Engineering Technologists Are Engineers

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Abstract

A perennial debate among engineering and engineering technology educators has been the question of where baccalaureate engineering technology (ET) graduates fit within the spectrum of engineering and technical careers. Many claim that a 4-year ET education is simply a path to an engineering career that emphasizes applications of technology over theory. Others claim that a 4-year ET education is "engineering-light" or "applied engineering" and only prepares graduates for supporting roles to "real" engineers. This is an important issue for ASEE's Engineering Technology Council (ETC). Thus, in an attempt to help answer this question, ETC's ET National Forum committee recently conducted a survey to obtain data about industry's perspectives on the comparative capabilities and performance of engineering and engineering technology graduates. The target audience for the survey was companies that hire both types of graduates and that would, therefore, have a sound basis for comparing the two. The survey responses, which came from 200 companies, most of which do hire both types of graduates, are described in this paper. The survey results indicate that roughly 7 out of 10 companies make no distinctions between graduates when hiring into engineering positions, nor do they make significant distinctions in assigning functions and responsibilities, nor do they note important differences in capabilities of either group while on the job. This paper describes the survey instrument and the survey process used to develop these results, provides details of the key results, and recommends future actions to confirm the results indicated by this effort.

1. Introduction

Baccalaureate engineering technology degree programs evolved from associate degree technology programs beginning in the early 1960s. This development of 4-year ET programs was in response to a trend by existing engineering programs to place greater emphasis on the scientific and theoretical aspects of engineering studies and less on some of the more practical and applied activities that had traditionally been part of an engineering education. The developing engineering technology programs represented an effort to restore paths to engineering careers that retained strong elements of practice and application of technology in the curriculum.

A study in 1955 by the Committee on Evaluation of Engineering Education (CEEE) of the American Society for Engineering Education (ASEE) (Grinter 1955, 43) suggested that it might be reasonable for engineering schools to adopt a "bifurcation" of the engineering curricula to include a "general professional category" and a "strong scientifically oriented curriculum." However, engineering faculty at the time were unreceptive of that idea. Nonetheless, some suggest (Grinter 1984, 7; Kelnhofer 2010) that, because of the development of the space race in the late 1950s and the demand it created for a broad spectrum of technical talent, the suggested bifurcation developed anyway. However, it did not develop as a second curriculum track in the existing engineering programs as suggested by the CEEE; it developed instead in a form that came to be called "engineering technology" programs.

Early engineering technology programs were 2-year associate degree curricula that focused on educating engineering technicians to support practicing engineers, and most were not associated with engineering schools. Over time, however, it became clear that there was demand within the engineering and technical professions for engineers who came with those more practical and applied skills that had been a part of traditional engineering education before the 1960s. Recognizing this demand, some institutions with engineering technology programs expanded their programs to include baccalaureate curricula that, to a great degree, mimicked the character of engineering programs before the changes of the late 50s and early 60s.

The one problematic issue in the establishment and growth of these baccalaureate programs was the name. Because of the reluctance of engineering faculty in the existing engineering schools to support a bifurcated engineering curriculum, engineering schools were (and generally remain) unwilling to have these

new programs called engineering programs, hence the adoption of the name "engineering technology." While academic institutions have maintained this naming convention for the last 50 years, the actual distinctions between baccalaureate engineering and baccalaureate engineering technology programs remain ill-defined at best, even within the academe. This lack of distinction has led to a number of persistent problems. Among them has been an inability of engineering technology programs to define themselves to potential students and their parents – is engineering technology engineering by another name, or is it "engineering-light," or is it technician education? If it is engineering, why is it not called engineering? Companies looking to hire engineers often ask similar questions.

Many engineering technology educators rely on decades of anecdotal experiences to answer these questions. Those experiences indicate that the academic distinctions between engineering and engineering technology at the baccalaureate level are much less relevant than are the commonalities. Experience also indicates a similar situation with respect to employment. Baccalaureate ET graduates are routinely hired into engineering positions and often work alongside their contemporaries from engineering programs. In fact, the sense is that the differences between the graduates, whatever they are, are mostly irrelevant and largely ignored by those companies that do employ ET graduates as engineers. However, to parents, prospective students, and prospective employers, these responses are just that – anecdotal, and as such, are often less than satisfactory.

