Preparedness of Civil Engineering Technology Graduates for Design Careers

Dr. Harry G Cooke P.E., Rochester Institute of Technology (CAST)

Dr. Harry Cooke is an associate professor in the Civil Engineering Technology program at Rochester Institute of Technology where he teaches courses in geotechnical engineering, construction materials, pavements, and mechanics of materials. His research interests include geotechnical engineering, civil engineering materials, and engineering education.

Mr. Todd Dunn, Rochester Institute of Technology (CAST)

Todd Dunn, P.E., is an associate professor in Civil Engineering Technology at the Rochester Institute of Technology.

Prof. Scott B. Wolcott P.E., Rochester Institute of Technology

Preparedness of Civil Engineering Technology Graduates for Design Careers

Abstract

Over the last decade there has been growing debate about whether baccalaureate programs in civil engineering technology, accredited by the Accreditation Board for Engineering and Technology's (ABET) Engineering Technology Accreditation Commission (ETAC), are graduating students who are prepared for civil engineering design careers and professional engineering licensure. The debate has been accentuated by a comparison of these graduates to those from baccalaureate civil engineering programs accredited by ABET's Engineering Accreditation Commission (EAC). This comparison has become more intense with the establishment of the "Body of Knowledge" for civil engineering and the "Raise the Bar" initiative for professional licensure, with the associated BS + 30 requirement for licensure eligibility. ABET itself distinguishes between "technologists" who graduate from ABET/ETAC accredited baccalaureate programs and "engineers" who graduate from ABET/EAC programs.

The objective of this study is to look at the preparedness and ability of graduates from one large civil engineering technology baccalaureate program to pursue design careers and professional engineering licensure compared to their civil engineering counterparts. An assessment of this issue is made by using a survey to obtain the impressions of employers/supervisors at local civil engineering design firms who have experience with both groups of graduates. The survey is designed to ascertain the employers/supervisors impressions of the differences between the civil engineering technology and civil engineering graduates in terms of their (1) positions and responsibilities within the company, (2) technical skills and knowledge when they are first hired, (3) overall engineering design abilities, (4) ability to develop the skill sets needed to become a professional engineer, and (5) potential to assume managerial responsibilities.

Based on the results of the survey data, informed observations are made concerning the readiness of one group of civil engineering technology graduates to pursue careers in civil design compared to their engineering counterparts. These observations may, in turn, shed some light on whether there can be parallel pathways for becoming a civil engineering designer and a licensed professional engineer.

Background

Ever since the split of the "engineering" discipline in the mid-1950's into engineering technology and engineering, there has been debate concerning the place and purpose to be filled within the engineering profession by graduates of Bachelor of Science (B.S.) engineering technology programs. The debate centers around whether the B.S. engineering technology graduates can and should fill the same roles in the engineering profession as graduates of B.S. engineering programs or, alternatively, the engineering technology graduate should serve as a "technologist" who provides support to the engineering graduate and handles more routine design work and tasks. As explained by Grinter[1] and Kelnhofer et al[2], B.S. engineering technology programs were typically designed to have a more practical, applied approach to

teaching engineering compared to B.S. engineering programs that were designed to have a more theoretical scientific approach to teaching the subject. However, Kelnhofer et al state that although different organizations, such as the National Society of Professional Engineers (NSPE) and Accreditation Board for Engineering and Technology (ABET), may draw distinctions between engineering and engineering technology, in reality both disciplines "have common roots and common goals via different educational paths". They go on to say that, after completing their B.S. degrees, graduates of both programs are ready to pursue the same basic career challenges and responsibilities in the engineering profession.

In an effort to substantiate that engineering technology graduates can and do fulfill similar functions in the engineering profession as engineering graduates, Land[3] obtained survey responses from 200 individuals at companies affiliated with engineering technology programs across multiple disciplines. One-hundred-seventy-three of the responses came from companies that employ both B.S engineering technology and B.S. engineering graduates for their engineering workforce, while the remaining responses came from firms that only hired engineering graduates. For the companies that hired both graduates, Land found that "both engineering and engineering technologists are given similar consideration for most engineering roles". The only exception was in the more senior design and research engineer positions. But even in filling those positions, the difference was not large between the percentage of the responding companies that use engineering graduates and the percentage that use engineering technology graduates. Of the respondents to Land's survey who indicated that both engineering and engineering technologists filled engineering positions, approximately 70% of them indicated there were no significant distinctions in the roles assigned to the two types of graduates nor were there observed significant differences in their capabilities. Land concludes that both engineering technology and engineering education prepare the graduate for roles in the engineering profession and there are some roles that may be better served by one program than the other.

The debate as to whether the B.S engineering technology graduate should serve a different role than the B.S engineering graduate has extended into the civil engineering profession. There are on-going discussions within the American Society of Civil Engineers (ASCE) and the Civil Engineering Division of the American Society for Engineering Education (ASEE) as to whether there are and should be clearly different roles for B.S. civil engineering technology and B.S. civil engineering graduates. This debate has been amplified, in part, by the development of the "Body of Knowledge" for the civil engineering profession by ASCE[4,5] that is used as part of the accreditation guidelines for civil engineering programs by ABET's Engineering Accreditation Commission (EAC), which accredits undergraduate and graduate engineering programs. Although civil engineering technology programs are likewise accredited by ABET, it is done by the Engineering Technology Accreditation Commission (ETAC).

