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Characterizing Employers' Expectations of the Communication Abilities of New Engineering Graduates

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To better understand the gap between recent graduates' communication abilities and employers' expectations, the authors surveyed software engineering professionals. They asked which of 67 communication abilities are unimportant for software engineers, which ones are learned on the job, which ones recent graduates are expected to have but lack, and which ones recent graduates possess. Results showed that employers expect graduates to communicate clearly and professionally, while specific audiences or forms of communication may be learned on the job. Recent graduates meet many of employers' expectations but lack others. For example, most are reported to use English fluently and terminology correctly but to lack concision and cohesion. Employers disagree about whether graduates' communication is sufficiently professional.

Study after study has pointed to the gap between the expectations of engineering employers for effective communication and the communication abilities of new engineering graduates (Bates & Connor, 1994; Pinelli, Barclay, Keene, Kennedy, & Hecht, 1995; Reave, 2004; Riley, Furth, & Zellmer, 2000; Sageev & Romanowski, 2001; Vest, Long, & Anderson, 1996). To address this gap, several studies have gathered evidence to describe the kinds of communication abilities engineers need on the job (Norback & Hardin, 2005; Pfeiffer, 1999; Ruff & Carter, 2009; Sageev & Romanowski, 2001; Vest, Long, Thomas, & Palmquist, 1995). For example, Pfeiffer (1999)

lists six expectations for communication of software engineers, such as "the ability to sell oneself" and "strong written and spoken English." Ruff and Carter (2009) used focus groups with software engineering managers and interviews with practicing software engineering professionals to identify 38 fine-grained communication abilities that participants identified as important for software engineers.

Although these studies are useful in characterizing on-the-job communication, we are aware of only one study (Lang, Cruse, McVey, & McMasters, 1999) that has taken the next step of prioritizing those communication abilities expected by employers. We extend that work significantly, not only to indicate the relative importance of the abilities, but also to distinguish between communication abilities learned on the job and those expected to be learned in college and to differentiate between those abilities that recent graduates possess and those that they lack. The value of pursuing these lines of inquiry is twofold. First, it can inform pedagogy for preparing students to meet the expectations of employers. Second, it can help instructors better understand employers' perceptions of what abilities are required to communicate effectively in the engineering workplace and where those perceptions may deviate from educators' own.

In particular, this study seeks to answer four research questions:

1. What communication abilities do employers expect recent graduates to have?
2. According to employers, which of these communication abilities do graduates usually possess, and which do they usually lack?
3. What communication abilities are recent graduates not expected to have?
4. Which of these abilities are not expected because graduates will learn them on the job, and which are not expected because they are not important?

This research was approved for exempt status by our institutions' committees on the use of humans as experimental subjects. We define a *recent graduate* as a software engineer with a related degree and less than one full-time year of experience working as a software engineer.

Method

Survey Design

To answer our research questions, we conducted an online survey of software engineering professionals who are responsible for hiring and/or reviewing the performance of recent graduates. These respondents were presented with a list of communication abilities and were asked the following question for each ability, with four possible responses:

Do you expect recent graduates to be able to [name of ability]?

- *Yes*, but they usually *lack* this ability.
- *Yes*, and they usually *possess* this ability.
- *No*, this ability is *unimportant* for software engineers.
- *No*, this ability will be *learned on the job*.

A separate survey was given to software engineering professionals who are not responsible for hiring or performance review. These respondents were asked to rate the importance of each ability on a scale of 0 to 5, where 0 = *not important*, 1 = *somewhat important*, and 5 = *essential*. These data enabled us to rank the abilities by importance and to compare the results against the number of respondents above who identified each ability as unimportant. For the remainder of this article, the groups that received the two different surveys—those responsible for hiring and evaluation and those not—will be referred to as *evaluators* and *practitioners*, respectively; however, it is important to note that most *evaluators* are also practicing software engineers. The two groups are described in more detail in Appendix A.

The communication abilities tested by both surveys were based on the list we had previously identified as important for software engineers in industry (Ruff & Carter, 2009), as modified for the purposes of this study in the following ways. To better focus the survey, we omitted items deemed as strategies rather than abilities. To increase the breadth of the survey, we included some abilities identified by too few of the participants in our previous study to be included in the results (for example, "use English fluently" and "respond professionally to one's own mistakes"). To broaden the survey's pedagogical scope, we added a few items of interest to communication educators: "order information in a way that makes explanations easy to follow," "connect new information to information that is familiar to the audience," and "use structure and formatting to enable fast reading." Finally, to provide a check on survey validity (and

to offer variety to minimize survey fatigue), we included a few items that our prior research had suggested were not very important to software engineers (for example, "communicate effectively via journal articles" and "communicate effectively via conference presentations"). The resulting list of communication abilities contains 67 items, listed in Tables 1-3.

To further minimize survey fatigue, we grouped similar abilities together and ordered abilities logically, as recommended by Dillman (2000); although a fixed ordering can cause order effects, such effects are the exception rather than the norm (Schumann & Presser, 1981, pp. 25-27) and are less likely for respondents, like ours, who have high cognitive sophistication (Krosnick & Alwin, 1987; Narayan & Krosnick, 1996). Communication abilities were grouped into five categories: tools to facilitate team communication, forms of communication, different communication audiences, professional communication, and clear communication.

