



## **Engineering Technology Workplace Competencies Provide Framework for Evaluation of Student Internships and Assessment of ETAC of ABET Program Outcomes**

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## **Abstract:**

The Department of Bioresources Engineering at the University of Delaware has used a competency-based assessment approach as one means of demonstrating program outcomes for Engineering Technology Accreditation Commission (ETAC) of ABET accreditation of its 4-yr Engineering Technology (ET) program. Fourteen ET workplace competencies<sup>1</sup> were derived from Iowa State University (ISU) workplace competencies used for EAC of ABET accreditation of ISU engineering programs<sup>2</sup>. To avoid the complexity and interdependence of ETAC of ABET *a-k* program outcomes, each workplace competency was designed to be “clear, concise and independent of all others.” Mastery of each competency is demonstrated by performance of a “set of observable and measurable key actions.” The ET workplace competencies were validated by mapping them to the ETAC of ABET *a-k* program outcomes and showing that mastery of the workplace competencies was necessary and sufficient to address achievement of the program outcomes.

Undoubtedly, the best venue for demonstrating mastery of workplace competencies is in the workplace. The University of Delaware (UD) has a general education requirement for all students to engage in a 3-credit “Discovery Learning Experience” that involves substantial outside of the traditional classroom learning. Such experiences typically include internships, service-learning, independent study, undergraduate research, and study abroad. ET students at UD are encouraged to satisfy the requirement with a “Technical Practicum in Industry” – an internship. Students are required to keep a reflective journal documenting their work activities and time on the job, which must reach 120 hours for a 3-credit course. The students also submit a final report summarizing their experience.

The ET workplace competencies provide an excellent framework around which the students can organize their journals and final reports. Artifacts consisting of work products generated by the students can be provided and discussed in the narrative to demonstrate mastery of specific workplace competencies. Students are encouraged to document significant workplace experiences using the behavioral interviewing response technique known as “STAR” – Situation/Task, Action, Result<sup>3</sup>. At the conclusion of the internship, the students’ supervisors are requested to complete a brief evaluation of their advisees that is based on achievement of the workplace competencies. This process yields excellent direct assessment data that can be used for ETAC of ABET accreditation purposes and a solid basis for assigning a grade to a student’s internship efforts.

## **Introduction/Background:**

The Department of Bioresources Engineering (BREG) at UD offered a B.S. degree in Engineering Technology (ET) that was an ETAC of ABET-accredited<sup>4</sup> general ET program from 1988 through August of 2013. The program typically graduated 20 to 25 majors per year. There are now a handful of students who are being allowed to finish their degrees after the department

and program’s elimination effective February 2013. In 2009, the department had instituted changes to its curriculum and adopted assessment of workplace competencies as a direct assessment tool for evaluating achievement of ETAC of ABET program outcomes<sup>1</sup>.

The changes were based on pioneering work conducted at Iowa State University (ISU) where 14 engineering “workplace competencies”<sup>2</sup> were developed and determined to be “necessary and sufficient” to demonstrate the 11 EAC of ABET General Criterion 3, Student Outcomes<sup>4</sup>. Because the EAC of ABET program outcomes were (and are) complex, interdependent, and difficult to measure, the definition for each workplace competency was designed to be “clear, concise and independent of all others”<sup>2</sup>. Each competency was associated with a specific set of “observable and measurable Key Actions”<sup>2</sup> that when demonstrated by students confirm achievement of that particular competency. Definitions of all the ISU competencies and Key Actions (now expanded to 15 in number) are available at ISU Department of Agricultural and Biosystems Engineering web site<sup>5</sup>. As an example, one of the ISU workplace competencies, communication, along with its associated key actions is defined as follows:

**Communication Competency:** *Clearly conveying information and ideas through a variety of media to individuals or groups in a manner that engages the audience and helps them understand and retain the message.*

**Key Actions:**

- **Organizes the communication.** *Clarifies purpose and importance; stresses major points; follows a logical sequence.*
- **Maintains audience attention.** *Keeps the audience engaged through use of techniques such as analogies, illustrations, body language, and voice inflection.*
- **Adjusts to the audience.** *Frames message in line with audience experience, background, and expectations; uses terms, examples, and analogies that are meaningful to the audience.*
- **Ensures understanding.** *Seeks input from audience; checks understanding; presents message in different ways to enhance understanding.*
- **Adheres to accepted conventions.** *Uses syntax, pace, volume, diction, and mechanics appropriate to the media being used.*
- **Comprehends communication from others.** *Attends to messages from others; correctly interprets messages and responds appropriately.*

A complete list of the ET Workplace Competencies (without definitions or key actions) is shown in Table 1.