It is these issues that form the rationale for this paper. While many in the engineering technology academy can share personal experiences to support the perceptions described above, there has never been an objective appraisal of industry's attitudes about and experiences with baccalaureate engineering technology graduates vis-à-vis engineering graduates. For that reason, the Engineering Technology Council (ETC) of the ASEE, through its ET National Forum committee, initiated an effort to gather data from industry that would clarify employers' views on these questions and provide a factual basis for defining ET's place in the engineering and technical career spectrum. The initial step in that effort was to conduct a mostly qualitative survey to establish a general picture of industry perceptions of both types of graduates, provide a foundation for follow-on, more focused studies to better characterize, and, if possible, quantify those perceptions. Also, to ensure that the base data represented actual, on-the-job experiences with both engineering and engineering technology graduates, this initial survey was targeted specifically at companies known to hire both types of graduates. This was done by submitting the survey only to industry personnel who were actively involved as employers, advisors, or consultants to existing baccalaureate ET programs.

The survey described above was conducted over most of 2010 and generated responses from 200 companies. The nature of the survey and details of the responses are described in the following sections.

(Note – *Engineering Technology programs encompass both 2-year associate degrees and 4-year baccalaureate degrees, and this often leads to confusion when discussing the issues outlined above. Also, there are bachelor of technology programs that are not accredited by the Accreditation Board for Engineering and Technology (ABET). The discussions in this paper relate strictly to 4-year baccalaureate engineering technology programs accredited by ABET. However, for the sake of brevity, the 4-year and/or baccalaureate modifiers are often dropped in the following text. Nonetheless, all references to engineering technology are references to accredited 4-year baccalaureate ET programs and their graduates*.)

2. Target Audience

Since the central aim of the survey was to gather data to compare industry experiences and attitudes about the skills and capabilities of engineering technology versus engineering graduates, it was essential that those surveyed had experience with both groups. Two groups easily fit this description. One is the industry advisors who are associated with each ABET-accredited ET program. A second is those individuals in industry who have formed close associations with ET programs through such activities as faculty consulting, student internships, sponsorship of capstone projects, etc. These individuals are intimately aware of the breadth and depth of ET programs, and the majority represents companies that hire from both graduate groups. They have the added advantage of being in regular contact with institutional personnel represented by the ETC. These personal contacts allowed for targeted, one-on-one survey requests that ensured a much higher response rate than is generally possible with a random survey. Furthermore, since ETC members represent the majority of all ABET-accredited baccalaureate ET programs in the U.S., responses from a range of industrial advisory group (IAG) members ensured that the collected data represent the full range of industry characteristics; i.e., products and services provided, engineering and technical disciplines employed, company size, annual revenues, geographic markets, and international business.

While restricting the survey recipients did provide assurance that respondents had first-hand experience with both types of graduates, it also introduced a possible bias in the results. Respondents' close associations with ET programs may well have influenced the results presented here. Future surveys targeting companies that hire both types of graduates but that are not closely associated with ET programs will need to be done to determine if there is influence and, if so, what the nature of the influence is.

3. The Survey

The survey developed for this project had three central goals. The first was to determine if a respondent represented a company that hired baccalaureate ET graduates into engineering positions. Second, for companies not hiring ET graduates, respondents were asked to identify the rationale for the hiring restrictions and the perceived weaknesses of ET graduates with respect to the role of engineers in their company. Finally, for companies that hired both engineering and ET graduates into engineering positions, the survey asked for additional details, including

- specific engineering job titles assigned to engineering and to ET graduates
- distinctions, if any, in job functions/responsibilities assigned to graduates
- if distinctions are made in assignments, motivations for those distinctions
- observed differences in capabilities of graduates with similar functions and responsibilities
- experiences with ET graduates that indicate a need to alter existing hiring policy
- recommendations to ET programs that would better prepare graduates for engineering positions

To ensure that collected data were representative of the full breadth of engineering and technical fields, the survey asked for company demographic data from respondents, including the commercial/technical sectors served by each company, size of the company workforce, annual revenues, and domestic and international areas served.