Piloting and Administering the Survey

The online survey went through five cycles of preliminary pilot testing and revision, with one pilot tester for each cycle: two communication educators and three software engineering professionals. Once the survey achieved a fairly stable design in September of 2009, it was opened to the general public. The first nine responses were treated as a pilot test, resulting in a minor restructuring of the survey. The data from this pilot were included in the final results because the resulting revisions were minor and because omitting the data would skew the results toward later responders. The survey remained open for two months.

To reach a broad cross-section of software engineering professionals, we advertised the survey in a variety of ways and used a prize drawing to encourage people to forward the survey. We advertised it to the participants in our 2009 research, to the participants in the June 2008 National Science Foundation-sponsored Chautauqua in Teaching Communication Skills in the Software Engineering Curriculum, to employers at two career fairs at Massachusetts Institute of Technology, to exhibitors and attendees at the October 2009 Frontiers in Education Conference in San Antonio, Texas, and to a Boston-area mailing list of technical communication educators. Most direct survey advertising was to software engineering professionals in Massachusetts, California, and North Carolina, but advertising went to at least four other states as well.

To encourage survey dissemination and participation, two $150 prize drawings were offered: one for taking the survey and one for being credited by a respondent for forwarding it. While each respondent could

Table 1
Communication Abilities Recent Graduates Are Expected to Have

A.	Evaluators agree that recent graduates usually *lack* these communication abilities. (These abilities appear in **Region A** of Figure 2 and in the bottom half of Figure 3.)	*Importance Rating* (σ)*
1.	Connect new information to information that is familiar to the audience (c)	3.6 (1.3)◆
2.	Order information in a way that makes explanations easy to follow (c)	3.9 (0.9)◆
3.	Recognize one's own communication weaknesses and improve one's own communication skills (p)	3.7 (1.1)◆
4.	Be concise (c)	3.5 (1.1)◆
5.	Communicate effectively via code comments (f)	3.5 (1.4)◆
B.	Evaluators *disagree* as to whether recent graduates lack or possess these abilities. (These abilities appear in **Region B** of Figure 2 and in the bottom half of Figure 3.)	*Importance Rating* (σ)*
6.	Communicate effectively via formal presentations to a group (nonconference) (f)	2.9 (1.5)◆
7.	Adjust communication based on non-verbal reactions of audience (p)	3.3 (1.3)◆
8.	Discern when to ask questions rather than to assert an opinion (p)	3.7 (1.0)◆
9.	Communicate with a balance of confidence and humility (e.g., when giving opinions or making one's own accomplishments known) (p)	3.7 (1.1)◆
10.	Give sufficient explanation (c)	3.9 (0.9)◆
11.	Give clear high-level overviews (e.g., of a problem or a system) (c)	4.3 (1.0)◆
12.	Listen actively (e.g., ask clarifying questions, admit to gaps in understanding) (p)	4.3 (0.8)◆
13.	Avoid taking debate, feedback, or others' opinions personally (p)	3.8 (1.2)◆
14.	Discern when to keep silent rather than to speak (p)	3.5 (1.3)◆
15.	Avoid complaining (by proposing a solution, fixing the problem, or remaining silent) (p)	3.4 (1.3)◆
16.	Manage one's own non-verbal communication to avoid sending inappropriate messages (p)	3.3 (1.3)◆

Table 1 (*continued*)
Communication Abilities Recent Graduates Are Expected to Have

B.	**(*continued*)** Evaluators *disagree* as to whether recent graduates lack or possess these abilities. (These abilities appear in **Region B** of Figure 2 and in the bottom half of Figure 3.)	*Importance Rating* (σ)*
17.	Communicate effectively via visuals (e.g., figures and tables) (f)	3.2 (1.5)◆
18.	Explain precisely and accurately (c)	4.3 (0.7)◆
19.	Communicate through transparency (make information openly available) (p)	4.0 (1.2)◆
20.	Respond professionally to one's own mistakes (p)	4.3 (0.8)◆
21.	Use e-mail appropriately (e.g., read before sending, know when to talk in person, avoid flaming) (p)	4.1 (1.0)◆
22.	Communicate effectively via informal presentation to a group (f)	3.6 (1.2)◆
23.	Use correct spelling and grammar most of the time (c)	3.3 (1.3)◆
24.	Communicate effectively via meetings (in person) (f)	4.1 (1.1)◆
25.	Participate in meetings (p)	3.5 (1.3)◆
C.	Evaluators agree that recent graduates usually *possess* these communication abilities. (These abilities appear in **Region C** of Figure 2 and in the bottom half of Figure 3.)	*Importance Rating* (σ)*
26.	Communicate effectively via one-on-one presentation of ideas (f)	4.3 (1.1)◆
27.	During discussion, treat others with respect (e.g., when giving an opinion, debating potential solutions, reviewing code) (p)	4.3 (0.9)◆
28.	Communicate to an audience of other software engineers (a)	4.6 (0.8)◆
29.	Communicate effectively via small talk / social conversation (f)	3.2 (1.4)◆
30.	Communicate effectively via telephone (f)	3.0 (1.3)◆
31.	Be nice to others, through words and tone (e.g., in daily interactions) (p)	3.9 (1.0)◆
32.	Use correct terminology and use terminology consistently (c)	4.0 (0.8)◆
33.	Use English fluently (c)	3.9 (1.0)◆
34.	Communicate effectively via instant messaging (f)	2.6 (1.9)◇