**Table 1. ET Workplace Competencies**

Engineering/Technical Knowledge	Analysis and Judgment
General Knowledge	Planning
Continuous Learning	Communication
Quality Orientation	Teamwork
Initiative	Integrity
Innovation	Professional Impact
Cultural Adaptability	Customer Focus

The ETAC of ABET *a-k* general criteria program outcomes share the difficult-to-measure qualities of the analogous EAC of ABET program outcomes<sup>4</sup>. Assessment of those outcomes can, therefore, benefit from the advantages of examining independent competencies such as those developed at ISU. The Department of BREG at UD used an approach modeled after the implementation at ISU to demonstrate student achievement of the ETAC of ABET *a* through *k* general criteria<sup>4</sup> for the ET program by assessing workplace competencies. To validate the ISU engineering workplace competencies, they were mapped to the ETAC of ABET *a* through *k* General Criterion 3 student outcomes by the BREG faculty and shown to be necessary and sufficient to establish achievement of the ABET student outcomes<sup>1</sup>. The ISU workplace competencies were adopted as UD ET workplace competencies. Students were required to document their mastery of the ET workplace competencies through use of an ePortfolio<sup>6</sup> thus providing, in addition to the ePortfolio's many developmental and learning benefits for students, a powerful direct assessment tool that could be employed by the department for ETAC of ABET accreditation purposes.

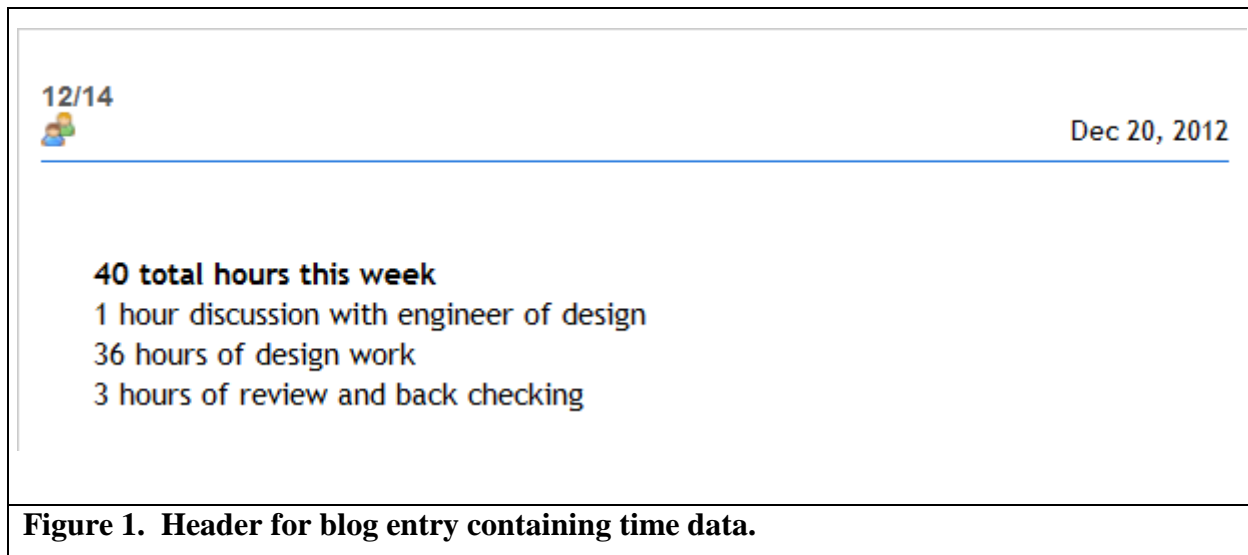
### **ET Workplace Competencies and Internships:**