The survey was conducted using two mechanisms. Many ETC members worked directly with their industry associates to complete the survey on paper. An online version was also made available for those who preferred that approach. Approximately 4 of 10 responses were submitted on paper, and the rest were submitted on-line. A summary of the key results of the survey are described in the following sections, but the totality of data is too large to be presented in full. However, for those interested, a copy of the survey showing details of all questions and a full compilation of responses are available on the Engineering Technology Division website at http://www.engtech.org/organizations.php#NationalETForum.

4. Composite of Responding Companies

For the survey results to be a credible representation of general industry attitudes about engineering and engineering technology graduates, it is necessary that the data represent the full spectrum of industries that employ engineers. That is, the responses must represent companies involved in the full range of engineering products and services. They must also represent companies large, small, and in -between, and they must represent companies that operate in or do business across the full range of domestic and international markets. The survey collected data on these characteristics; results are shown in Figures 1 through 5 below.* The figures show, respectively, technical areas served by the respondents' companies, company size by number of employees and by annual revenues, and the domestic and international markets served by the companies.

Figure 1 confirms that the collected data are representative of the full range of engineering and technical service areas. Further, the remaining four figures demonstrate that large and medium size companies (greater than 50 employees and revenues greater than $10M) are well represented. If there is a limitation in the data, it is with regard to small companies. The small number of responses from this sector may bring into question any conclusions drawn from the survey when applied to small engineering endeavors. Such questions may deserve more in depth investigation in the future.

5. Survey Results

The central focus of the survey was to characterize industry attitudes about the comparative abilities and performance of engineering and engineering technology graduates serving in engineering positions. Thus, it was necessary that respondents be familiar with both groups as practicing engineers; that is, that their companies actually hired engineers from both groups so that respondents were capable of providing objective comparisons. Of the 200 survey responses received, 173 (87%) came from companies with a history of both types of graduates serving in engineering roles.

That a company may hire engineers from both graduate groups does not tell a complete story. It is also necessary to know if both groups are hired into engineering positions with similar roles and responsibilities. To clarify that question, respondents were also asked to identify the types of engineering positions occupied by each group. Figure 6 shows those data. With the exception of the four job titles that explicitly contain the descriptors "technician" or "technologists," it is evident that, for most companies represented by the data, both engineering and engineering technologists are given similar consideration for most engineering roles. The only distinction appeared to be in the roles of design engineer, research engineer, and senior engi-

* Though there were 200 responses to the survey, not all respondents answered all questions. Further, some questions permitted multiple responses. Thus, the response counts on some figures do not correlate with the count of respondents. Also, for those companies indicating an international market, the survey made no attempt to identify whether the companies were U.S. corporations with international branches or foreign companies with U.S. branches.

