ASSESSMENT REPORT

Aerospace Engineering, BS

The origins of the undergraduate program in aerospace engineering at Auburn University are found in courses in aeronautical engineering offered at the Alabama Polytechnic Institute in the late 1920's. Over more than seven decades, the program has evolved to meet the changing educational requirements of engineers who specialize in "things that fly."

A formal program in Aeronautical Engineering was implemented at Alabama Polytechnic Institute in 1942 and the Department of Aeronautical Engineering was established in 1945. In 1960, Alabama Polytechnic Institute was renamed Auburn University and the designation "Aeronautical" in the program and department names was changed to "Aerospace" to reflect changes in curriculum in response to the start of the "Space Age." The Aerospace Engineering Program has continuously produced graduates since 1960 and remains the foremost source of aerospace engineers in the state of Alabama.

Program alumni can be found throughout the country with a significant number contributing to aerospace industry with a significant presence in the southeastern United States, most notably at NASA Marshall Space Flight Center, the U.S. Army Aviation & Missile Research Development & Engineering Center, Eglin Air Force Base, Gulfstream, Airbus and Lockheed Martin amongst many others. The program is poised to continue in this tradition and remain a key supplier of aerospace engineers as the nation's aerospace programs continue to evolve and grow.

All undergraduate engineering programs are on-campus in nature. Courses include a variety of experiences including lectures, recitations, and laboratories. There are no options or tracks in the Program. The Program is more heavily weighted toward aeronautical engineering with a required course in orbital mechanics, and electives in orbital mechanics, rocket propulsion, space propulsion, and other astronautical subjects

Student Learning Outcomes

Student Learning Outcomes

Below are the current set of student learning outcomes:

a. An ability to apply knowledge of mathematics, science, and engineering appropriate to aerospace 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
d. An ability to function on multi-disciplinary 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 in a 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

These student learning outcomes are a part of our ABET (Accreditation Board for Engineering and Technology) accreditation process and are aligned with our program educational objectives. The outcomes are written and provided to us by the ABET accreditation body. We recognize that some of the student learning outcomes are vague and lack action verbs.

Specifically, for our department, we take outcome g, “an ability to communicate effectively” to extend to both written and oral communication, giving our students multiple opportunities to communicate with a range of audiences and providing feedback. We expand on this outcome according to the University Writing Committee’s “Guidelines for Writing in the Major.”

Some outcomes such as outcome f: “An understanding of professional and ethical responsibility” have more precise action verbs in ABET’s newest version of the student learning outcomes which are being implemented in the 2019-2020 school year. The new outcome related to ethical responsibility states: “an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.”

ABET has clarified some of the vagueness and verbiage of the old outcomes in the new outcomes being implemented next year. The new, more specific outcomes provided by ABET for next year have enhanced our descriptions of the old outcomes and have verified our understanding of the intentions of those outcomes.

Comprehensive Outcomes

The list of student learning outcomes is comprehensive. These student learning outcomes accurately reflect the scope of the Aerospace Engineering program. These student learning outcomes are a part of our ABET accreditation process and are aligned with our program educational objectives.

Note: these 11 student learning outcomes from ABET are changing to 7 different (but similar) learning outcomes in 2019. The assessment reports likewise will change next year.

Communicating Student Learning Outcomes

The student learning outcomes listed above are documented on the Aerospace Engineering Department website. Student learning outcomes are also listed on course syllabi and communicated with students in each class. Student learning outcomes are a topic of our Aerospace Engineering Faculty retreat in August. Also, in at least one faculty meeting student learning outcomes are discussed. This past year, as we are beginning to change to new student learning outcomes, the new (and old) student learning outcomes have been presented and discussed with all faculty meetings multiple times. Student learning outcomes are also presented and discussed in senior design classes in conjunction with the Alumni Council senior exit surveys.

Curriculum Map

Curriculum Map

Below is a curriculum map that illustrates the connections between the student learning outcomes and the required courses in this program.