UD has a Discovery Learning Experience (DLE)<sup>7</sup> that is a general education requirement for all majors. The DLE is defined as “discovery-based and experiential learning that involves instructional experiences out-of-class and beyond typical curriculum courses” under the guidance of a faculty member. At UD students in the ET program have been encouraged to satisfy the DLE requirement through either a three-credit internship course titled “Technical Practicum in Industry” or through three credits of undergraduate research. Most have done the technical practicum. As ISU found with co-op and internship experiences<sup>2</sup>, such a DLE is an ideal opportunity for students to demonstrate mastery of the workplace competencies. Students doing either an internship or undergraduate research experience are performing in a workplace-like setting and are under the direction of an industry or research supervisor. Supervisor evaluations can be used for direct assessment of student workplace competencies<sup>8</sup>.

**Student Reflective Journal and Report:** The student interns are required to keep a reflective journal to document the hours they have worked and the nature of the work performed. The students are asked to structure their journals around documentation of the workplace competencies. An ideal format for such journals is an electronic blog. At UD, the online learning management system Sakai<sup>9</sup> is used institution-wide by a large segment of the faculty. Sakai includes a basic blogging feature that is suitable for such an application. The entries can be arranged by weekly activities which is convenient because that is how time sheets are typically completed. Figure 1 shows the header for a blog entry that summarizes work activities for the week.

This format is helpful for the supervisor when he or she is asked to verify the intern's work hours. An additional bit of information not included in Figure 1 but which is beneficial to the academic advisor is for the student to show a running total of the hours worked, so that the total required hours of 120 for three credits can be easily confirmed.

Students were encouraged to use the format from the STAR<sup>3</sup> method of answering behavioral interview questions when documenting the competencies. The Situation/Task the students were presented with is first discussed. The students then describe the Actions they took in response to the situation/task and finish by relating the positive Result that came about because of their actions.



Using the blog feature of Sakai, it is then easy to attach artefacts (i.e., supporting documentation) to further illustrate the student’s work. Figure 2 is a screen shot of a representative blog entry. When the hyperlink “Expansion Dam” is activated, a multipage pdf document is displayed showing some of the student’s work. A small portion of that document is depicted in Figure 3.

The final requirement of the course is submittal of a report that provides an overview of the student’s whole internship experience. The journal/blog provides an excellent resource for assembling the final report. For the report, the students are again asked to focus on documentation of their mastery of the ET Workplace Competencies. In their discussions, the students can reference documents attached to their blogs and draw from specific entries.

This author has advised students doing internships for many years. The requirements have always been similar over that time: a reflective journal and a written report summarizing the experience. Introduction of the ET Workplace Competencies as a framework around which to organize the technical practicum in industry course has had several benefits. Among those benefits is a clearer understanding on the student’s part about what he or she should gain from the internship experience. In addition, there has been a noticeable improvement in the quality of the reports submitted, and the instructor has better defined criteria to use for assigning a grade.

Without hard data as backup, this author has the impression that asking the students to reflect on the workplace competencies and their mastery has had a positive impact on the students’ sense of professionalism and its importance, especially for those who have had little professional work experience. An internship by itself encourages such development, but reflection encourages deeper analysis and maturity.

**Supervisor Survey:** ISU employed an online evaluation system that was used by supervisors to evaluate interns and by the interns to complete self-evaluations<sup>2</sup>. The supervisors were asked to evaluate the performance of the interns for *each* of the Key Actions for *each* of the 14 workplace competencies yielding a total of 61 Key Actions that would need to be rated for each intern. The Likert scale ratings for each of the Key Actions were in the following form<sup>2</sup>:

*When given the opportunity, how often does this individual perform the action?*

1. *Never or almost never*
2. *Seldom*
3. *Sometimes*
4. *Often*
5. *Always or almost always*

**Engineering and technical knowledge-**  
Having achieved a satisfactory level of knowledge in the relevant specialty areas of mathematics, science and engineering/technology.