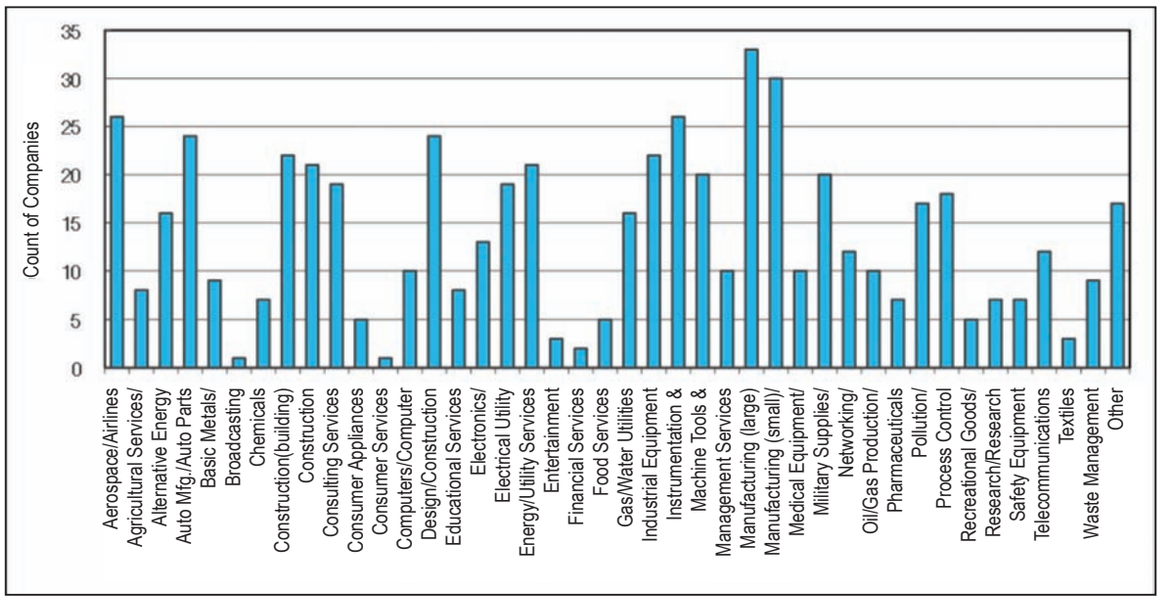

Figure 1. Industrial Sectors Served (Most companies served multiple sectors).

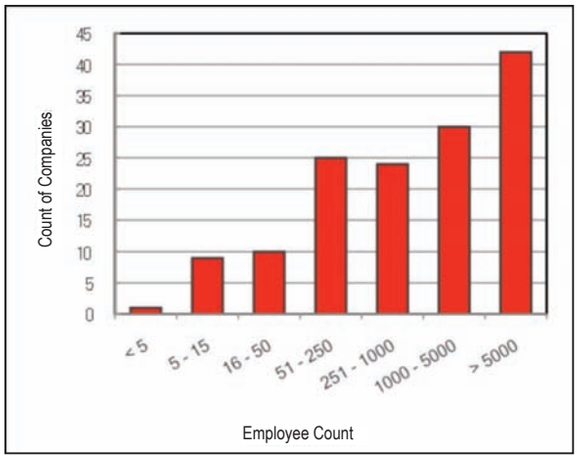

Figure 2. Number of Employees.

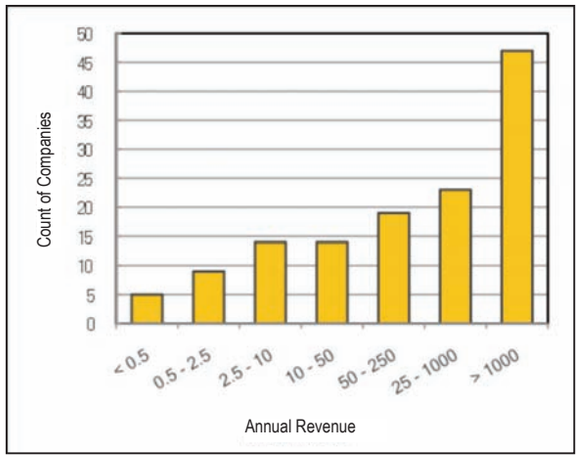

Figure 3. Annual Revenue in Millions.

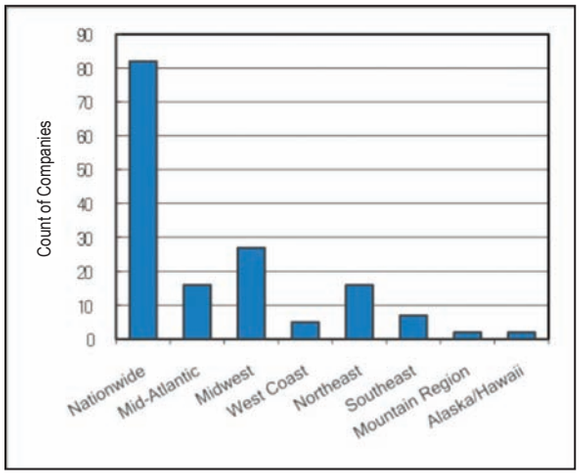

Figure 4. Primary Domestic Service Areas.