The perception of a difference between the abilities of the civil engineering technology graduate and the civil engineering graduate has also been accentuated by requirements for professional engineering licensure, including the BS + 30 model law adopted by the National Council of Examiners for Engineering and Surveying (NCEES). Civil engineering technology graduates, like their civil engineering counterparts, are currently eligible to become licensed as professional engineers in most states if they hold a B.S. degree in civil engineering technology, successfully pass the Fundamentals of Engineering (F.E.) and Principles and Practice of Engineering (P.E.)

exams, and have sufficient years of engineering work experience between the F.E. and P.E. exams. However, civil engineering technology graduates are often required to have more years of acceptable professional work experience to get licensed than a civil engineering graduate and, in some states, are required to obtain a Master's degree to be eligible for licensure.

Adding to the licensure confusion are provisions, effective January 1, 2020, in the model law adopted by NCEES[6] in August 2011. These new provisions introduce minimum education requirements of a B.S. degree in an ABET/EAC engineering program, or one deemed by ABET to be substantially equivalent, plus 30 additional semester credit hours of upper-level undergraduate and/or graduate courses offered at institutions that have an ABET/EAC accredited program. It is not clear if graduates of an ABET/ETAC accredited B.S. engineering technology program would be able to apply the additional 30 credit hours of coursework towards professional engineering licensure without having supplemental academic work beyond the 30 hours. It should be noted that any new licensure requirements need to be promulgated by individual states before they become legal requirements.

The purpose of the study presented in this paper is to collect and evaluate information regarding the capabilities of the B.S. civil engineering technology graduates from Rochester Institute of Technology (RIT) to work in the civil engineering design profession in comparison to B.S. civil engineering graduates. The undergraduate civil engineering technology program at RIT has about 250 enrolled students and seven full-time faculty. It is a five year program of study that includes one year of mandatory cooperative education with suitable employers. About one-half of the graduates pursue careers in civil engineering design immediately upon graduation and the other half pursue careers in construction management, with a small percentage pursuing graduate studies. RIT does not offer a degree in civil engineering.

The information used in this study is obtained from civil design firm supervisors/department heads who directly work with B.S. civil engineering technology graduates from RIT and B.S. civil engineering graduates from other schools. The perceptions obtained from the supervisors/department heads provide insight into whether differences exist in the capabilities and responsibilities of the two groups of graduates. From this information, the broader issue of separating the professional roles filled by graduates from civil engineering technology and civil engineering programs will be addressed. The results of this study should complement the work done by Land that encompasses most of the major engineering-related disciplines, but from which specific information related to the civil engineering design profession cannot be gleaned or separated out.

Research Method

Information comparing the capabilities and responsibilities of B.S. civil engineering technology graduates from RIT (referred to as RIT-CET) working in the civil engineering design profession to those of B.S. civil engineering graduates (referred to as CE) was obtained from direct supervisors/department heads (referred to as supervisors or respondents) of those graduates through use of a web-based survey. Each supervisor was asked to complete the survey based on their knowledge from working with each type of graduate in the workplace, either currently or in the past. Respondents were asked to share their observations of graduates holding a B.S. degree,

only. They were asked to exclude any work experience where the individual possessed a Master's or higher degree. Supervisors who worked with RIT-CET graduates only, or both RIT-CET and CE graduates, were asked to complete the survey. Participation in the survey was not restricted based on the educational background of the supervisor who responded.

Supervisors completed the survey by responding to 12 statements using a five-point Likert scale that included the options of strongly disagree, disagree, neutral, agree, or strongly agree. The 12 statements are shown in Table 1 and broadly fit into the following categories:

- Preparedness and skills of new graduates during their first year of work,
- Abilities and responsibilities of graduates for routine and complex projects after their first year of work,
- Ability of graduates later in their careers to take the lead role in directing design work, as well as manage project budgets and clients, and
- Ability of graduates to assume similar responsibilities at similar points in their career, as well as possess the educational and design experience needed for licensure.

Table 1 – Overview of Survey Statements

Category:	*Preparedness and abilities of new graduates during first year of work*
Statements:	• Have the necessary knowledge in fundamental engineering subjects (e.g. statics, strength of materials, etc.) to start career. • Have adequate background in civil engineering design methods and procedures. • Verbal communication skills are adequate. • Written communication skills are adequate. • Mathematics background is adequate. (asked for RIT-CET only)
Category:	*Ability to work on routine and complex projects after first year of work*
Statements:	• Frequently (or infrequently) perform design calculations and tasks for routine projects. • Adequately perform design calculations and tasks for routine projects. • Frequently (or infrequently) perform design calculations and tasks for complex projects. • Adequately perform design calculations and tasks for complex projects.
Category:	*Ability to take lead role in directing work and managing projects*
Statements:	• Have the ability to take the lead role in directing design work on projects. • Can successfully mange project clients and budgets.
Category:	*Career advancement and professional licensure*
Statements:	• Have the ability to accept similar responsibilities and duties at similar points in their career as a CE graduate. (asked for RIT-CET only) • Should be eligible for licensure as a professional engineer with only a B.S. degree because have sufficient education and suitable design experience.

The supervisors first responded to the set of statements shown in Table 1 based on their knowledge of the work of RIT-CET graduates. They then responded to a duplicate set of statements based on their knowledge of the work of CE graduates. In addition to responding to the statements shown in Table 1, the supervisors provided information regarding the different positions that RIT-CET and CE graduates hold in the company. Space was provided in the survey for respondents to provide written comments, if they so desired.