Table 4.1

		Student Learning Outcomes										
		a) Math Sci. Eng.	**b)** Experi ments	**c)** Systems	**d)** Teams	**e)** Eng. Prob.	**f)** Ethics	**g)** Comm.	**h)** Soc. Imp.	**i)** Life-Long Learn.	**j)** Cont. Iss.	**k)** Eng. Prac.
Courses	AERO 2200	X				X						
	AERO 3110	X				X						X
	AERO 3120	X				X						X
	AERO 3130	X	X			X	X	X				X
	AERO 3220	X		X		X						X
	AERO 3230	X				X		X				X
	AERO 3310	X				X						X
	AERO 3610	X	X	X	X	X	X			X		X
	AERO 4140	X				X						X
	AERO 4510	X	X	X					X		X	X
	AERO 4620	X				X						X
	AERO 4630	X				X						X
	AERO 4710	X		X		X		X			X	X
	AERO 4720	X		X	X	X	X	X			X	X
	AERO 4AA0						X			X		

Measurement

End of Course Faculty Survey

The first assessment process relates to the assessment of achievement of each student outcome by the individual faculty at the end of each fall and spring semester. Each faculty member teaching a required AERO course completes an “End of the Course Faculty Survey.” This assessment form allows the instructor to determine an “achievement score” for the students as a group with respect to the Student Outcomes associated with his/her course. The instructor also is asked to answer a set of questions related to student performance, student prerequisite preparation and instructional improvements that the instructor feels should be made before the course is taught again.

The End of Course Faculty surveys consist of grades from assignments in the course that the instructor believes are directly related to their achievements of the student learning outcomes. The instructor calculates the scores from a scale of 1 (unacceptable) to 10 (excellent) from course-embedded assignments. The types of assignments (homework, tests, writing assignments, lab assignments, or projects) used in calculating the scores for each outcome from each course are shown in table 5.1. All scores in the survey are <u>direct measures</u> of student achievements from <u>course-embedded</u> assignments.

Note that some instructors used all grades in a certain category (i.e. the average of all homework assignments throughout the semester) if they felt that all homework assignments accurately reflected that learning outcome (such as e – engineering problems). However, many instructors used only certain grades within a category (the average of homework #1, #3, and #6) if they felt those three homework assignments reflected a certain learning outcome. A sample survey is provided in Appendix A.

For Table 5.1:

H = Homework
T = Tests
W = Writing assignment
L = Lab assignment
P = Project

Table 5.1

		Student Learning Outcomes										
		a) Math Sci. Eng.	**b)** Experi ments	**c)** Systems	**d)** Teams	**e)** Eng. Prob.	**f)** Ethics	**g)** Comm.	**h)** Soc. Imp.	**i)** Life-Long Learn.	**j)** Cont. Iss.	**k)** Eng. Prac.
Courses	AERO 2200	H, T				H, T						
	AERO 3110	H, T				H, T						H, T, P
	AERO 3120	H, T				H, T						P
	AERO 3130	T, W, L	T, W, L			T, W, L	W, L	W, L				H, T, W, L
	AERO 3220	H, T		P		H, T						H, T, P
	AERO 3230	H, T				H, T		H, T				H, T
	AERO 3310	H, T				H, T						H, T
	AERO 3610	H		W, L, P	W, L, P	H, T						L, P
	AERO 4140	H, T				H, T						H, T
	AERO 4510	H, T, W, L	L, P	H, P					P		H, T, L, P	H, T, L, P
	AERO 4620	H, T				H, T P						H, T, L, P
	AERO 4630	H, T				H, T						H, T, L
	AERO 4710	T, L		L		T, L		W, L			L	T, L
	AERO 4720	T, L		L, P	W, L, P	T, L, P		L, P			W, L	T, L, P

