

## Biosystems and Agricultural Engineering

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Degree Programs Assessed	Assessment Methods	Number of Individuals Assessed
Bachelor of Science in Biosystems Engineering	Exit interview	9
	Student performance on the Fundamentals of Engineering (FE) Exam	10 (2003-2004) 40 (1999-2004)
	Student performance in the senior design experience	7
	Undergraduate program alumni survey	8
Master of Science in Biosystems Engineering Doctor of Philosophy in Biosystems Engineering	ABET accreditation review	N/A
	Graduate program alumni survey	12
	Graduate student satisfaction survey	5

### Analysis and Findings

#### For the Bachelor of Science Degree Program

*Exit interview:* The written survey instrument focused on questions corresponding directly to the twelve expected student outcomes for the degree program. In the survey, each graduating senior was asked: "How well did your OSU education prepare you:

To apply knowledge of mathematics, science, and engineering  
To design and conduct experiments, as well as to analyze and interpret data  
.....  
Etc.

A numerical scale was used (1 = "very well"; 2 = "adequately"; 3 = "not very well"; 4 = "not at all"). The overall mean response for all students and all 12 questions was 1.52, and none of the twelve outcomes had a mean response above 1.88. These results clearly indicate that the graduating seniors felt adequately prepared in the outcome areas.

Using the same numerical scale, the survey also asked about the adequacy of the student's undergraduate studies in preparing him/her for the first job following graduation (mean response = 1.50), the student's satisfaction with the quality of instruction in the major field of study (mean response = 1.22), and the student's satisfaction with the overall educational experience at OSU (mean response = 1.67).

During the individual, private, exit interview with the department head, each graduating student shared observations on such things as instructional quality, adequacy of advising, helpfulness of staff, etc. These confidential observations are evaluated and integrated by the department head and, as appropriate, provide impetus for improvements in departmental programs.

*Student performance on the Fundamentals of Engineering (FE) Exam:* The nationally administered Fundamentals of Engineering examination provides a useful assessment tool to evaluate students' knowledge of engineering subject matter. This examination is the first of two examinations that must be passed to obtain registration as a professional engineer. The examination covers subject matter in the categories: chemistry, computers, dynamics, electrical circuits, engineering economics, ethics, fluid mechanics, materials science/strength of materials, mathematics, mechanics of materials, statics, and thermodynamics. This examination is administered in morning and afternoon sessions. The morning session surveys the general knowledge in each category. The afternoon session requires solution of engineering problems in each category. There are twice as many questions in each category in the morning session.

Oklahoma State University Biosystems Engineering Student performance can be compared to the performance of all students nationally in similar majors. In looking at the combined results of the October 2003 and April 2004 exams, 80% of OSU Biosystems Engineering students passed the exam. Nationally, 78% of students in ag/bio engineering curricula passed the exam. With regard to performance in individual subject matter areas, data were pooled over the five-year period because of the small sample size in any one semester. In addition, a weighted composite score was constructed to account for the difference in the number and difficulty of questions in the morning and afternoon sessions. Assuming a normal distribution of scores, a statistical comparison of student performance can be made by category. Results can be used to determine strengths and weaknesses of Biosystems Engineering students' engineering education in each subject matter category over the five-year period.

Results of the analysis are shown in Table 1. In nine of the twelve subject matter categories, Oklahoma State University student performance was not significantly different from the national student performance. In the engineering economics category, OSU student performance was significantly better than the national average. In two categories (mathematics and materials), performance was significantly poorer. The students' education in mathematics has been a significant concern within the College of Engineering, Architecture and Technology and in this department. The OSU Mathematics Department has instituted a major restructuring of the calculus sequence, which should improve student performance. The relatively lower performance in the materials science section is likely a direct result of our curricular emphasis on the properties of biological materials. Most of our students do not take the traditional materials science course whose subject matter is tested in the FE examination.

Table 1. Performance of Oklahoma State University Biosystems Engineering students compared to the performance of all students nationally in similar curricula on the Fundamentals of Engineering Examination administered for the period from Fall 1999 through Spring 2004. Weighted composite scores (morning and afternoon sessions) are compared.