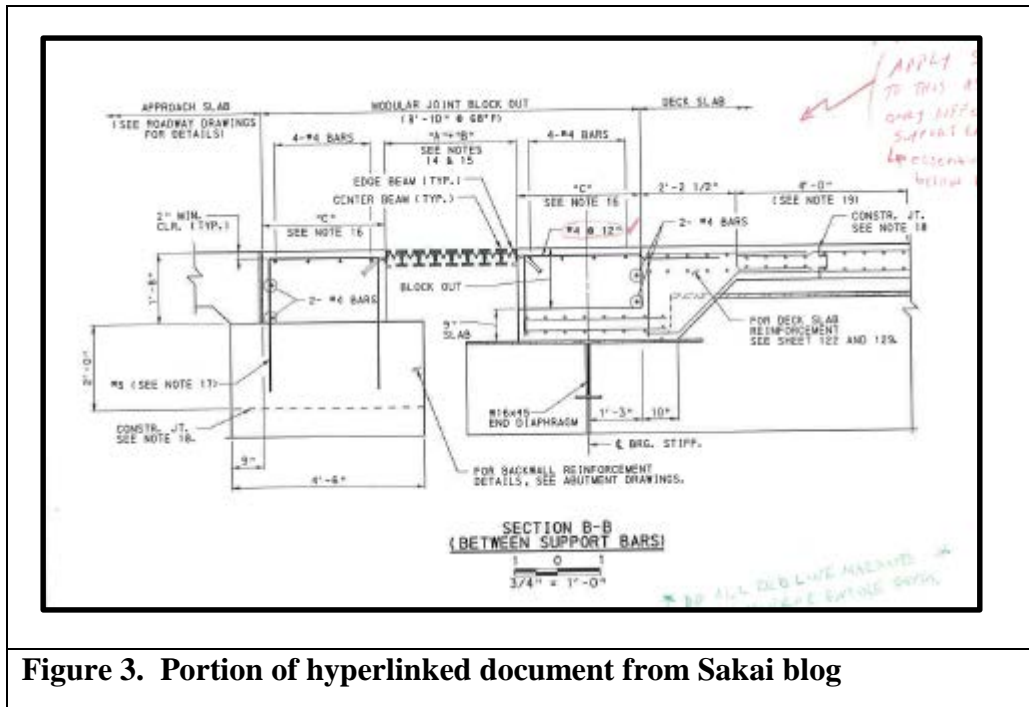
Situation/Task	(Key) Action	Result
<p>This week's task is a continuation of last week, which was creating modular expansion joint details. This week was more of the detailing and the fine tuning of the plans to get them to the level the engineer wants them. By completing these plans it shows that I have high level of engineering and technical knowledge. I have to understand what the engineer is trying to communicate.</p>	<p><b>Knowledge of mathematics-</b> This I use every day, usually changing decimal feet to fractional feet and inches or measuring the lengths of beams, girders, or reinforcement bars. Also used a lot in stationing.</p> <p><b>Knowledge of technology -</b> I also use this every day. Learning and using new and different computer programs is one of the things that keep me interested in this job.</p>	<p>The engineer and I worked closely this week in order to get the expansion details to the level of detail that is consistent with the standards. I spent time ensuring everything was drawn to a correct scale and the dimensions are measuring correctly. I also ensured that call out were point to the proper locations and call out the proper names.</p> <p>See link below for example.</p>

[Expansion Dam](#)  
[Edit entry](#) | [Remove entry](#) | [0 comments](#) | [Leave a comment](#) | [Permalink](#)

**Figure 2. Blog entry documenting Engineering and Technical Knowledge workplace competency.**

The estimated time for completion of the survey was 20-30 minutes<sup>10</sup>. A survey of 61 questions with an estimated completion time of over 20 minutes could certainly be perceived as burdensome. For evaluation of our ET interns, a survey of this length looked to be an excessive demand on supervisor time. To streamline the evaluation process, the survey was shortened to 16 questions, one for each of the 14 ET workplace competencies, plus a question asking the supervisor to verify the hours and character of

the student’s journal entries and an open response question allowing the supervisors to write in comments or observations they thought were appropriate. An Adobe form was developed with radio buttons used to select the appropriate response for each of the survey questions. Figure 4 shows an example survey question for the “Analysis and Judgment” workplace competency. This survey form was used beginning in spring of 2012.