To collect information from as many employers of RIT-CET graduates as possible, e-mails were sent out to over 1,000 individuals having ties to the RIT-CET program requesting that they provide the names of supervisors who could potentially complete the survey. From this initial e-mail solicitation, 71 supervisors were identified and e-mailed information about completing the online survey. Forty-eight of the 71 supervisors logged onto the website to complete the survey. Anywhere from 30 to 38 supervisors answered the statements evaluating RIT-CET graduates and anywhere from 36 to 39 supervisors answered the statements evaluating CE graduates. Of the supervisors who responded to statements, roughly 55% to 60% of them were RIT-CET graduates, 25% to 30% were CE graduates, and 10% to 20% were graduates of other programs. Although a significant percentage of the supervisors who responded had degrees from the RIT-CET program themselves, similar trends in survey results were observed from respondents who possessed a CE degree, as will be discussed in the next section.

Demographic information was collected on both the companies and supervisors where RIT-CET and CE graduates are employed. Figure 1 shows the number of technical employees/staff

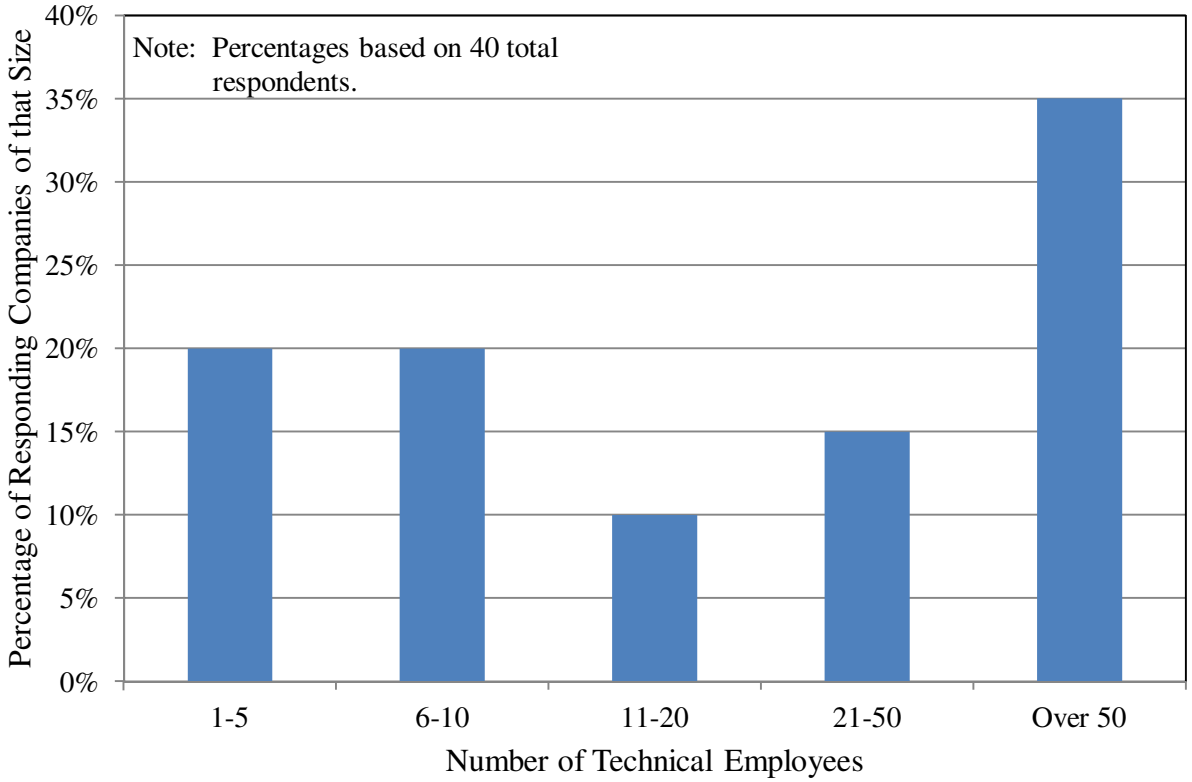

Figure 1 – Size of Responding Companies

working at the companies where supervisors completed the survey. As seen from this figure, of the 40 supervisors that responded to the survey, 35% of them work at companies having over 50 technical employees and the remainder are fairly evenly divided between the 1 to 5, 6 to 10, 11 to 20, and 21 to 50 technical employee ranges. The percentage of responding companies having a certain number of RIT-CET or CE graduates is shown in Figure 2. Based on Figure 2, 50 percent of the supervisors work at companies that only employ 1 to 2 RIT-CET graduates, whereas a combined 45% of them work at firms having 6 to 10 or over 20 CE graduates. As shown in Figure 3, about 60% to 70% of the supervisors work at companies that focus on the structural, transportation, and site development areas of civil engineering and roughly 40% of the companies focus on the water/wastewater, water resources, and environmental areas.

Nearly all of the supervisors who responded work for companies in New York State and 80% of the respondents have professional engineer's licenses. Most of the supervisors have a B.S. degree in either civil engineering technology or civil engineering as their highest degree. Only about 10% of the respondents had a Master of Science (M.S.) degree in civil engineering and about 7% had a Master's degree in another discipline.