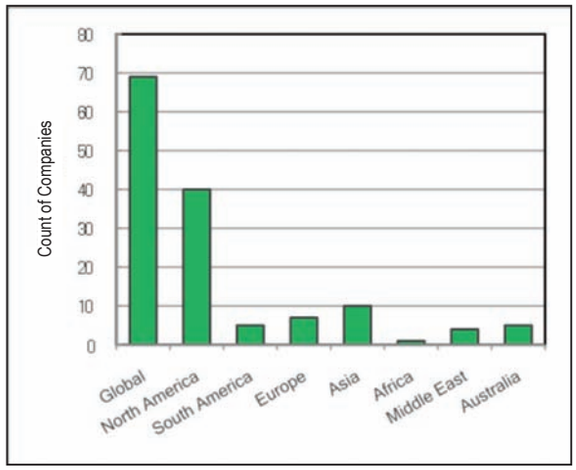

Figure 5. International Service Areas.

neer. Here, there is some tendency to favor engineering over engineering technology graduates, a fact that might be anticipated given the key distinction between the two educational paths; i.e., applications versus scientific theory. Yet, even in these categories, the distinction is not dramatically different from the more general categories. The percentages of companies hiring either type of graduate into engineering designations (other than senior, design, or research) range between 80% and 83%. In comparison, for the senior, design, and research engineer positions, fewer companies use engineering technology graduates; those numbers are 70%, 71%, and 60% respectively.

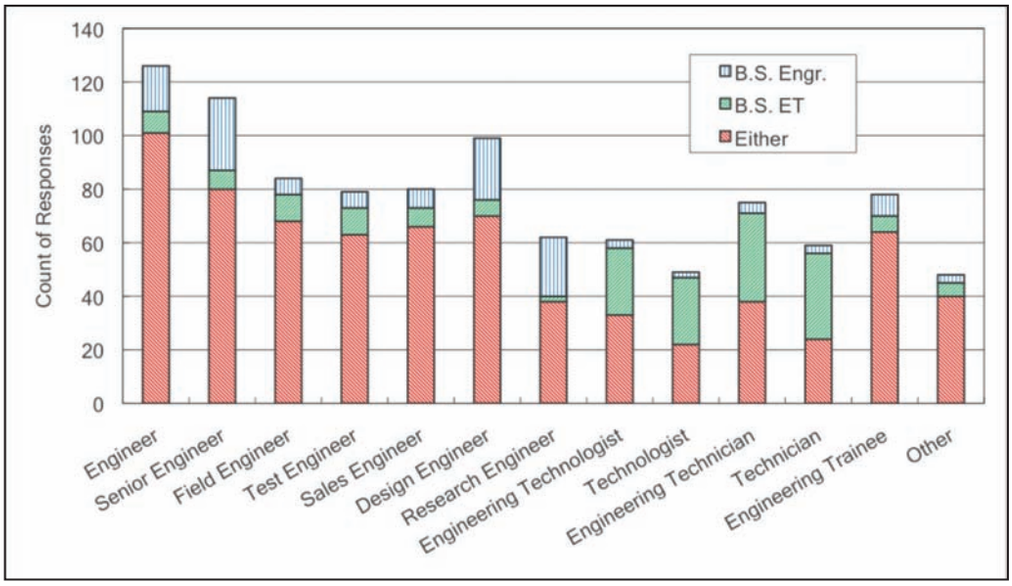

Figure 6. Specific Job Titles Assigned to Each Degree Category.

The fact that a company hires graduates from either group into similar engineering roles does not ensure that those hired perform with similar effectiveness. The survey asked two other questions to investigate the comparative effectiveness of graduates in similar roles. Table 1 summarizes those questions and the responses received.

Those respondents who answered "yes" to these questions were also asked to comment on the distinctions, or the rationale for the distinctions, addressed by the questions. Those comments are too numerous to recount here; however, some of the more noteworthy ones are summarized below. As noted earlier, those wishing to see all of the comments can find them on the Engineering Technology Division website.

Distinctions in Assignments: Notable comments in response to this question included

- "Anyone with the job title 'engineer' must have ABET credentials."
- "ET graduates must have PE [registration] before being classified as engineers."
- "In general, technology-based degrees will start as field or test or field engineers; however, movement to other titles is common."
- "Responsibility for design is given to engineers while responsibility for building and testing the design is given to the technologist."
- "If the work is math, statistics or science intense, then an engineering or science degreed employee would most likely be positioned for the job first."
- "We prefer engineering technology majors as we have found them to be more hands-on and can make a better transition to a manufacturing environment."
- "BS engineering new hires generally start

Table 1. Distinctions Between Engineering & Engineering Technology Roles, Responsibilities & Performance.

