total engineering revenue in the United States¹⁰. Unless graduates go to work at a large firm, it is unlikely they will receive formal only training.

Does the location in the United States dictate the type of training a recent graduate will receive? It may or it may not as all the respondents did not provide a ZIP code; therefore, their location

could not be determined. There was not enough data to make decisive conclusion on location versus training.

The type of degree does make a difference in the type of training received. Figures 4 and 5 show that a Master of Science in Civil Engineering (MSCE) degree graduate will more than likely receive informal only training than a Bachelor of Science in Civil Engineering (BSCE) degree graduate. The BSCE graduate will have a higher probability of receiving both informal and formal training.

Figure 4 - MSCE Degree - Types of Training

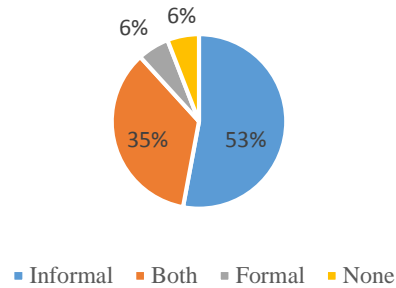
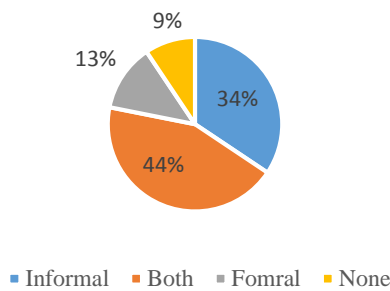


Figure 5 - BSCE Degree - Types of Training



Conclusions and Recommendations

The survey provides a portrait of how recent graduates are being trained. With today's "I've got to have it now" mentality, many employers have bought into the idea that college can and should completely prepare recent graduates for the workforce. With the changes that have occurred at the university level, especially with the decrease in credit hours required to graduate with a bachelor of science degree, it is imperative that business owners realize that they must assume more responsibility and make changes in their training of recent graduates. Only so many changes can be made at the academic level and the changes that industry would like universities to make would take years to incorporate or not be achievable at all.

Additional research is needed to fully understand the training process that recent engineering students are being provided on the job. A more in-depth look on the type of informal training would be one area to focus on in the next survey. It would be of great benefit to have a larger data set to work with but based on the results of this study, it is extremely difficult to get people to respond to a survey.

Based on the results of this survey and past experience of the authors it is recommended that companies evaluate how they are training recent graduates. Does the training provide the

technical experience required for the PE or SE exam as well as training on soft skills, specifically oral and written communication? Do the supervisors or senior staff have the skill set to provide mentoring?

The next step would be to develop a mentoring and formal training program. Mentoring is still one of the best ways to provide guidance, knowledge, and understanding on a subject. The formal training allows for in-depth training into a specific area that the mentor may not have knowledge or the time to go over. The formal training could be from outside sources such as professional societies and industry groups. This allows smaller engineering firms the access to specialized skills.

Universities are limited by program requirements and state boards on higher education on adding credit hours to a curriculum but they could offer certification and training programs that would assist in the training of senior engineers on how to be better mentors/coaches.

The educating and training of recent engineers is critical to the profession and to the protection of society. If engineers are not provided with the appropriate training, then the profession suffers and society is put at risk with substandard designs.

The following quote from the famous martial artist Bruce Lee is great advice for all engineers: “Learning is never cumulative, it is a movement of knowing which has no beginning and no end.” Never stop learning.

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