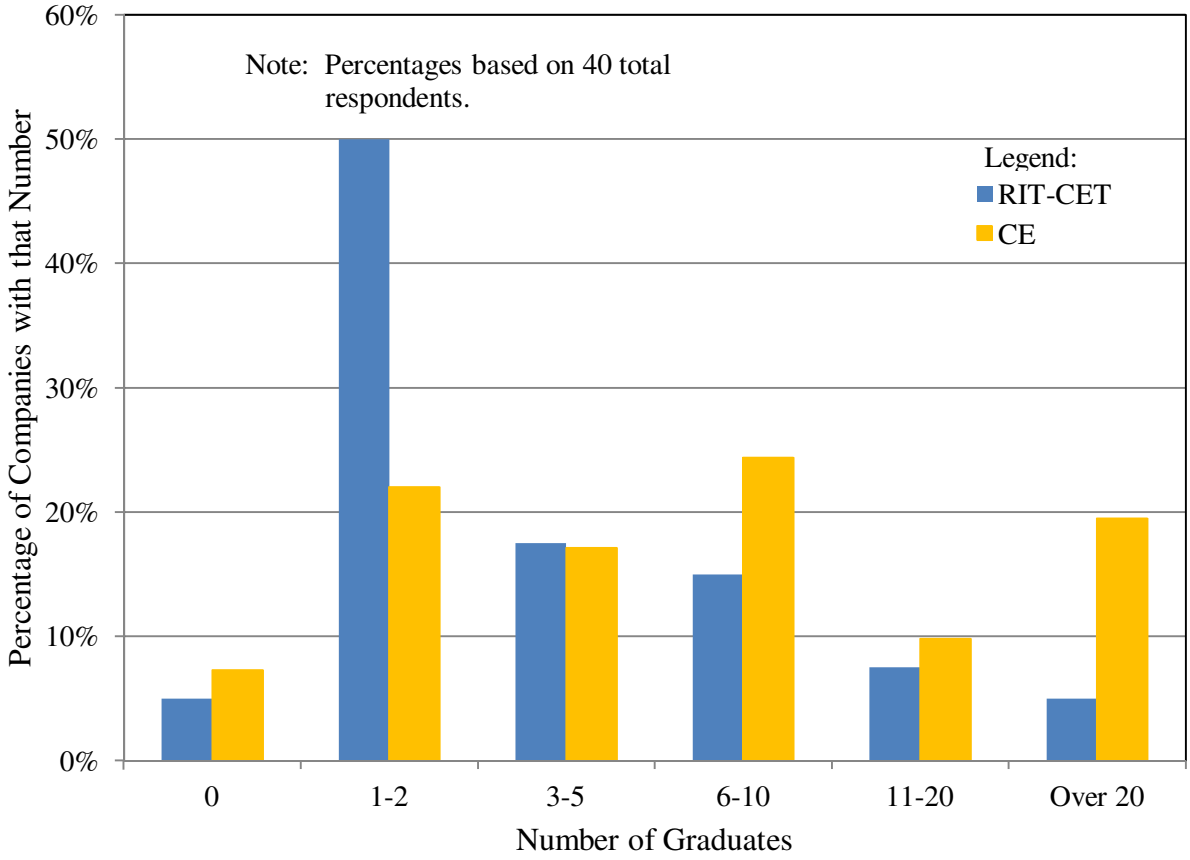

Figure 2 – Number of Graduates at Responding Companies

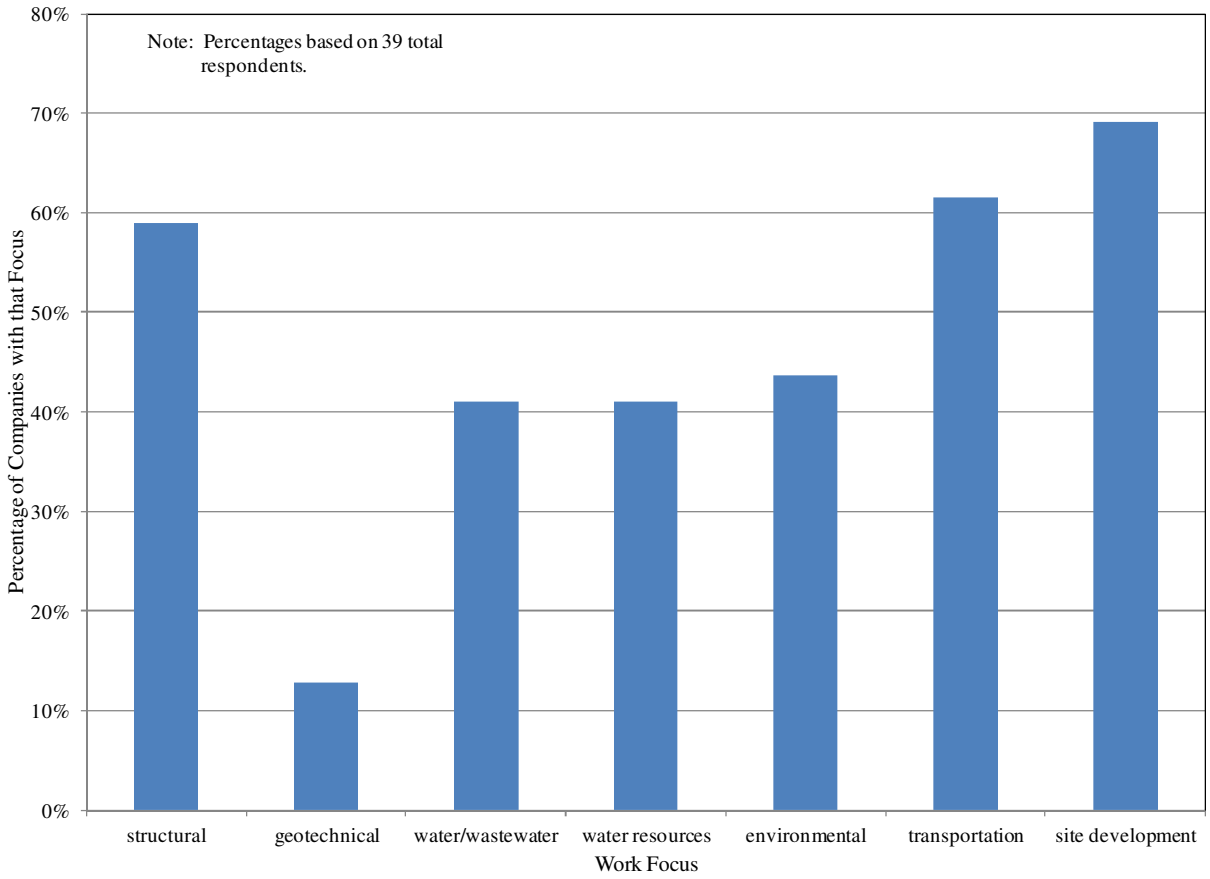

Figure 3 – Work Focus of Responding Companies

Results and Analysis of Survey Data

Tables 2 to 5 present the survey data collected from supervisors of RIT-CET and CE graduates, in response to the statements given in Table 1, concerning the preparedness, abilities, and responsibilities of each of these groups in the civil engineering design profession. These tables provide the percentage of respondents who selected strongly disagree, disagree, neutral, agree, or strongly agree for each statement in relation to RIT-CET graduates (denoted by RIT-CET in the table) and then CE graduates (denoted by CE in the table), to allow direct comparison of the results obtained for each group. In the discussion of the results, the primary focus will be on the combined percentage of respondents who either "agree" or "strongly agree" with each of the statements in that table. This combined percentage provides the percentage of positive responses received from supervisors.

The tables include responses from all supervisors, including those holding either a B.S. CET or B.S. CE degree. If there are any notable differences in the results when the responses of all supervisors are used versus the results when only the supervisors holding a B.S. CE degree are considered, those differences will be highlighted. The total number of supervisors that responded to the statements in a table is provided in the notes and is the basis for the percentages in the table.

Following the discussion of each table, the results will be analyzed in terms of what they appear to indicate about the preparedness and ability of graduates from the CET program of RIT to pursue design careers and professional engineering licensure compared to their civil engineering counterparts.

Initial Preparedness and Abilities

Table 2 presents the responses obtained to survey statements that pertain to the preparedness and abilities of RIT-CET and CE graduates during their first year of work in a civil engineering firm both in terms of their technical and communication skills. As seen in the table, nearly all of the respondents (97%) agree/strongly agree that each set of graduates have the necessary knowledge of fundamental engineering subjects (i.e. – statics, strength of materials, etc) to start their career in design. Although both groups also had a large percentage of respondents who agree/strongly agree that they have adequate background in civil engineering design methods, the RIT-CET graduates scored about 13% points higher (96% vs. 83%).