Table 1 (*continued*)
Communication Abilities Recent Graduates Are Expected to Have

C.	**(*continued*)**Evaluators agree that recent graduates usually *possess* these communication abilities. (These abilities appear in **Region C** of Figure 2 and in the bottom half of Figure 3.)	*Importance Rating* (σ)*
35.	Communicate effectively via e-mail (f)	4.6 (0.8)◆

Note. (c), (p), (f), & (a) indicate the groups by which the abilities are classified: clarity, professional, audiences, forms, and tools.
For comparison with evaluator data, diamonds represent importance as rated by practitioners: open = *unimportant*; shaded = *somewhat important*; black = *important*.

submit only one entry to the drawing for taking the survey, multiple entries to the drawing were encouraged for forwarding the survey. Various tactics were used to prevent and check for multiple or illegitimate survey entries: cookies, direct appeal, and inspection of the data. No illegitimate entries were identified.

The demographics of the resulting sample are shown in Appendix A; although a range of industries and regions of the U.S. are represented, the results of this survey may best represent information industries along the two coasts.

Results

Agreement Between Evaluators and Practitioners

Both practitioners and evaluators were asked to indicate the importance of each ability: Practitioners rated the ability's importance on a scale of 0 to 5, while evaluators had the option to identify each ability as unimportant. As a rough check of validity, these data are plotted against each other in Figure 1. Each data point represents a communication ability listed in Tables 1-3. The resulting R^2 (0.69) indicates a strong correlation.

Although practitioners tended to agree with evaluators *on average*, agreement among practitioners themselves was weak, as illustrated by the representative error bar in Figure 1. For each ability, the "average importance according to practitioners" is the mean of 64 ratings, and the standard deviation of those ratings is typically about 1.3. Given the large standard deviations, the data from practitioners should be interpreted

Table 2
Communication Abilities Recent Graduates Are NOT Expected to Have

E.	Evaluators agree that these communication abilities are *unimportant* for software engineers. (These abilities appear in **Region E** of Figure 3 and in the bottom half of Figure 2.)	*Importance Rating* (σ)*
	None of the tested communication abilities falls into this category.	
F.	Evaluators *disagree* as to whether these abilities are unimportant or whether they are learned on the job. (These abilities appear in **Region F** of Figure 3 and the bottom of Figure 2.)	*Importance Rating* (σ)*
59.	Communicate effectively via conference posters (f)	1.0 (1.2) ◇
60.	Communicate effectively via journal articles (f)	1.1 (1.4) ◇
61.	Be aware of the knowledge and concerns of lawyers (a)	1.1 (1.3) ◇
G.	Evaluators agree that these communications abilities will be *learned on the job*. (These abilities appear in **Region G** of Fig. 3 and in the bottom half of Fig. 2.)	*Importance Rating* (σ)*
62.	Show experience with document management systems (f)	†
63.	Communicate effectively via online meetings (f)	3.0 (1.5)◆
64.	Show experience with tools for project planning (f)	†
65.	Develop the flexibility to communicate in different roles within an organization (p)	3.2 (1.4)◆
66.	Be aware of the knowledge and concerns of customers of the company (a)	3.1 (1.7)◆
67.	Be aware of the knowledge and concerns of business &/or marketing (a)	2.7 (1.6) ◇

Note. (c), (p), (f), & (a) indicate the groups by which the abilities are classified: clarity, professional, audiences, forms & tools.
*The *importance rating* is the mean of ratings assigned to the communication ability by 64 practitioners (0 = *not important*; 1 = *somewhat important*; 5 = *essential*).
σ = standard deviation
For comparison with evaluator data, diamonds represent importance as rated by practitioners: open = *unimportant*; shaded = *somewhat important*; black = *important*.
†Practitioners were not asked to rate the importance of tools for team communication.

Table 3
Communication Abilities on Which Evaluators Disagreed as to Whether Recent Graduates Are Expected to Have Them