Question	# of Responses	Yes Responses	No Responses	% No Responses
Are there significant distinctions made in assigning roles & responsibilities to engineering vs. engineering technology graduates?	135	44	91	67
Are there significant differences observed in the capabilities of engineering & engineering technologists when performing similar roles?	119	36	83	70

out in 'design' engineering; BSET grads generally start in manufacturing. Eventually, they merge."
- "Engineers must have professional engineering (PE) certification to perform work for other companies requesting work from our company. Very rare that an engineering technologist would have a PE. Must have a PE to be promoted to most management level positions or above."
- "BSET positions are usually in the factories as QA engineers, mfg. engineers, automation and tooling engineers, test lab, and tool room. We need the hands on skills that these engineers have for these positions. Design engineers and R&D engineers usually need a higher level of abstract thinking ability and creativity. We have found these positions are better filled with traditional engineering degrees."

Many of the other comments reflect the same distinctions that are noted above; i.e., applications versus theoretical emphasis in the two programs. However, several comments addressed an issue related to the focus of this survey, and that is the absolute barrier in some states† to professional registration for baccalaureate engineering technology graduates.

Distinctions in Capabilities: The majority of responses to this question repeated some variation of the theme that engineers are more theoretical, analytical, and design-oriented while engineering technologists are more hands-on and applications-oriented. Those comments are not repeated here; however, the following comments reflect some additional insights:

- "B.S.ET typically is involved in engineering activity along with project management, working toward all phases of engineering activity. B.S. Engr typically is concentrated in the design aspect of circuits, and is not typically involved with all aspects of a project."
- "BSET are often more comfortable proceeding without detailed direction."
- "ET graduates are actually better prepared to hit the ground running. We find the type of education provided by the technology program is more suited for the types of engineers that we hire. Over time, I would tend to find that the playing field levels out and each is able to learn on the job the skills needed to be effective."
- "BS Engineers are more theoretical and less hands on. Need additional technical training usually. BS Engineering Technologists are ready to dig in and get the job done."
- "Personally I find the ET graduate more prepared to follow directions and finish the job assigned with less supervision."
- "Typically engineers . . . have additional skill sets in the design and implementation of systems. These engineers typically become engineering managers and run large projects. The EET engineers typically provide the technical execution of performing daily engineering tasks (i.e., assembly, programming, debug). This is a broad statement. The ultimate performance of the engineer is primarily from the individual, and in our company, promotion is awarded to high performers vs. degree designations."
- "Although there are no significant differences in the capability of each graduate, EE graduates are usually big picture oriented and grounded in engineering principles. The tech graduates are usually more short term and hands on focused. EEs are better project management oriented employees, whereas EETs are task oriented."
- "We have seen that technology students better bridge the gap between theory and the practical application in manufacturing."
- "Mostly the differences manifest themselves in the approach to problem solving. Engineering grads tend to take a more top-down approach reducing to algorithm or equation. Technologists are a bit more heuristic in their approach."

Beyond the oft quoted "applications" versus "theory" distinction, it is obvious from these comments that many employers observe another advantage of engineering technology graduates; i.e., the ability to be productive more quickly than their counterpart engineers.

The survey included a number of other questions that required free-form responses. Those questions related to issues such as the rationale for hiring distinctions, if they existed, or the rationale for differing job assignments, if those differences existed. Respondents who indicated that they observed difference in capabilities between engineering and engineering technology graduates were asked to comment on the nature of those differences. Respondents were also asked to comment on any issues that do, or should, influence hiring practices related to the two graduate groups. Finally, respondents were asked for their recommendations to improve the preparation of engineering technology

† Many states do permit engineering technology graduates to obtain professional licensure, although in some cases the qualification requirements are more stringent for ET graduates.

Table 2. Constraints on Hiring Engineering Technology Graduates.