Graduating Senior Exit Survey

The second assessment process is an online, exit survey completed by the graduating seniors. Three members of the Aerospace Engineering Advisory Council (AEAC), Mr. Morris Penny, Mr. Gene Fuller, and Mr. Louis Connor, have interviewed graduating seniors on essentially an annual basis since 2002. Initially, these interviews were face-to-face meetings between a sample of the graduating senior class and the members of the AEAC team. The current system is an online survey that is completed by all graduating seniors in the spring semester with the survey results being directly sent to the AEAC team. The team members analyze the survey results and then write a summary report for the Department Chair. Prior to the students completing the on-line survey, the AEAC team comes to campus for a discussion with the students concerning the survey and their experiences with situations concerning professional ethics. The AEAC presentation to the students takes place in the AERO 4AA0 Program Assessment course. The assessment process offers the students an opportunity to evaluate the achievement of the Student Outcomes in an anonymous environment. This survey is an indirect measure of student outcomes, but it is very useful in understanding our students' opinion of their education received in our program. In this graduating senior survey, the students are asked to rate their ability to achieve each student learning outcome on a scale of 0 (very poor) to 10 (excellent). The complete survey is shown in Appendix B.

Results

Results

In an attempt to quantify the level of achievement of the Program Outcomes, numerical scores are collected from two sources: faculty course instructors, AE advisory council student exit survey. The scores from the 2015-2016, 2016-2017, and 2017-2018 school years are listed in the table below.

TABLE 7.1 - Outcome Achievement Composite Data (Score out of 10 points)

Outcome	Instructor End of Course Survey			AE Advisory Council student exit survey**		
	2016	2017	2018	2016	2017	2018
a – Math Sci. Eng.	8.1	8.4	8.3	9	9	8
b - Experiments	8.4	8.5	7.7	8	8	8
c - Systems	8.4	8.4	8.2	8	8	8
d - Teams	9.7	9.1	8.8	8	9	8
e – Engineering Problems	7.9	8.0	8.0	8	9	8
f - Ethics	*	*	*	9	9	8
g - Communication	9.0	9.2	8.8	8	9	8
h – Societal Implications	9.0	9.0	9.0	7	8	7
i – Life Long Learning	*	*	*	9	9	8
j – Contemporary Issues	8.7	8.0	8.3	7	8	7
k – Engineering Practice	8.4	8.4	8.3	8	8	8

* Not assessed by course instructors

** These are averaged values that were rounded to a single digit

Interpreting Results

For both surveys, an acceptable score is 7, but our goal is a 10 for each measure. As shown in table 7.1, each student learning outcome in both surveys for all years achieved an acceptable score of 7 or above. Outcomes h and j (societal implications and contemporary issues) generally scored lowest in the alumni council senior exit interviews, however our instructor based measures gave higher marks for these outcomes. These two outcomes are non-technical in nature compared to the others and are harder to measure.

The largest change in the assessment of outcomes occurred for outcome b, “An ability to design and conduct experiments, as well as to analyze and interpret data.” This can be directly attributed to a new instructor teaching a section of a lab course giving lower scores than the previous instructor. In communications with this instructor, this is not an indication of decreasing student ability in laboratory experiments, but rather seems to an instructor who is expecting higher performance from students in laboratory experiments and technical communication. The instructor is implementing changes in the course to increase student achievement. These improvements are detailed in section 10 of this report.

When compared to the previous senior class, the class of 2018 appeared to have a slightly more conservative outlook about their preparedness to enter the workforce. Most of the outcome assessments were a little less positive than the previous class. In the alumni council’s opinion, “this was consistent across the spectrum of expected outcomes and is not considered an indication of a decrease in quality of the Aerospace Engineering curriculum.”

Communicating Results

The results are distributed to the faculty once per year after the surveys have been tabulated. Additionally, the End of Course Faculty survey encourages each faculty member to reflect on their own courses at the end of each semester. Assessment and student learning outcomes will also be a topic of the Aerospace Engineering faculty retreat on August 15th, 2018.