H. Evaluators *disagree* as to whether they expect recent graduates to have these communication abilities. (These abilities appear in **Region D** of Figures 2 and 3.)	*Importance Rating* (σ)*
36. Communicate to an audience of end users of the software (a)	3.5 (1.6)◆
37. Use metaphors to communicate a system's purpose (c)	2.4 (1.4) ◇
38. Communicate to an audience of software architects (a)	3.9 (1.2)◆
39. Communicate to an audience of managers (a)	4.3 (1.0)◆
40. In conflicts, collaborate to identify win-win solutions (p)	3.8 (1.2)◆
41. Communicate effectively via code check-in notes (f)	3.0 (1.5)◆
42. Communicate across organizational boundaries (consult others and keep them informed of developments that may affect them) (p)	3.7 (1.3)◆
43. Communicate effectively via slides for distribution (f)	2.6 (1.4) ◇
44. Prioritize communication tasks (e-mail, meetings, responding to questions) to use time wisely (p)	3.6 (1.2)◆
45. Show experience using source code control systems (f)	†
46. Use structure and formatting to enable fast reading (c)	3.2 (1.2)◆
47. Communicate to an audience of new hires (a)	3.1 (1.7)◆
48. Communicate to an audience of persons from other countries & cultures (a)	2.8 (1.7)◆
49. Communicate effectively via web pages (including blogs) (f)	2.5 (1.7) ◇
50. Show experience using wikis f)	†
51. Communicate effectively via conference presentations (f)	1.6 (1.5) ◇
52. Communicate effectively via audio/video (e.g., for presentations) (f)	2.1 (1.5) ◇
53. Communicate effectively via formal requirements / specifications (f)	3.0 (1.6)◆
54. Communicate effectively via bug reports (f)	4.0 (1.2)◆
55. Communicate effectively via formal documentation (f)	3.0 (1.6)◆
56. Communicate effectively via conference calls (f)	3.2 (1.4)◆
57. Be aware of the knowledge and concerns of UI designers (a)	3.2 (1.4)◆

Table 3 (*continued*)
Communication Abilities on Which Evaluators Disagreed as to Whether Recent Graduates Are Expected to Have Them

H. **(*continued*)** Evaluators *disagree* as to whether they expect recent graduates to have these communication abilities. (These abilities appear in **Region D** of Figures 2 and 3.)	*Importance Rating* (σ)*
58. Show experience with bug management systems (f)	†

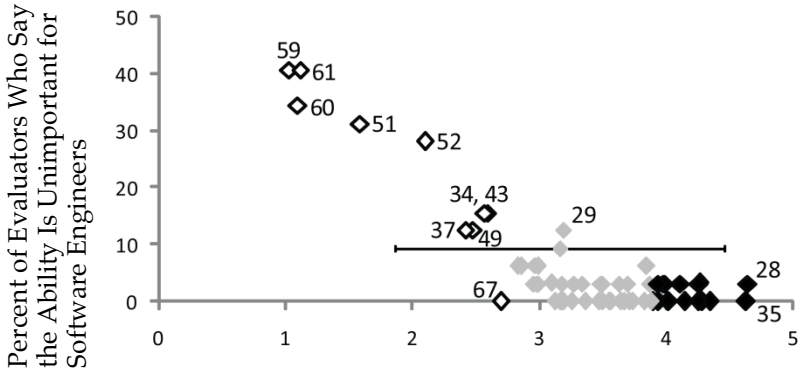
Note. (c), (p), (f), & (a) indicate the groups by which the abilities are classified: clarity, professional, audiences, forms & tools.
*The *importance rating* is the mean of ratings assigned to the communication ability by 64 practitioners (0 = not important; 1 = somewhat important; 5 = essential)
σ = standard deviation
For comparison with evaluator data, diamonds represent importance as rated by practitioners: open = *unimportant*; shaded = *somewhat important*; black = *important*.
†Practitioners were not asked to rate the importance of tools for team communication.

with some caution. The remainder of the article focuses primarily on the data from evaluators; practitioner data is reflected only in the shading of the data points. Grey shaded points indicate that an ability is of average importance (within two standard deviations of the mean of the distribution of means), black shading indicates that an ability is particularly important (average importance > 3.9), and white shading indicates that an ability is relatively unimportant (< 2.8).

Survey Results

The responses to the survey questions are shown in Figures 2 and 3. For each ability, Figure 2 shows the percentage of evaluators who expect recent graduates to have the ability, along with a breakdown between the specific responses of "*Yes*, but they usually *lack* this ability" and "*Yes*, and they usually *possess* this ability." In particular, the percentage of evaluators who said "yes" is shown on the vertical axis, while the horizontal axis shows the percentage of these respondents who said specifically, "*Yes*, and they usually *possess* this ability." The remainder can be assumed to have responded, "*Yes*, but they usually *lack* this ability"; responses of "Don't Know" were rare and are treated as nonresponses. Thus, the closer a data point is to the right side of the graph, the greater the agreement that recent