<b>Subject</b>	<b>Percent Correct OSU Biosys. Eng.</b>	<b>Percent Correct Nat'l. Bio/Ag Eng.</b>	<b>Deviation from Peer Mean</b>	<b>P-value (two- sided not-equal variance test)</b>
Chemistry	59.22%	59.39%	-0.16%	0.9226
Computers	63.96%	63.60%	0.36%	0.8654
Dynamics	47.79%	49.35%	-1.57%	0.3873
Electrical Circuits	53.31%	51.26%	2.05%	0.2028
Engineering Economics	59.30%	51.06%	8.23%	0.0006 ***
Ethics	78.11%	75.11%	3.00%	0.1455
Fluid Mechanics	59.34%	57.29%	2.05%	0.2955
Materials Science/ Strength of Materials	48.34%	56.37%	-8.04%	0.0001 ***
Mathematics	50.54%	56.46%	-5.93%	0.0000 ***
Mechanics of Materials	49.48%	47.70%	1.77%	0.3700
Statics	52.35%	53.22%	-0.87%	0.5873
Thermodynamics	48.01%	49.51%	-1.49%	0.3646

\*\*\* Significantly different at the 1% level.

*Student performance in the senior design experience:* The capstone design course sequence (BAE 4012/4022 – Senior Engineering Design Project I & II) allows the student to demonstrate their ability to develop design solutions for "real-world" open-ended biosystems and agricultural engineering projects. Student class assignments are "deliverables," much the same as would be found in industry. The assignments include: a project schedule, functional engineering specifications, concept generation and feasibility analysis, detailed design, fabrication/assembly drawings, working prototype, test plan and report,

and final documentation. Project deliverables are presented in writing and orally to the course instructor, industry representatives, other faculty and staff, students and guests.

The purpose of the senior design sequence is to integrate much of the engineering knowledge and skills acquired in the curriculum and apply them to the design and implementation of a “product,” and to give the students an opportunity to experience team-based design under conditions that somewhat resemble those that will be encountered in industry. In order to be successful in this capstone experience, students must develop and sharpen skills in team organization, time management, self-discipline, and technical writing. An important goal is to expose students to a hands-on experience in which they have to specify, design, and produce a comprehensive solution beginning from relatively ill-posed needs as stated by a customer. This has to be accomplished while working as a team, and under time pressure.

The senior design final presentations were given on April 29, 2004 to an audience comprised of faculty, staff, graduate and undergraduate students, project sponsors, members of the BAE Advisory Committee, and other guests. Those in attendance were requested to fill out an evaluation form to assess each group’s presentation. Summaries of those evaluations are presented below in Tables 2 and 3. The majority of respondents ranked the student presentations in the outstanding (> 90%) category, with strong performance in each of the individual evaluation categories.

Table 2. Evaluation results for the final project presentation of the senior design students who developed an automatic system for separating and packaging pig ears for packaging as dog treats.								
Evaluation Category								
	No.	Organization (15 pts)	Transfer of technical information (25 pts)	Poise/skill/professionalism in communicating (20 pts)	Quality of visual aids (15 pts)	Response to questions (15 pts)	Comments (10 pts)	Total (100 pts)
BAE Advisory Committee	6	12.8	21.7	17.7	13.7	14.2	8.8	88.8
Project Sponsors	2	14.5	24.0	15.5	15.0	14.5	9.5	93.0
Faculty	8	11.3	19.3	14.8	11.9	11.6	9.8	78.5
Staff	5	14.0	22.4	17.2	14.6	14.8	9.8	92.8
Students	28	14.6	23.9	19.2	14.5	14.4	9.5	96.0
Others	22	14.4	22.9	18.2	14.2	14.0	8.4	92.1
ALL	71	14.0	22.8	18.0	14.1	14.0	9.1	91.9