Use of Results

Purposeful Reflection and Action Plan

It is the goal of the Aerospace Engineering department to make continual improvements in the undergraduate academic program. If the “product” of our undergraduate program is to be considered our students, then we can use the Student Outcomes as a set of goals for our Continuous Improvement Process (CIP). The basic steps of the ideal CIP are listed below

Step #1: Assess the “product” with respect to the Student Outcomes
Step #2: Note any “weaknesses” with the “product”
Step #3: Inform the “controllers” of these “weaknesses”
Step #4: Have the “controllers” make adjustment to the “process” to strengthen the “weaknesses”

The definitions of the terms used above are

“products” - undergraduate student
“weaknesses” – weak attainment of a Student Outcome
“controllers” - academic faculty

The Aerospace Engineering CIP places the faculty as the sole “controller” for the process. The Aerospace Engineering department is comprised of twelve tenure-track faculty and three full-time lecturers. The department is fortunate to have a faculty composed of individuals that are very interested in devoting the time and effort to continually improving the undergraduate curriculum. The faculty consider the CIP to be an important task that is an expected activity associated with their professional duties.

As mentioned in the previous section on Student Outcomes, Faculty members assess students through their coursework, discuss student "weaknesses" through faculty meetings and the Course Review process, obtain industrial-oriented input from the AE Advisory Council and review the data from the student self-assessment instruments. The inputs from these various sources guide the faculty in altering the course content and curriculum to strengthen the "weaknesses" identified through the Student Outcomes.

The main factors that the department faculty uses to influence the "product" are course frequency and course instructor assignments. To maintain viable bachelor, master and doctoral programs with this size faculty, the required undergraduate courses are typically only offered once each academic year (Fall or Spring semester) with an occasional course or two taught over the summer (most recently Aerospace Propulsion). Along with offering the undergraduate courses on a yearly cycle, many of the required undergraduate courses are taught by the same faculty member from year to year allowing for personal observation by the faculty of changes in student performance. This also leads to a relatively consistent experience for students from different graduating classes.

In addition to course frequency and instructor assignments, the department also has the ability to modify the undergraduate curriculum, either through required coursework or technical electives. In general, this is limited by the size of the undergraduate curriculum, which is fixed in terms of the allowable credit hours. University requirements limit the Aerospace Engineering undergraduate program to a total of 125 semester credits. The current curriculum is in a "zero-sum" situation. The introduction of any "new" course material must entail the removal of an equivalent amount of "old" material. Second, the undergraduate enrollment in the Aerospace Engineering program is controlled by the admissions policy of the University and by the College of Engineering.

This continuous improvement process has led to enhancements in the past few years such as altering the position of courses within the curriculum sequence, changes to prerequisites, and a proposal to add a computer aided design course (by adjusting a freshman programming course).

One example of improvements recently made to help students in their laboratory experiments, technical writing, and communication skills student learning outcomes in the lab course (AERO 3130) are described below:

In order to help students improve in technical communication, several changes were implemented starting in the summer 2016 semester. All lab reports were required to be electronically submitted on the Canvas website and were evaluated using a rubric. The rubric has been revised in subsequent semesters. Feedback to the student was provided through Canvas and came in the form of rubric category descriptions and, many times, from more detailed information for individual categories. Each student was also given a short summary which highlighted two or three focus areas which would result in the most significant improvement in the next assignment.

In the fall 2017 semester, an inexpensive book, Reporting Results: A Practical Guide for Engineers and Scientists, which addresses presentation techniques for technical data, was added to the required texts. And electronica version of another book, A Scientific Approach to Writing for Engineers and Scientists, which focuses on proper sentence and paragraph structure, forming and justifying arguments, and organization and presentation was procured by the Auburn Library and was made available to all students. In addition, one lab session was dedicated to providing instruction and answering questions regarding expectations for the reports and teaching the skills necessary to write technical reports effectively.

Finally, students were encouraged to have peers review their reports and to seek help from the Miller Writing Center, although the utilization of either of these resources is unknown. In future semesters, use of one or both of these resources may be factored into the grading in order to encourage their use.

