A Measure of Minimum Technical Competence to Use in Hiring

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Economic incentives and misconceptions often steer students in the basic sciences away from careers in agricultural, food, and feed sciences. The number of highly qualified students entering disciplines and fields connected to agricultural production and processing has not kept pace with the number of unprecedented challenges to producing sufficient food and feed for a growing world population. This situation has led the AACC International Scientific Advisory Panel and the Coalition for a Sustainable Agricultural Workforce to voice their concerns about the number, suitability, quality, and adequateness of future agricultural, food, and feed industry employees (3,6). A greater number of potential employees are needed to replace ≈50% of the current workforce in government and industry who are preparing to retire during the next decade (3). A significant number of these new employees are needed to address engineering and processing considerations to ensure abundant, healthy, and safe foods (i.e., candidates with engineering degrees).

Typical inputs used in current hiring practices include personal and technical interviews, personality and psychological assessments, and reference checks. Previous job and industry experiences, involvement in extracurricular activities, and international experience and language skills are also evaluated and factored into hiring decisions. Direct measures of candidate preparation that may be used in evaluating potential employees include academic degrees, professional certificates, and grade point averages. However, I wonder how many employers are actively taking advantage of a measure of minimum technical competence when hiring engineers? For those employers hiring engineers in technical positions, do employers ask candidates if they sat for the Fundamentals of Engineering (FE) exam?

Use of FE Exam as a Measurement Instrument

An overlooked measure that I contend holds value for employers in the hiring process is performance on the National Council of Examiners for Engineering and Surveying (NCEES) FE exam. NCEES is a nonprofit organization that develops, administers, and scores the examinations used for engineering licensure in the United States to facilitate professional mobility and promote uniformity for its member licensing boards and licensees (4). The FE exam, which is taken by more than 50,000 examinees per year, is intended to measure the minimum technical competence of engineers who are entering their professional careers (2). While the FE exam offered throughout the United States is the same in each state, individual states oversee licensure within their jurisdiction. Because of differences between states relative to licensure rules and regulations, the requirements that an examinee must meet to sit for the FE exam and to obtain licensure differ by state. Information about individual state boards for engineering licensure can be found at ncees.org/licensing-boards.

The FE exam, as briefly described in the accompanying FE Exam Structure sidebar, is a pencil and paper, pass/fail exam. For the most part, it is taken by college seniors during their last year of professional education or by recent college graduates. The various topic areas covered by the multiple-choice questions included in the morning session of the FE exam are listed in the accompanying FE Exam Session Specifications sidebar. The seven engineering disciplines covered in the afternoon modules (the examinee must select one to complete) are also listed in the FE Exam Session Specifications sidebar. It is my contention that the engineering disciplines listed in Table I (i.e., chemical, environmental, mechanical, and other disciplines) are the most realistic and practical disciplines for potential employees seeking a processing or engineering position in the food or feed industry. Common topics for examination questions among these four disciplines are those related to process management and economics and to fluid properties and applications (Table I).

During the administration of one FE exam in October 2012, examinees self-identified as agricultural, biological, and biomedical engineers who completed the Other Disciplines module had pass rates of 73, 66, and 67%, respectively, compared with a pass rate of 67% for examinees from 15+ disciplines (5). Examinees completing the Chemical, Environmental, and Mechanical modules of the FE exam had pass rates of 81, 80, and 81%, respectively (5).

A record of passing the FE exam implies a candidate has minimum technical competence in an engineering discipline and awareness of the obligation to protect the public from incompetent or unethical practices. Knowing that a candidate has passed the FE examination provides another piece of information that an employer may find useful in the hiring process. Determining the composite performance of students from the candidate’s

FE Exam Structure

Currently offered every April and October as an 8 hour exam (with 1 hour lunch break)
Multiple choice (4 options/question) exam
120 common questions in morning session
60 discipline-specific questions in afternoon session

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http://dx.doi.org/10.1094/CFW-58-4-0187
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school compared with students from peer schools may provide an employer with yet more information.

Employers considering using a candidate’s performance on the FE exam in their hiring assessment need to remember that passing the examination does not indicate that a potential engineering or processing employee has competence in all engineering disciplines, has good work habits, is committed to activities and projects, or possesses suitable social and communication skills and interests. The other measures and inputs in the hiring process must be depended on for an evaluation of any candidate in these areas.