In terms of written and verbal communication skills, both the RIT-CET and CE graduates get a higher rating for their verbal communication skills. About 83% of respondents agree/strongly agree that RIT-CET graduates have adequate verbal communication skills, as opposed to 64% for CE graduates. For written communication skills, about 63% of respondents indicate RIT-CET graduates have adequate skills, whereas 53% indicate so for CE graduates.

When it comes to the mathematics background of RIT-CET graduates, 93% of respondents agree/strongly agree that it is adequate for civil engineering design.

Table 2 – Survey Statements Related to Initial (1st year) Preparedness and Abilities

Survey Statement: Graduates have …	Graduate Group Evaluated	Percentage of Respondents Selecting Likert Rating				
		SD	D	N	A	SA
Necessary knowledge in fundamental engineering subjects to start career.	RIT-CET	0	0	3.3	50.0	46.7
	CE	0	0	2.8	72.2	25.0
Adequate background in civil engineering design methods and procedures.	RIT-CET	0	0	3.3	53.3	43.3
	CE	0	2.8	13.9	72.2	11.1
Adequate verbal communication skills.	RIT-CET	0	0	16.7	50.0	33.3
	CE	0	11.1	25.0	47.2	16.7
Adequate written communication skills.	RIT-CET	0	16.7	20.0	40.0	23.3
	CE	0	16.7	30.6	44.4	8.3
Adequate mathematics skills (applies to RIT-CET only).	RIT-CET	0	0	6.7	46.7	46.7

*Note: In Likert rating system SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree. Percentages based on 30 and 36 respondents for RIT-CET and CE, respectively.

The results in table 2 indicate that RIT-CET graduates enter their first year of civil engineering practice equally prepared, if not somewhat better prepared, as their CE counterparts in terms of their technical knowledge related to design and their communication skills. It is interesting to note that when looking at the percentage of respondents who strongly agree with statements, that percentage was anywhere from two to four times higher for the RIT-CET graduate than the CE graduate. Likewise, it seems apparent that although RIT-CET graduates may take higher level math courses later in their program of study than their CE counterparts, and the math courses may be less theoretical in presentation, this does not seem to have an impact on their math readiness for civil engineering practice. Some survey respondents commented that the required co-operative education program at RIT is significant in preparing the graduates for full-time employment at an engineering design firm.