Appendix A: End of Course Survey

Basic Course Data

Instructor Name: Robert Gross
Course Name: AERO 3610
Semester: Spring
Year: 2016

Student Outcomes

Evaluate the overall student attainment of the Student Outcomes
Score 1- unacceptable to 10-excellent)

Outcome	Definition	Score
a	an ability to apply knowledge of mathematics, science, and engineering appropriate to aerospace engineering	8.7
b	an ability to design and conduct experiments, as well as to analyze and interpret data	9.1
c	an ability to design a system, component, or process to meet desired needs	9.1
d	an ability to function on multi-disciplinary teams	9.4
e	an ability to identify, formulate, and solve engineering problems	8.5
f	An understanding of professional and ethical responsibility	NA
i	A recognition of the need for, and an ability to, engage in life-long learning	NA
k	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	9.1

Indicate which course activities were employed to create the Student Outcome scores shown in the above table

Outcome	Activity	Activity ID
a	Homework	All
	Test	NA
	Writing Assignment	NA
	Lab Assignment	NA
	Project	NA
c	Homework	NA
	Test	NA
	Writing Assignment	Memos
	Lab Assignment	Memos
	Project	Structural Grade

d	Homework	NA
	Test	NA
	Writing Assignment	Memos
	Lab Assignment	Memos
	Project	Peer Grade
e	Homework	All
	Test	All
	Writing Assignment	NA
	Lab Assignment	NA
	Project	NA
k	Homework	NA
	Test	NA
	Writing Assignment	NA
	Lab Assignment	Memos
	Project	Structural Grade

Student Preparedness

1. Were the students taking the course this term adequately prepared (in terms of prerequisite skills and knowledge). This information is used to improve the preparedness of our students to be successful in their courses.

Generally Well Prepared

2. List specific information about deficiencies (topics, extent of problems, etc.):
Some weakness in basic shear and moment diagrams. Also, some weakness in buckling of columns.

Changes Made to Course

Please discuss any changes you have made to the course to better meet this course's outcomes or to meet the department's program educational outcomes. This could include special topics covered, examples taken from "real life" (real world issues), group projects, handouts developed to help overcome deficiencies, handouts developed to enhance learning skills, etc.
Increased the number of laboratory group assignments that needed to be completed during the lab. I feel that this emphasis on immediate group work helped the "weaker" group members to participate in the group activities.

Appendix B: Senior Exit Survey

AUBURN UNIVERSITY

Samuel Ginn College of Engineering

Aerospace Senior Exit Interview

1. Enter a numerical rating in column indicated
2. Enter comments (optional)

Rating Score										
Very Poor	*Poor*		*Below Avg*		*Average*		*Very Good*		*Excellent*	
0	1	2	3	4	5	6	7	8	9	10

Item	Based on Your University Learning Experience	Rating Score	Comments
A	Rate your ability to apply knowledge of mathematics, science, and engineering		
B	Rate your ability to design and conduct experiments, as well as to analyze and interpret data		
C	Rate your ability to design a system, component, or process to meet desired goals		
D	Rate your ability to function on multi-disciplinary teams		
E	Rate your ability to identify, formulate, and solve engineering problems		
F	Rate your understanding of professional and ethical responsibility		
G	Rate your ability to communicate effectively		
H	Rate acquiring the broad education necessary to understand the impact of engineering solutions in a global and societal context		
I	Rate acquiring a recognition of the need for, and an ability to engage in life-long learning		
J	Rate your knowledge of contemporary issues		
L	Rate your ability to use the techniques, skills, and modern engineering tools necessary for engineering practice		
M	Rate your knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control		
N	Rate your Proficiency in the design process to include performing tradeoffs and achieving compromises necessary to meet stated design objectives covering broad spectrum of the topics enumerated in (I).		

O Rate the Auburn University Department of Aerospace Engineering integration of aeronautical and astronautics topics

P Considering general aeronautics, rate your knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, stability and control

Q Considering general astronautiacs rate your knowledge of orbital mechanics, space environment, attitude determination and conrol, telecommunications, space structures, rocket propulsion.

Additional Information

Rate the quality of the academic advising that you received from the Aerospace Department during your last two years at Auburn

First Name Last Name Email Address

Clear Form Submit