Table 3. Evaluation results for the final project presentation of the senior design students who developed an effective means of silt fence installation.								
Evaluation Category								
	No.	Organization (15 pts)	Transfer of technical information (25 pts)	Poise/skill/professionalism in communicating (20 pts)	Quality of visual aids (15 pts)	Response to questions (15 pts)	Comments (10 pts)	Total (100 pts)
BAE Advisory Committee	6	13.7	21.8	19.5	14.3	12.5	9.7	91.5
Project Sponsors	2	15.0	23.5	17.5	15.0	13.0	9.0	93.0
Faculty	7	13.6	23.1	17.6	13.7	13.9	9.9	91.7
Staff	4	14.8	20.3	17.5	14.5	14.3	9.5	90.8
Students	26	14.6	23.1	18.7	14.9	14.7	9.9	95.9
Others	20	14.4	22.9	19.0	14.4	14.1	8.5	93.1
ALL	65	14.4	22.7	18.6	14.5	14.2	9.4	93.8

In addition to the evaluations of the final project presentations, senior design students are assessed based on the course assignments and reports, other oral presentations, general class participation, and peer feedback. The reports and presentations prepared by the student design teams are evaluated in the areas of technical content, creative application of knowledge, teamwork, student-client interaction, communication skills, and overall professionalism. The senior design experience supports all of the expected outcomes for the Biosystems Engineering program, with particular emphasis in the areas of ability to design systems, teamwork, and communications.

*Undergraduate program alumni survey:* An undergraduate alumni survey was conducted by the OSU Bureau for Social Research in February 2004, and the report from the Office of University Assessment recently became available. This survey assesses alumni perception for B.S. graduates of 1998 and 2002. Responses from both years were combined. Based on the survey results, the following general observations are made:

1. All Biosystems Engineering undergraduate alumni observed that their academic program prepared them adequately or very well for their current positions. They were universally employed in a position that was either "highly related" or "moderately related" to their field of study.
2. All Biosystems Engineering undergraduate alumni were "very satisfied" or "somewhat satisfied" with their instruction in Biosystems Engineering and with their overall undergraduate experience at OSU. Most felt the same regarding advising in Biosystems Engineering although 25% of the respondents were "somewhat dissatisfied."
3. 37.5% of the Biosystems Engineering undergraduate alumni surveyed were pursuing or have completed graduate degrees and all observed that their undergraduate training had prepared them "adequately" or "very well" for graduate work. We believe this indicates that the graduates recognize the need for life-long learning and a significant proportion have taken action in that regard.
4. The program-specific portion of the survey addressed ABET outcomes that are an important part of the accreditation process. The Biosystems Engineering undergraduate alumni surveyed were unanimous in observing that they were either "adequately" or "very well" prepared with regard to ABET outcomes, with the exception of one respondent indicating "not very well prepared" in each of the following three areas: designing a system, component, or process to meet desired needs; providing a foundation for understanding and addressing social, political, aesthetic issues in decisions; and communicating effectively in oral, written, and graphical forms.
5. A final question surveyed Biosystems Engineering undergraduate alumni regarding participation in six different types of continuing education. In each of the six categories, half or more of the alumni responded that they had participated in these types of activities.

We conclude from the responses that Biosystems Engineering undergraduate alumni are generally very satisfied with their undergraduate education. Steps have been taken to address the concern regarding advising, and we are confident that the results of those actions will be reflected in future alumni surveys.

*ABET accreditation review:* Along with all other undergraduate engineering programs in the College of Engineering, Architecture and Technology, in 2003 Biosystems Engineering underwent an accreditation review under the auspices of the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. Following the submission of a comprehensive written report in the summer, an on-site visit was conducted in the fall. The final accreditation action will be reported in the fall of 2004. ABET stipulates that the only information that can be made public is whether or not a program is accredited (i.e., "yes" or "no"). We expect a positive final action.

#### For the Master of Science and Doctor of Philosophy Degree Programs

*Graduate program alumni survey:* A survey of graduate student alumni was conducted in January 2003, and the results became available in August 2003. Coordinated by the Office of University Assessment, the survey targeted alumni who received their graduate degrees in calendar years 1997 and 2001. Among Biosystems Engineering graduate alumni, seven (7) Ph.D. graduates and five (5) M.S. graduates responded to the survey. Based on the survey results, the following general observations are made relative to program assessment:

1. All Biosystems Engineering graduate alumni observed that their program prepared them "very well" for their current positions. They were universally employed in a position that was either "highly related" or "moderately related" to their graduate studies.