Work on Routine and Complex Projects

Feedback from supervisors concerning the frequency that RIT-CET and CE graduates, who have more than one year of experience, work on routine projects and complex projects (project having non-routine design factors and conditions) is summarized in Table 3, along with ratings of their ability to complete the calculations and tasks associated with those projects. As seen from the results, 75% of the respondents indicate that both groups of graduates work on routine projects "often" and about 25% indicate both groups are "sometimes" involved in these projects. About

Table 3 – Survey Statements Related to Work on Routine and Complex Projects (after 1st year)

Survey Statement: How often do graduates …	Graduate Group Evaluated	Percentage of Respondents Selecting Frequency Rating*				
		Not App.	Never	Seldom	Sometimes	Often
Perform design calculations and tasks for routine projects.	RIT-CET	0	0	2.7	21.6	75.7
	CE	0	0	0.0	25.6	74.4
Perform design calculations and tasks for complex projects.	RIT-CET	2.7	0	24.3	43.2	29.7
	CE	2.6	0	15.4	46.2	35.9
Survey Statement: Graduates are able to ….	Graduate Group Evaluated	Percentage of Respondents Selecting Likert Rating*				
		SD	D	N	A	SA
Adequately perform design calculations and tasks for routine projects.	RIT-CET	0	0	2.7	48.6	48.6
	CE	0	0	2.6	66.7	30.8
Adequately perform design calculations and tasks for complex projects.	RIT-CET	0	0	22.2	52.8	25.0
	CE	0	2.6	15.8	60.5	21.1

*Note: In Likert rating system SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree. In frequency rating system Not App. = Not applicable. Percentages based on 37 and 39 respondents for RIT-CET and CE, respectively.

97% of respondents agree/strongly agree that the graduates were able to adequately perform the design calculations and tasks associated with routine projects, although there was a higher percentage of strongly agree responses for RIT-CET graduates than for CE graduates (49% versus 31%).

When it comes to the frequency of working on complex projects, 30%, 43%, and 24% of respondents indicate RIT-CET graduates are often, sometimes, and seldom involved in these projects, respectively. For CE graduates the corresponding percentages are 36%, 46%, and 15% for often, sometimes, and seldom, respectively. The results for RIT-CET graduate involvement on complex projects changes somewhat if one looks at only the responses from supervisors who hold B.S. CE degrees. In this case, the percentages for frequency of involvement change to 20%, 60%, and 20%, respectively, for RIT-CET graduates.

In terms of the abilities of both sets of graduates to adequately perform the calculations and tasks associated with complex projects, 21% to 25% of survey takers strongly agree that they are able to do so, 53% to 60% agree, and 16% to 22% are neutral, with RIT-CET graduates being at the upper limit of the ranges for the strongly agree and neutral responses and the lower limit for the agree response. CE graduates are at the other ends of these ranges.

From the results obtained for these statements pertaining to routine and complex projects, it is apparent that it is fairly common for both RIT-CET and CE graduates having more than one year of experience to be involved in both types of projects, with RIT-CET graduates perhaps being slightly less involved than CE graduates on complex projects. Overall RIT-CET graduates appear equally able to perform the calculations and tasks associated with routine and complex projects as CE graduates. This information leads to the conclusion that RIT-CET graduates have similar civil engineering design abilities as their CE counterparts.

Lead Role in Directing Work and Managing Projects

Table 4 presents the responses of supervisors in regards to the ability of RIT-CET and CE graduates to take a lead role in directing design work on projects, as well as managing project clients and budgets, later in their careers. About 81% of respondents agree/strongly agree that RIT-CET graduates have the ability to take a lead role in directing design work versus 95% for CE graduates. Sixteen percent are neutral about this ability for RIT-CET graduates versus 5% for CE graduates.

When it comes to successfully managing project clients and budgets, 84% to 91% of respondents agree/strongly agree that both groups have this ability, with RIT-CET graduates having the lower percentage. For both groups the results for the neutral and disagree responses were about 8% and 3%, respectively.

The results in Table 4 indicate that both RIT-CET and CE graduates have the ability to direct design work and manage the associated clients and budgets, with CE graduates having a stronger rating, particularly in regards to taking a lead role in directing design work. A recurring comment from respondents was that leadership abilities and the ability to manage projects is more a matter of an individual's character rather than their degree.

Table 4 – Survey Statements Related to Directing Work and Managing Projects

Survey Statement: Graduates have …	Graduate Group Evaluated	Percentage of Respondents Selecting Likert Rating*				
		SD	D	N	A	SA
Ability to take lead role in directing design work on civil engineering projects.	RIT-CET	0	0	16.2	48.6	32.4
	CE	0	0	5.1	66.7	28.2
Ability to successfully manage project clients and budgets.	RIT-CET	0	2.7	8.1	43.2	40.5
	CE	0	2.6	7.7	61.5	28.2

*Note: In Likert rating system SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree. Percentages based on 37 and 39 respondents for RIT-CET and CE, respectively. 2.7% and 5.4% gave no response for RIT-CET directing design work and managing projects, respectively.

Table 5 – Survey Statements Related to Career Path and Professional Licensure

Survey Statement: Graduates have …	Group Evaluated	Percentage of Respondents Selecting Likert Rating*				
		SD	D	N	A	SA
Ability to accept similar responsibilities and duties at similar points in their career compared to CE graduates (applies to RIT-CET only)	RIT-CET	2.6	5.1	2.6	41.0	48.7
Sufficient education (with B.S. degree only) and suitable design experience for licensure and therefore should be eligible for P.E. licensure.	RIT-CET	5.3	5.3	10.5	26.3	52.6
	CE	2.6	12.8	10.3	33.3	41.0

*Note: In Likert rating system SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree. Percentages based on 37 and 39 respondents for RIT-CET and CE, respectively.