Figure 1
Importance of Communication Abilities According to Practitioners

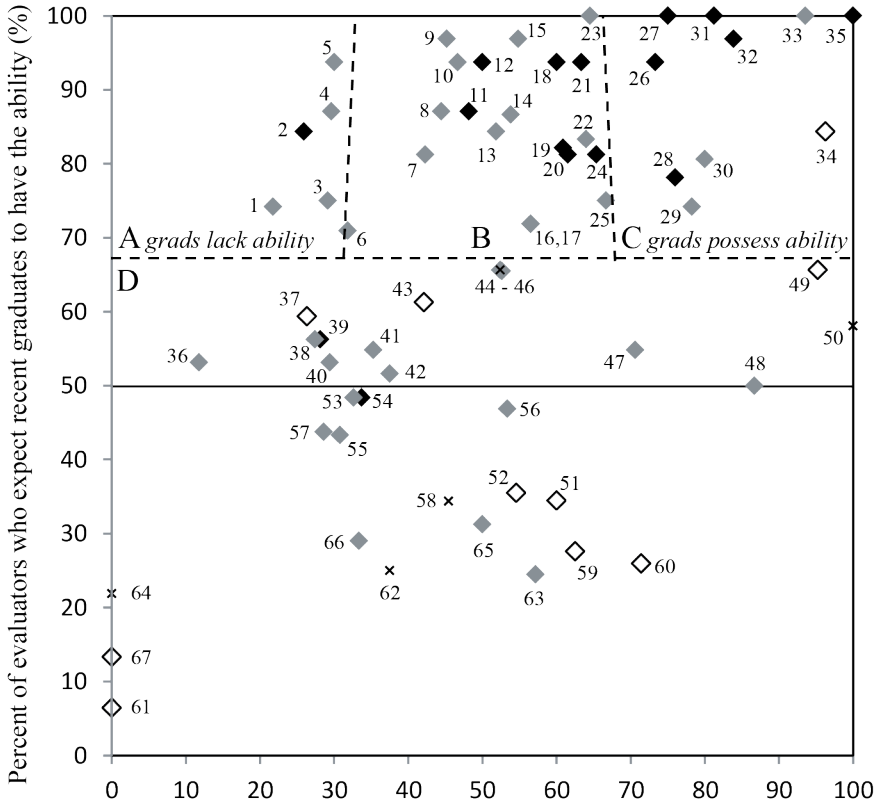


graduates usually possess the ability, while the closer it is to the left side of the graph, the greater the agreement that they usually lack the ability.

Dashed lines indicate significance in a two-tailed exact binomial test with $p = 0.05$. For example, Region A shows abilities recent graduates are expected to have but lack, while region C shows abilities they are expected to have and possess. The shading of each data point indicates the communication ability's relative importance according to practitioners, as explained in Figure 1. Relative importance was not requested for abilities marked by ×.

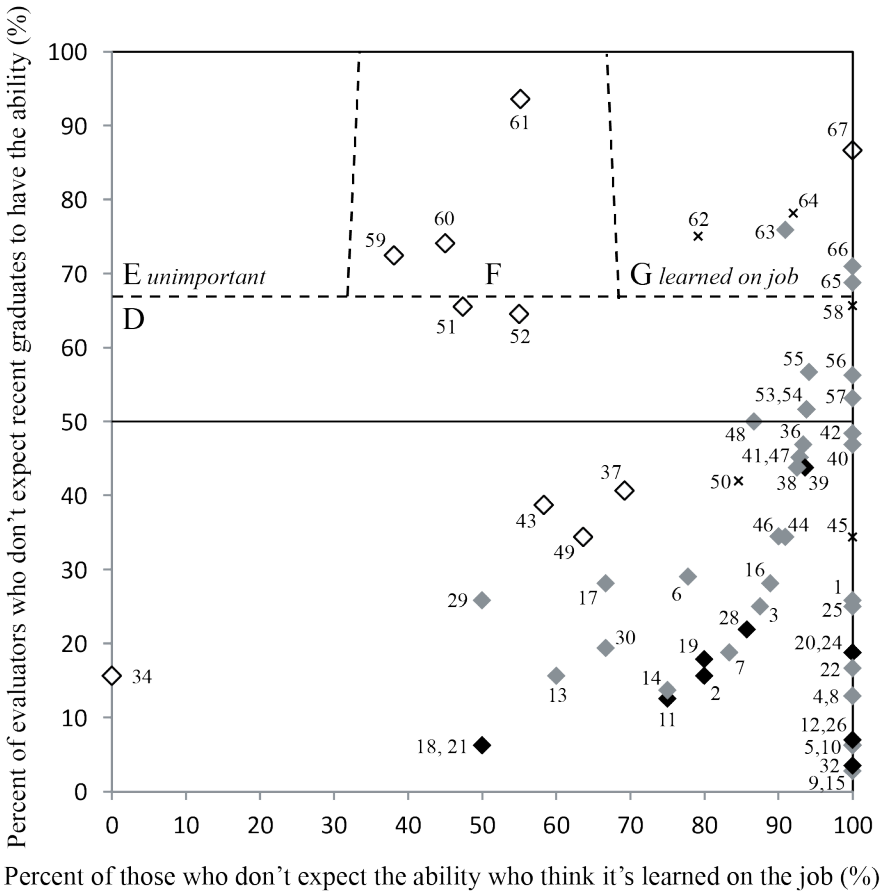
The abilities that recent graduates are *not* expected to have are the focus of Figure 3. In particular, for each ability, the percent of evaluators who said they do *not* expect the ability is shown on the vertical axis, while the horizontal axis indicates which of those respondents said specifically, "*No*, this ability will be *learned on the job*." The remainder responded, "*No*, this ability is *unimportant* for software engineers." Each ability appears in both graphs. The abilities, shading of data points, and significance tests are as in Figure 2. For example, Region E shows abilities recent graduates are not expected to have because they are unimportant, while region G shows abilities that are not expected because they are learned on the job. Some overlapping points have been moved slightly to improve visibility. For example, the ability to communicate effectively via formal presentations to a group (nonconference) is the

Figure 2
Communication Abilities That Evaluators Expect Recent Graduates to Have



point numbered 6 in both graphs: In Figure 2, it is in Region B, while in Figure 3, it is in the bottom half of the graph. Figures 2 and 3 show that, of evaluators who responded to this item, 71% responded "yes," they expect recent graduates to have this ability, while 29% responded "no," they do not expect recent graduates to have this ability. Of those who responded "yes," only 32% said recent graduates actually possess the ability; the rest (68%) said recent graduates lack the ability. Of those who responded "no," 78% reported that the ability is learned on the job, while the rest (22%) reported that the ability is unimportant for software engineers.