Answer Option	Response Count[1]	Percentage
Inadequate/limited math skills	4	10
Inadequate/limited science knowledge	5	12
Inadequate/limited analytical skills	6	15
Inadequate/limited design skills	7	18
Inadequate/limited knowledge of engineering topics	10	26
Limitations on professional registration	5	13
Constraints imposed by customers	2	5
[1] *Count total is greater than 27 because some respondents chose more than one response.*		

graduates. Each of these questions generated a significant number of responses, and some of the responses offer interesting perspectives on the comparisons between engineering and engineering technology. However, none produced a common theme that was easily summarized in context of this paper. Those interested in seeing these responses are encouraged to review the complete survey data set on the Engineering Technology Division website.

A final question on the survey that deserves attention was the input from the 27 respondents who indicated that their companies did not hire engineering technology graduates into engineering positions. Those respondents were also asked to indicate why that hiring policy was in place. A free-form response was not requested; instead, the question assumed the reasons were related either to perceived weaknesses in academic training or customer/service area constraints. Thus, responses were limited to a series of specific issues, as indicated in Table 2.

If there is news in these responses, it is that there is no news. These data seem to reflect the generally held perception by many that engineering technology graduates are "engineering light" graduates. Other data reported here may well belie this perception, but clearly the perception persists.

6. Summary & Conclusions

As noted at the outset, the purpose of the ET National Forum survey was to investigate whether industry's perception of baccalaureate engineering technology graduates confirmed or refuted an opinion held by many academics that engineering technology graduates are not truly engineers but are less well prepared technical professionals. The results presented show that, for a very broad range of engineering companies operating across the full spectrum of engineering services and products, baccalaureate engineering technology graduates are engineers. Moreover, these graduates function in many engineering roles equally as well as their contemporaries from engineering. In some roles, they perform even better. The results also show that the conventional description of the differences between the two academic disciplines (that engineering is more scientifically- and theory-oriented while technology is more applications- and practice-oriented), seems to hold true on the job. When companies do see differences in roles and/or performance, the differences tend to reflect the different academic orientations. However, it is important to note that the differences are not viewed as accommodations to inferior or inadequate engineering skills but simply as preparation for equally valuable, yet different, engineering roles.

The engineering profession is comprised of many different roles. Engineering education is better preparation for some roles while engineering technology education is better for others, and either academic path is beneficial preparation for the remaining roles. Nonetheless, from industry's perspective, at least those industries represented here, all the roles are engineering roles. To summarize, the oft-debated distinctions between engineering and engineering technology in the academic environment seem largely irrelevant to engineering industries.

These results also add credence to a position taken by many in the ET academic community that the bifurcation represented by the existence of both engineering and baccalaureate engineering technology program has outlived its usefulness, if such usefulness ever existed. Recent trends in many engineering curricula to re-emphasize laboratory activities, increase system-level design content, and include courses based on comput-

er-automated design and manufacturing tools are seen by many as a move toward what has always been the core concept of engineering technology. This is not a new idea. It has been suggested by the engineering technology community (Cheshier 1985, 710; Kenyon 1985, 707) as far back as 1985, but it was then and continues to be now an unpopular idea to the engineering community. The results presented here may provide justification for once again opening that discussion.

7. Recommendations for Future Work

As noted in the Introduction, one purpose of this study was to provide direction for future investigations designed to fully and more accurately document industry attitudes about engineering and engineering technology graduates. The data reported here indicate some of those directions. For example, the findings show that a high percentage of baccalaureate engineering technology graduates are recognized as engineers by their employers. However, the data have not been examined to see if there are correlations between company characteristics and company attitudes about engineering and engineering technology graduates. It is possible that factors such as company size or service sector could influence attitudes and change the results indicated by this survey. It is also important that all respondents to this survey were industry advisors or consultants to baccalaureate engineering technology programs. Thus, all were familiar with the academic details of engineering technology programs and of the academic distinctions that are often used to describe them. That familiarity may also have flavored the results, and a similar survey of industry representatives without a close association with academia, or those with a close association with only engineering programs, could produce different results. Finally, there are hints in these results that relate to the importance of professional registration to some engineering roles. That raises the question of whether removing the existing barriers to professional registration for engineering technology graduates would enhance the engineering workforce of U.S. industries. Each of these questions represents useful avenues for additional study.

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