How Engineering Schools Use FE Exam Performance

It is becoming more common for U.S. and international engineering colleges and degree programs to use the FE exam results of their graduating students as part of their ABET Criterion 3 Student Outcomes (a–k) or similar self-assessment process (2). Beyond assessing the minimum competency (i.e., FE exam pass rates) of examinees, colleges and their programs are using examination results to assess attainment of educational objectives by their graduating students (2).

Criteria that an engineering degree program must meet to achieve or maintain ABET accreditation include 1) the educational objectives for the program; 2) the outcomes for the program; 3) an assessment process to collect data on objectives and outcomes; and 4) an evaluation process that shows how the program interprets the collected data (2). FE exam performance (a third-party direct measure) allows for comparison of student knowledge against a measurable norm (i.e., measuring minimal competence as well as achievement of program outcomes).

An ABET-accredited program must have documented program outcomes that prepare graduates to attain the educational objectives of the program (1). Program outcomes are outcomes a–k (listed) plus any additional outcomes that may be articulated by the faculty overseeing the program.

### FE Exam Session Specifications

#### Morning Session

Same questions for all examinees per exam  
Average of 2 minutes per question  
Topics covered and percentage of questions:  
- Mathematics, 15%  
- Engineering Mechanics (Statics), 6%  
- Engineering Mechanics (Dynamics), 4%  
- Engineering Probability and Statistics, 7%  
- Strength of Materials, 7%  
- Chemistry, 9%  
- Material Properties, 7%  
- Computers, 7%  
- Fluid Mechanics, 7%  
- Ethics and Business Practices, 7%  
- Electricity and Magnetism, 9%  
- Engineering Economics, 8%  
- Thermodynamics, 7%

#### Afternoon Session

Choose one of seven discipline modules:  
- Chemical  
- Civil  
- Electrical  
- Environmental  
- Industrial  
- Mechanical  
- Other Disciplines

### Table 1. Specification topics covered and percentage of questions asked in the Fundamentals of Engineering exam afternoon session modules that are logical for food engineers to take

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chemical</th>
<th>Mechanical</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced engineering mathematics</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Engineering probability and statistics</td>
<td>9</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Biology</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Engineering economics</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Application of engineering mechanics</td>
<td>13</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Engineering of materials</td>
<td>11</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Fluids</td>
<td>15</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Electricity and magnetism</td>
<td>12</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Thermodynamics and heat transfer</td>
<td>15</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

* Source: Barrett et al. (4).
a) An ability to apply knowledge of mathematics, science, and engineering
b) An ability to design and conduct experiments, as well as to analyze and interpret data
c) An ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) An ability to function on multidisciplinary teams
e) An ability to identify, formulate, and solve engineering problems
f) An understanding of professional and ethical responsibility
g) An ability to communicate effectively
h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) A recognition of the need for, and an ability to engage in, life-long learning
j) A knowledge of contemporary issues
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

In a 2010 survey of more than 375 institutions with engineering degree programs, only 36% of respondents indicated that some or all programs within their institution required students to take (but not necessarily pass) the FE exam to graduate, yet 81% indicated some level of use of results from the FE exam for assessment of their programs (2). Given that colleges and engineering degree programs are likely aware of the performance of their students by topic areas compared with national peers, I encourage employers to ask college deans and program chairs about how their students measure up compared with national averages. Comparing the performance of students from a potential employee's school to students from peer schools may provide information beyond a candidate's minimal technical competence.

**Conclusions**

I believe a measure exists that can be used by employers to assess the minimum technical competence of potential processing and engineering employees. Comparison of the level of performance of engineering students from a particular school with engineering students from a peer group of schools might be possible if all graduating engineering students were to take the FE exam and if all engineering programs shared the performance of their students.

**Note.** Beginning in January 2014, the FE exam will move to a computer-based test format with 110 multiple-choice questions to be completed in six hours. The current morning session topics will be blended in with the afternoon session's seven module discipline topics. Examinees will be required to select one of the seven discipline-based examinations to complete. More information on the new format can be found at cbt.ncees.org.

**References**