Supervisors are contacted via email and are given access to the students’ Sakai blogs. To facilitate their reviews, supervisors are provided with instructions on use of the Sakai site. An Adobe survey form is attached to the email. Emails also contain the following background information and instructions:

*We have identified 14 work-place competencies that are critical for an individual's success in engineering-related employment that each student should master as part of the ET program. Undoubtedly, the best place to demonstrate mastery of workplace competencies is in the workplace, so as the student’s supervisor your perspective on the student’s performance is extremely valuable to us. Please read the definitions for each of the competencies in the survey questions along with the associated key actions for each competency that demonstrate an individual's mastery of it. The 16th and final question on the survey allows you to enter any comments you feel are appropriate.*

*Please use your professional judgment to choose the response for each question that seems best based on your observations of the student intern’s actions under your supervision. We don't necessarily expect a student intern to have the opportunity to demonstrate each key action or to get experience with each*

*competency. For some such competencies, the last response, “unable to evaluate -- no opportunity to observe”, may be appropriate.*

As a self-evaluation, the student intern can be required to complete a similar survey consisting of the same questions asked from the student’s point of view.

<p><b>Question 1: Competency - Analysis and Judgment</b></p> <p><b>Definition:</b> Identifying and understanding issues, problems, and opportunities; comparing data from different sources to draw conclusions; using effective approaches for choosing a course of action or developing appropriate solutions; taking action that is consistent with available facts, constraints, and probable consequences.</p> <p><b>Key Actions:</b>  <b>Identifies issues, problems and opportunities.</b> Recognizes issues, problems, or opportunities and determines whether action is needed.  <b>Gathers information.</b> Identifies the need for and collects information to better understand issues, problems, and opportunities.  <b>Interprets information.</b> Integrates information from a variety of sources; detects trends, associations, and cause-effect relationships.  <b>Generates alternatives.</b> Creates relevant options for addressing problems/opportunities and achieving desired outcomes  <b>Commits to action.</b> Implements decisions or initiates action within a reasonable time.  <b>Chooses appropriate actions.</b> Formulates clear decision criteria; evaluates options by considering implications and consequences; chooses an effective option.  <b>Involves others.</b> Includes others in the decision-making process as warranted to obtain good information, make the most appropriate decisions, and ensure buy-in and understanding of the resulting decisions.  <b>Values diversity.</b> Embraces and values diverse collection of inputs, values, perspectives, and thought paradigms in approaching the application of engineering and technology to products and processes.</p> <p>When given the opportunity, how often, on balance, does the student perform the Key Actions associated with this competency?</p> <table border="1"> <tr> <td><input type="radio"/></td> <td>Never or almost never</td> </tr> <tr> <td><input type="radio"/></td> <td>Seldom</td> </tr> <tr> <td><input type="radio"/></td> <td>Sometimes</td> </tr> <tr> <td><input type="radio"/></td> <td>Often</td> </tr> <tr> <td><input type="radio"/></td> <td>Always or almost always</td> </tr> <tr> <td><input type="radio"/></td> <td>Unable to evaluate; no opportunity to observe</td> </tr> </table>		<input type="radio"/>	Never or almost never	<input type="radio"/>	Seldom	<input type="radio"/>	Sometimes	<input type="radio"/>	Often	<input type="radio"/>	Always or almost always	<input type="radio"/>	Unable to evaluate; no opportunity to observe
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<input type="radio"/>	Always or almost always												
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<p><b>Figure 4. Example Supervisor Survey Question for the Analysis and Judgment Workplace Competency.</b></p>													

**Results and Discussion:**

With elimination of the BREG department, phase-out of the ET program, and no more admittance of students, the number of opportunities to test this assessment process has plummeted. The author has used the ET Workplace Competencies to structure seven internships under his direction. Two more are currently underway. Supervisors have been very willing to



comply with requests for completion of the surveys. For this admittedly small sample size, a 100% return rate was achieved without the need for any follow-up to get responses from laggards. Supervisors have tended to rate the student interns highly. A 5-point Likert scale where “1” corresponds to “Never or almost never” and “5” is “Always or almost always” was used to quantify the supervisor responses. Responses of “Unable to evaluate; no opportunity to observe” were treated as “no response.”