Figure 3
Communication Abilities That Evaluators Do *Not* Expect Recent Graduates to Have



In the bottom half of each graph, each data point's horizontal position is based on a small sample size (less than 16, or 50% of evaluators) and should be treated with particular caution; more robust results for the ability can be seen by looking at the other graph, where the ability will appear in the top half of the graph (sample sizes greater than 16). For each ability, we determined whether significantly more evaluators said

"yes," whether significantly more said "no," or whether the results are not significant (two-tailed exact binomial test with a *p*-value of 0.05). For significant results, we then analyzed the specific explanations. For example, if significantly more evaluators said "yes," they do expect recent graduates to have a particular communication ability, we then performed a second binomial test to determine whether significantly more of those respondents said recent graduates usually possess the ability or whether significantly more said graduates usually lack the ability (total expected Type 1 errors = 5.55). Because the response "Don't Know" was treated as a non-response, the number of evaluators for each ability ranged from 27 to 32 (with a mean of 31.3) for the first round of tests. Because the second round of tests looked in more detail at only the "winning" response from the first round, these sample sizes are smaller: 20-32 (with a mean of 26.5).

The dashed lines in Figures 2 and 3 delineate which results are statistically significant. For example in Figure 2, abilities that appear above the dashed line were expected by a significantly large number of evaluators. If a significantly large percentage of these evaluators reported that recent graduates usually lack the ability, the ability appears in Region A. If a significant fraction said that recent graduates actually possess the ability, the ability appears in Region C. Finally, if the evaluators who expect the ability disagreed as to whether recent graduates lack or possess it, the ability appears in Region B. In Figure 3, Regions E, F, and G are defined similarly. The significance regions correspond to the regions in Tables 1 and 2. The abilities in each graph's non-significant region D are listed in Table 3. Thus, point 6's position in the upper-left region of Figure 2 suggests that it is expected of recent graduates, but that recent graduates usually lack the ability; the first result is statistically significant, but the second is not.

Discussion

What Communication Abilities Do Employers Expect Recent Graduates to Have?

The overall trends in Tables 1-3 suggest that employers expect recent graduates to be able to communicate clearly and professionally. The expected abilities for communicating clearly include using correct spelling and grammar most of the time; being concise; giving sufficient explanation; and giving clear, high-level overviews. The 15 expected abilities for communicating professionally echo the communication ability identified as most important in aerospace and defense by Lang et al. (1999): "interpersonal skills (verbal, non-verbal, and written), which maintain high

professional quality, convey appropriate respect for individuals, groups, teams, and develop a productive working environment." For example, our results suggest that employers expect recent graduates to develop a productive working environment by participating in meetings, communicating through transparency, listening actively, and communicating with confidence, while simultaneously treating others with respect and being nice to others.

2. *Which of the Expected Communication Abilities Do Recent Graduates Usually Possess, and Which Do They Usually Lack?*

Our data suggest that for many communication abilities, recent graduates meet employers' expectations (see Figure 2, Region C): the ability to use correct terminology and use terminology consistently, to use fluent English, to be nice to others through words and tone, and to communicate via telephone, instant messaging, e-mail, one-on-one presentation, and small talk.

Recent graduates also lack several expected abilities, however. New graduates do not meet employers' expectations when it comes to recognizing one's own communication weaknesses and improving one's own communication skills, being concise, connecting new information to information that is familiar to the audience (Ability 1), and ordering information in a way that makes explanations easy to follow (Ability 2).

Abilities 1 and 2 were intended to represent the communication ability called "cohesion" by Williams and Bizup (2014) and described by Gopen and Swan (1990) as the ability to meet readers' expectations with respect to the positioning of old and new information within sentences. We should treat the result for Ability 2 with caution, because survey respondents may have been influenced by the wording "in a way that makes explanations easy to follow" rather than by the wording "order information." Yet our results suggest that recent graduates do not meet employers' expectations with regard to cohesion.

For many communication abilities that are expected of recent graduates, evaluators disagree as to whether recent graduates usually lack or usually possess these abilities. These abilities are shown in Region B.

3. *What Communication Abilities Are Recent Graduates* Not *Expected to Have?*

As shown in Table 2, the abilities that are not expected include occu-

pation-specific abilities and the ability to communicate effectively via conference posters and journal articles. Interestingly, communicating via journal articles had the greatest number of "Don't Know" responses of any ability: five, or 16% of evaluators. This could be the result of evaluators not understanding what *journal article* referred to, because it is a shorthand term for a scholarly publication.

4. Which of These Abilities Are Not Expected Because Graduates Will Learn Them on the Job, and Which Are Not Expected Because They Are Not Important?