2. Eleven of the twelve respondents indicated that they were "very satisfied" with their overall educational experience at OSU, and the other respondent indicated "satisfied."
3. All respondents were "satisfied" or "very satisfied" with the following aspects of their graduate program: instruction in courses; availability of facilities, equipment, and instrumentation; the contributions of their graduate advisor; and preparation for continuing professional and personal development.
4. One of the twelve respondents was "dissatisfied" with the availability of computer resources (the other eleven were "satisfied" or "very satisfied"): A similar response was received with regard to the assistance of technicians and other support staff (only one of twelve was "dissatisfied").

*Graduate student satisfaction survey.* In spring 2002, the Graduate College and the Office of University Assessment coordinated a satisfaction survey of OSU graduate students. Results became available in October 2003. Five (5) of the survey respondents indicated that their graduate program was in the Biosystems and Agricultural Engineering Department. The survey covered a broad range of topics related to life as a graduate student (student services, health insurance, Graduate College, etc.). Based on the survey results, Biosystems Engineering graduate students were clearly satisfied with the quality and climate of their academic programs, and with their relationships with their advisors and advisory committees.

### **Uses of Assessment Results**

#### For the Bachelor of Science Degree Program

In recent years, program assessment has indicated that the quality of undergraduate advising is an issue that should be addressed. Effective with the spring 2004 semester, the number of faculty advisors for Biosystems Engineering undergraduate students was expanded from one to five. We are also assuming more of the advising responsibilities for underclassmen in engineering's pre-professional program; traditionally these students have been advised exclusively through the CEAT Student Services office. These changes have resulted in an average student to advisor ratio of approximately 20:1 for the Biosystems Engineering program. We have also implemented a more systematic procedure for students to follow in working with their advisor during each semester's enrollment period. This procedure is supplemented with the dissemination of advising-related guidelines, suggestions, course changes, etc. via e-mail and class announcements. The full impact of these improvements in undergraduate advising will best be assessed in future exit interviews and alumni surveys, but the initial reaction of students has been positive.

Biosystems and Agricultural Engineering regularly participates in the alumni surveys conducted by the OSU Bureau for Social Research and reported by the office of University Assessment. While very helpful in our assessment efforts, these surveys are constrained in terms of the number and type of questions that are asked. Stimulated by a concern expressed during our most recent accreditation review, we see value in conducting an extended survey of recent alumni. We will ask additional, targeted questions of the same cohorts, and probably expand the survey base to additional years of graduates. Details of the survey methodology are in the process of being worked out.

Assessment results over the past few years have prompted a mild level of concern with the preparedness of our students in the areas of contemporary issues, global and societal impacts, and lifelong learning. Additions have been made in several BAE courses in an attempt to incorporate more of these outcomes into the curriculum. In addition, we have implemented a process that will encourage students to give more structure and thought to the selection of courses in the humanities and social and behavioral sciences. An excellent extracurricular program that has been initiated is the "BAE Speakers Guild," a weekly activity in which students are given opportunities to practice public speaking (both prepared and impromptu).

In response to the FE exam results in the area of mathematics, we are suggesting to BAE faculty that they look for opportunities to increase mathematics content in the courses that we teach in the BAE curriculum. We feel that exposing students to more applications of mathematics in engineering will help to reinforce the important concepts.

#### For the Master of Science and Doctor of Philosophy Degree Programs

Formal assessment results have not revealed any glaring problems that need to be addressed. Through communication with both students and faculty, the departmental Graduate Committee is typically able to learn of issues as they arise and then deal with them appropriately.

One consistent concern on the part of both students and faculty is a deficiency in the number of graduate courses offered through the BAE Department. This problem has been exacerbated by a (budget-driven) reduction in the number of tenure-track faculty in the department. BAE students are of course able to complete their plans of study through graduate offerings in other departments, but students definitely desire the subject-matter focus and classroom interaction available with faculty in their home department. We are exploring ways of trying to meet graduate course needs in a time of greatly constrained resources.