Career Path and Professional Licensure

Supervisor responses are presented in Table 5 concerning the ability of RIT-CET graduates to assume similar responsibilities as CE graduates at similar points in their career, as well as whether each group should be eligible for licensure as a professional engineer based on their education and suitability of their design experience. Nearly 90% of respondents agree/strongly agree that RIT-CET graduates are able to assume similar responsibilities as CE graduates at similar times in their career and about 8% disagree/strongly disagree. Roughly 79% agree/strongly agree that RIT-CET graduates holding only a Bachelor's degree have sufficient education and suitable design experience to be eligible for professional licensure, whereas about 11% disagree/strongly disagree and 10% are neutral. Responses concerning whether CE graduates holding only a Bachelor's degree should be eligible for licensure were similar to those obtained for RIT-CET graduates. It should be noted most of the supervisors who responded had a B.S degree in either civil engineering technology or civil engineering as their highest degree,

with only about 10% of the respondents having a M.S. degree in civil engineering and 7% having a Master's degree in another discipline.

Overall the results indicate that RIT-CET graduates can follow career paths similar to their CE counterparts and RIT-CET graduates, like CE graduates, should be eligible for professional licensure. The data from the professional licensure statement, along with the positive responses previously discussed concerning the ability of RIT-CET graduates to be involved in routine and complex design projects as well as direct design work, support the premise that RIT-CET graduates can develop the skill sets needed to become a professional engineer.

Positions Held in Companies

Figure 4 shows a breakdown of the different levels of technical positions common in civil engineering design firms, the number of respondents who recognize those positions in their company, and the number of respondents who indicate that they use or have used RIT-CET graduates and CE graduates to fill those positions. As seen from the figure, RIT-CET and CE graduates are used more or less equally to fill the support positions of lab technician, field engineer, and inspector, as well as the technical design position of design engineer. For the more

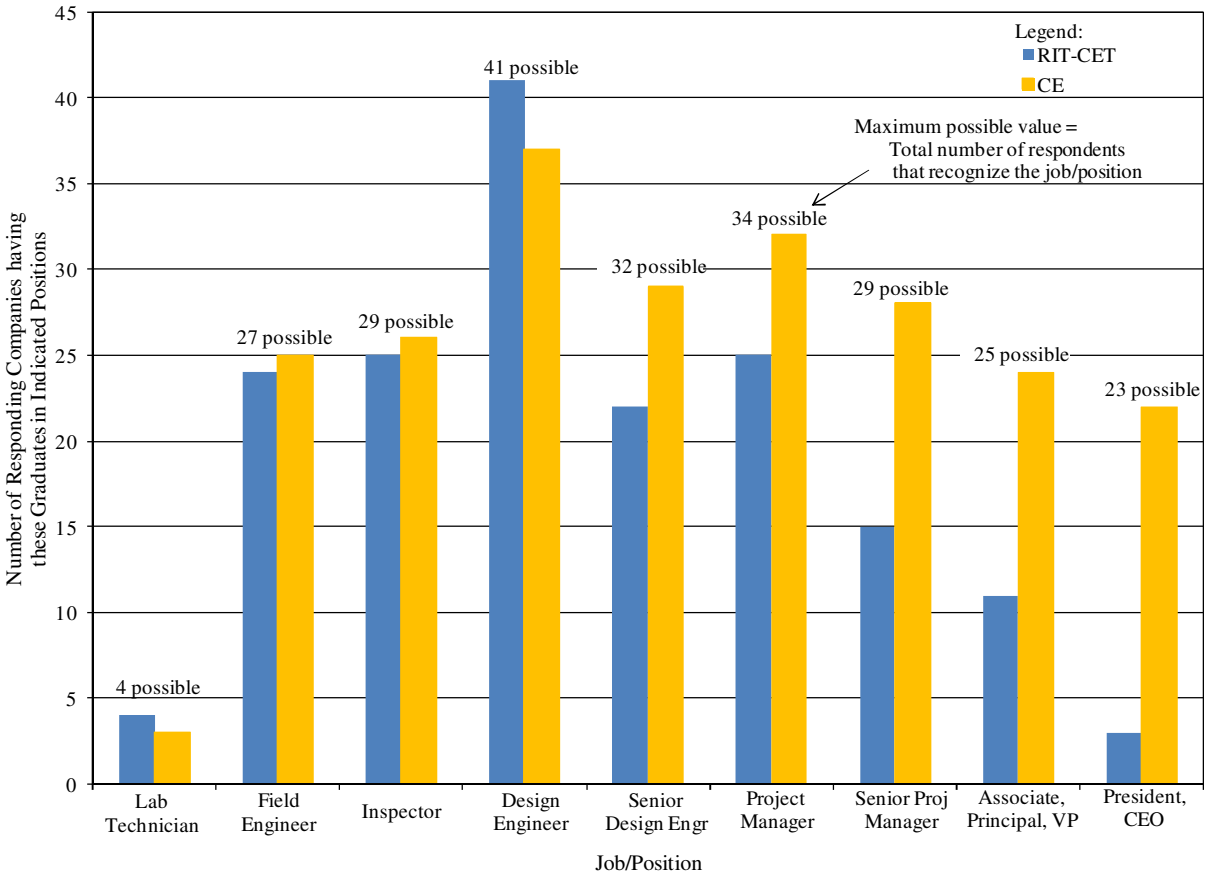

Figure 4 – Positions Held by Graduates

senior positions of senior design engineer and project manager, RIT-CET graduates were in those positions in about 70% of the responding companies whereas CE graduates filled those positions at nearly all of the responding companies. At the upper level of senior project manager and associate/principal/vice president, RIT-CET graduates occupied those positions in roughly half of the firms and CE graduates were in those positions in nearly all of the responding companies. Finally, at the company president or chief executive officer level, RIT-CET graduates occupied that uppermost post in about 13% of the companies and CE graduates filled it in nearly all of the companies.