The abilities that will be learned on the job (Region G) include those that are specific to the occupation or company, for example, the ability to use document management systems and tools for project planning. Although these abilities are expected to be learned on the job, some educators may wish to address them in order to help students be particularly competitive. Additional abilities that may help students to be particularly competitive are those shown in Table 3, for which a significant percentage of evaluators said either that the ability is learned on the job or that it is expected but recent graduates lack it. These abilities, shown in Table 4, are also primarily occupation-specific—for example, communicating via bug reports, formal requirements/specifications, and code check-in notes. Interestingly, although recent graduates are expected to learn many occupation-specific communication abilities on the job, they are expected already to be able to communicate effectively via code comments. According to evaluators, they usually lack this ability.

Implications

We began this article by pointing to the well-documented gap between employers' expectations for communication abilities of recent engineering graduates and abilities those graduates bring to their jobs. Our research has sought a more nuanced understanding of this gap, specifically, what abilities engineering graduates are expected and not expected to have, which they are perceived as already possessing, and which they are expected to learn on the job. Our findings have implications in particular for engineering educators and for technical communication educators.

Instructors could apply these research results by considering teaching those abilities that are expected of recent graduates (Table 1) and omitting from their courses those abilities that are not expected (Table 2). More specifically, if recent graduates are perceived as usually possessing an

ability that evaluators expect (Region C), then educators may either congratulate themselves on a job well done or assume that graduates gain the ability elsewhere. In the latter case, and for those abilities in Region B, individual attention could be given to students who lack the ability so that they will be able to meet employers' expectations. Educators might consider adding to the curriculum those abilities that employers expect but that recent graduates usually lack (Region A), while those who wish to graduate more competitive engineers might consider also adding those abilities that are expected by some employers and seen as learned on the job by others (see Table 4). Finally, the most ambitious programs might consider teaching the general principles of abilities that employers agree are learned on the job (Table 2, Region G). Given the inherent limitations of survey research, these general strategies must be tempered by a knowledge of the program's own goals and students, and of the expectations of the employers that typically hire those students.

As an example of teaching strategies that may be influenced by this research, to help students learn how to communicate both clearly and professionally, we suggest that engineering educators engage students in communicating via common engineering genres or types of communication. As described by Carter et al. (2011), genres are not simply "forms" of communication; rather, genres are *generic*, or common, communication situations handled by engineers. By engaging students in actual engineering genres, engineering educators can teach by providing feedback on how effectively students handle these common engineering situations, with consideration for both clarity and professionalism. Giving effective feedback may require providing the reasoning behind it, as suggested by Taylor's research (2011).

We were surprised at the value attributed to politeness in communication. This aspect of communicating professionally is indicated by the list of items in Table 5. What emerges is a portrait of an employee who is able to read and interpret situations and react appropriately, someone who acts with restraint when he or she might be inclined to act negatively, who gets along well with and respects others—in sum, someone who is *nice*. It is understandable that employers would value politeness so highly: Workplaces are social institutions and run more effectively when employees—especially newcomers—are polite. The high premium placed on politeness may strike some educators as being more about personality and the ability to empathize than about the ability to communicate effectively. However, sources such as *Team Writing: A Guide to Working in Groups* (Wolfe, 2010) offer concrete communication strategies for students in such areas as managing conflict, responding

Table 4
Items From Table 3 That a Significant Percentage of Evaluators Say Are Either Learned on the Job or Are Expected of and Lacked by Recent Graduates

36. Communicate to an audience of end users of the software.
37. Use metaphors to communicate a system's purpose.
38. Communicate to an audience of software architects.
39. Communicate to an audience of managers.
40. In conflicts, collaborate to identify win-win solutions.
41. Communicate effectively via code check-in notes.
42. Communicate across organizational boundaries (consult others & inform them of developments that may affect them).
53. Communicate effectively via formal requirements / specifications.
54. Communicate effectively via bug reports.
55. Communicate effectively via formal documentation.
56. Communicate effectively via conference calls.
57. Be aware of the knowledge and concerns of UI designers.

constructively to group members' writing, dealing productively with personal problems among team members, and taking full advantage of diversity in groups. Opportunities to provide such instruction are amply provided by group projects in technical communication and engineering courses and, especially, in engineering capstone courses.

We were also somewhat surprised by the value attributed to cohesion in writing, sometimes referred to as "flow," because cohesion was not one of the abilities volunteered as important by software engineers in our prior research (Ruff & Carter, 2009). We added this ability to the survey because it is considered important by communication educators and because Gopen and Swan (1990) note that lack of cohesion is one of the primary problems with technical writing in the U.S. Thus, evaluators did not identify cohesion as important until their attention was drawn specifically to it. In our experience, professionals are often astounded to discover the difference made by improved cohesion, so recent graduates with a strong command of cohesion are likely to make a good impression on employers. Thus, educators may want to retain or add instruction in cohesion to the curriculum.