For the limited number of supervisor surveys completed, the vast majority of ratings in all the categories have been “4”s and “5”s. Such scores correspond to “Often” and “Always or almost always” with respect to the student interns performing the Key Actions that demonstrate each competency. The average rating for the 14 competencies and completed supervisor surveys for the seven interns was 4.59. Given the small sample size, there are limits to the conclusions that can be drawn from these data, but other departments using the same methodology could obtain valuable information for continuous improvement. The ratings of the competencies for the seven interns are displayed in Table 2. Competencies are listed in order from highest to lowest supervisor ratings. As indicated by the Sample Size column, the Initiative and General Knowledge competencies each received one “unable to evaluate” response while the “Cultural Adaptability” competency had two supervisors unable to evaluate.

**Table 2. Average supervisor evaluations of the ET Workplace Competencies for ET Interns**

<u>Competency</u>	<u>Rank</u>	<u>Sample Size</u>	<u>Average</u>
Integrity	1	7	5.0
Quality Orientation	1	7	5.0
Teamwork	3	7	4.9
Continuous Learning	4	7	4.7
Engineering/Technical Knowledge	4	7	4.7
Initiative	4	6	4.7
Analysis and Judgment	7	7	4.6
General Knowledge	8	6	4.5
Innovation	9	7	4.4
Planning	9	7	4.4
Professional Impact	9	7	4.4
Cultural Adaptability	9	5	4.4
Communication	13	7	4.3
Customer Focus	13	7	4.3

Even with consideration of the small sample size, the results shown in Table 2 are comparable to those obtained by Brumm et al.<sup>10</sup>. It should be noted that the results at ISU and U\_ were obtained with two somewhat different populations of student interns. At ISU, the students are engineering majors; while at UD, the students are in ET.

For supervisor evaluations of over 2300 ISU engineering interns<sup>10</sup>, the four competencies that were most consistently ranked the highest were: Integrity, Quality Orientation, Teamwork, and Cultural Adaptability. The top three correspond exactly to those ranked most highly for the ET students from UD. Interestingly, the “Cultural Adaptability” competency was much more highly

rated at ISU than at UD, which could have been a consequence of the small UD sample size. A comparison of the lower rated competencies from the study by Brumm et al.<sup>10</sup> with those at UD also shows good agreement. At ISU the four lowest rated competencies were Innovation, Communication, Customer Focus, and Initiative. The relatively higher rating for Initiative at UD could again be a result of the small sample size. Several of the student interns at UD were non-traditional older students who already had varied work experiences. Such students might be expected to exhibit more independence and initiative in the workplace than traditional university students who would typically lack an extensive work background.

These type of data are extremely valuable for use in the continuous improvement process demanded by ABET accreditation<sup>4</sup>. The supervisor surveys are considered direct assessment instruments<sup>8</sup> and can help inform decisions about curriculum improvement. For the individual student, the workplace competencies provide a gage student interns can use to self-evaluate their readiness for work, guide behavior on the job, and target areas for improvement.

### **Conclusion:**

Using the workplace competencies as a lens through which to evaluate the internship experience has benefits for the academic advisor, the student, and the ET program. Advisors can use the workplace competencies to give structure to the internship course and help provide the students with a positive learning experience. Student interns are introduced to elements of professionalism in the workplace and become aware of critical competencies and the associated behaviors that make a positive impact in the workplace. Finally, the academic programs can use supervisor surveys as direct assessment tools that can assist with continuous quality improvement measures.

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