These results indicate that at some companies RIT-CET graduates have not worked in senior design and managerial positions. The reasons for this are unclear and no specific comments were received from respondents to explain this trend. Based on the positive responses received in the survey regarding RIT-CET graduates and their abilities to do design work, as well as direct and manage projects, one would expect a proportional number of companies to have RIT-CET graduates in senior positions. One potential explanation for the observed trend could be the smaller number of CET graduates in the workforce and companies, in comparison to CE graduates, given the fact there are nearly ten times as many B.S. civil engineering programs as there are B.S. civil engineering technology programs. Another contributing factor could be more stringent eligibility requirements for professional licensure faced by civil engineering technology graduates in several states. Such licensure issues may influence company decisions as to who should fill the more senior level positions within the organization to avoid potential obstacles or hindrances when dealing with outside agencies or entities from a business standpoint. However, these considerations are more reflective of dealing with the business climate rather than reflective of the abilities of the RIT-CET graduate to perform the necessary work effectively.

Conclusions

From the data collected from the supervisors/department heads of civil engineering firms that employ graduates of the Bachelor of Science in civil engineering technology degree at Rochester Institute of Technology (RIT), the conclusions outlined below can be reached concerning the abilities and preparedness of these graduates for pursuing careers in civil engineering design.

- RIT-CET graduates enter their first year of employment with adequate technical design and adequate communication skills, and in some respects may be slightly better prepared than CE graduates.
- After their first year of employment, RIT-CET graduates work on both routine and complex design projects and have the abilities to perform the calculations and tasks associated with those projects.
- Later in their careers RIT-CET graduates have the ability to take the lead role in directing design work, as well as managing the clients and budgets of projects.
- RIT-CET graduates can accept similar responsibilities and duties in a similar timeframe as CE graduates.
- RIT-CET graduates having only a B.S. degree possess adequate education and can acquire suitable work experience to be eligible for professional engineering licensure, just like CE graduates.

- RIT-CET graduates hold job positions at all levels in civil engineering design companies, but some companies do not have them in more senior managerial positions, perhaps due to the smaller number of these graduates in the workforce or other factors like more stringent requirements for professional licensure.

The results seem to clearly indicate that a Bachelor of Science degree in civil engineering technology from RIT is a viable and legitimate path for pursuing a civil engineering design career from the perspective of the companies that hire these graduates. The civil engineering technology program at RIT helps meet the needs of students with an interest in the civil engineering profession, but who may benefit from a more practical and applied approach to the subject matter or may have an interest in civil engineering related professions, such as construction management. It appears that the needs of these students can be met by this program while still providing them with the skills and abilities required to pursue a career that encompasses positions at any level within a design firm, as well as professional licensure, if they opt to choose that path. Graduates of this program are capable of serving as "engineers" within the profession and there appears to be no need, from the standpoint of an employer, to create a special job category for them beyond those which already exist. Likewise, there appears to be no need to limit their responsibilities or duties beyond methods already used in firms.

Further study is needed to evaluate whether the trends observed supporting the preparedness and abilities of CET students from RIT also hold when the database is expanded to include additional companies/respondents and other civil engineering technology programs. There is also a need to study how the civil engineering technology program at RIT and other institutions fit into the "Body of Knowledge" framework that has been adopted as part of the accreditation criteria for civil engineering programs. In particular, do the current civil engineering technology programs generally fit the criteria laid out in the "Body of Knowledge" and may there be a need to consider some modification to the "Body of Knowledge" to provide some flexibility in terms of the paths that lead to civil engineering design careers and professional licensure? The results of this study seem to support the idea that there can be similar, but different, roads to a career in civil engineering design.

References

1. Grinter, L.E., "Engineering and Engineering Technology Education", *Journal of Engineering Technology*, American Society for Engineering Education, Washington, D.C., Vol. 1, pp. 6 – 8, 1984.

2. Kelnhofer, R., Strangeway, R., Chandler, E., and Peterson, O., "Future of Engineering Technology", *Proceedings of the 2010 ASEE Annual Conference*, Louisville, KY, 11 pp., June, 2010.

3. Land, R. E., "Engineering Technologists are Engineers", *Journal of Engineering Technology*, American Society for Engineering Education, Washington, D.C., Vol. 29, No. 1, pp. 32 – 39, Spring, 2012.

4. ASCE, *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*, American Society of Civil Engineers, Reston, VA, 2004.

5. ASCE, *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*, *2nd Edition*, American Society of Civil Engineers, Reston, VA, 181 pp., 2008.

6. NCEES, *Model Law*, National Council of Examiners for Engineering and Surveying, Clemson, S.C., 32 pp., 2011.