Table 5
Items From Table 1 Indicating the Quality of Politeness in Communication

7. Adjust communication based on non-verbal reactions of audience.
8. Discern when to ask questions rather than to assert an opinion.
9. Communicate with a balance of confidence and humility (e.g., when giving opinions or making one's own accomplishments known).
13. Avoid taking debate, feedback, or others' opinions personally.
14. Discern when to keep silent rather than to speak.
15. Avoid complaining (by proposing a solution, fixing the problem, or remaining silent).
16. Manage one's own non-verbal communication to avoid sending inappropriate messages.
20. Respond professionally to one's own mistakes.
21. Use e-mail appropriately (e.g., read before sending, know when to talk in person, avoid flaming).
27. During discussion, treat others with respect (e.g., when giving an opinion, debating potential solutions, reviewing code).
31. Be nice to others, through words and tone (e.g., in daily interactions).

Finally, we were surprised by the dominance of oral communication in the expectations of evaluators. For example, evaluators expect recent graduates to be able to communicate effectively via formal and informal presentations to a group, via one-on-one and group meetings, via small talk and discussion, and nonverbally. In contrast, the only expected abilities that refer explicitly to writing are e-mail, instant messaging, the specialized genre of code comments, and correctness in spelling. The ability to write journal articles is not expected by evaluators, and they disagree as to whether they expect facility with formal documentation, specifications, or other specialized written genres. The dominance of oral communication may reflect the kinds of situations in which new graduates are most likely to communicate in the workplace; however, educators would probably not want to limit themselves to oral situations.

At the very least, written communication provides a particularly useful medium for teaching those communication abilities that are relevant to both written and oral communication, such as elements of style related to cohesion, concision, sufficiency, and correctness. Furthermore, although

recent graduates may learn about written genres such as formal requirements/specifications and formal documentation on the job, to do so they will benefit both from strong writing ability and from an understanding of how to analyze and respond to new genre situations.

Conclusions

Our analysis of the data regarding the expectations of employers of engineering graduates reveals a complex understanding of the expectations gap, going beyond simply a list of what new graduates should be able to do to a characterization of employers' expectations: what abilities engineering graduates are expected and not expected to have, which they are perceived as already possessing, and which they are expected to learn on the job. This complexity may explain why the expectations gap has been so persistent. The understandings that the data reveal may be useful to educators as they design their courses to prepare their students for employment in engineering. We believe, however, that it may be best that a course, or even a curriculum, be *informed* by this information rather than *dictated* by it. Educators need to find the proper balance between the employers' perceptions of effective communication and the educators' perceptions of the communication abilities their students need. As a general example, technical communication educators may place greater weight on broader principles, and engineering educators who emphasize communication may place a greater weight on employers' expectations. But any particular course could find its own balance in accordance with its purpose and audience.

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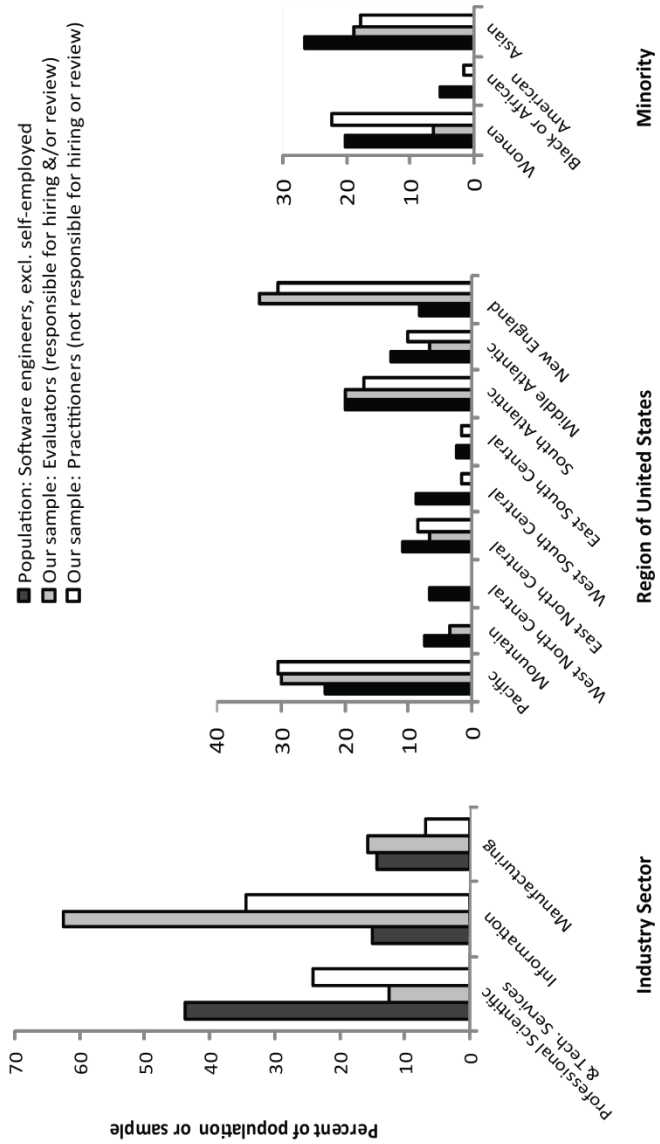
Appendix A

Demographics of Survey Respondents Compared With That of the Population of All Software Engineers



Note. The demographics of our samples differ somewhat from those of the population, so survey results should be used with caution. The results of this survey may best represent expectations in information industries along the coasts. Population data are from the Bureau of Labor Statistics.