

1997 version of Educational Objectives

1. To provide students with a comprehensive education that includes in-depth instruction in aerodynamics, aircraft and spacecraft structures, flight mechanics, orbital mechanics, flight propulsion, and design of aerospace systems.
2. To prepare students for careers in A.E. by emphasizing analysis and problem solving; exposure to open-ended problems and design issues including manufacturing, maintenance and fostering teamwork; communications skills; and individual professionalism.
3. To provide adequate research and independent study opportunities that cultivate lifelong learning skills and nourish creative talents.

1997 version of Expected Outcomes

1. The graduates of the undergraduate program in aerospace engineering will have an understanding of physics, chemistry and mathematics, and how they pertain to solving real world problems.
2. They will have a firm understanding of engineering science fundamentals that enables the graduates to examine real world problems for the underlying physical principles, and decide on appropriate methods of solution.
3. They will have the ability to analyze and design aerospace structural elements such as trusses, beams and thin walled structures.
4. They will have the ability to analyze and design airfoils and wings, accounting for viscous and compressibility effects.
5. They will have the ability to analyze and design air-breathing and rocket propulsion systems.
6. They will have the ability to analyze the flight dynamics of aircraft and spacecraft, and design flight control systems.
7. They will have the ability to work in teams and design complex systems such as aircraft and spacecraft, from a preliminary design perspective.
8. They will have good oral, written and graphical communication skills.
9. They will be well trained in the role of the engineer in society, and have an awareness of ethical, environmental and quality concerns in the engineering profession.
10. They will be trained to be life-long learners, pursuing and interested in independent study, research and development.

While revising educational objectives, according to ABET, the following thoughts must be kept in mind:

- (a) Educational objectives should be consistent with the mission of the institution and School.
- (b) There must be a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated.
- (c) There must be a curriculum and processes that ensure the achievement of these objectives.

(d) There must be a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

While revising Program Outcomes, we should link them to the educational objectives. The outcomes must be measurable and consistent with the ABET list:

Engineering programs must demonstrate that their graduates have:

- (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
- (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 solutions in a global 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.

Constituents' Input: faculty:

Date: Thu, 27 Sep 2001 09:02:55 -0400

To: academic.faculty@ae.gatech.edu

From: Lakshmi Sankar <lsankar@ae.gatech.edu>

Subject: Your comments sought on revisions to our educational objectives and expected outcomes

Dear colleagues: As you know, ABET requires us to periodically review and revise our educational objectives and expected outcomes, in consultation with our constituency (students, faculty, employers, alumni..). The last time we looked at this was in 1997 prior to the ABET visit.

Would you take a few minutes to look at the objectives and expected outcomes reproduced below, and send me your suggestions, additions, or revisions? The expected outcomes, in particular, may need revision since they represent the skill sets our graduates should have to be successful and productive in their professions. Technology has changed a lot over the past 5 years.

If you have industry and government contacts who will be willing to look at this list and give their comments, please feel free to discuss it with them. An e-mail response is all that is required of them, to keep a paper trail.

Thanks.

Date: Thu, 27 Sep 2001 09:13:01 -0400
To: Lakshmi Sankar <lsankar@ae.gatech.edu>
From: "Dewey H. Hodges" <Dewey.Hodges@AE.GaTech.edu>
Subject: Re: Your comments sought on revisions to our educational objectives and expected outcomes

Lakshmi,

Something similar to what I've added needs to be incorporated. You may feel free to shorten it yourself or shoot it back to Olivier, Marilyn, and me and give us a target length to work toward.

Dewey

Date: Thu, 27 Sep 2001 12:12:54 -0400
X-Mailer: Apple Mail (2.388)
From: John R. Olds <john.olds@ae.gatech.edu>
To: Lakshmi Sankar <lsankar@ae.gatech.edu>
Subject: Re: Your comments sought on revisions to our educational objectives and expected outcomes

Sankar,

It looks good to me as is.

John

Constituents' Input: AHS

Date: Thu, 20 Dec 2001 14:24:11 -0500
From: Ed Smith <ecs@coe.psu.edu>
X-Mailer: Mozilla 4.75C-CCK-MCD {C-UDP; EBM-APPLE} (Macintosh; U; PPC)
X-Accept-Language: en,pdf
To: Lakshmi Sankar <lsankar@ae.gatech.edu>
CC: "Melton, Bob" <rgmaer@enr.psu.edu>
Subject: Re: AHS Education Committee thoughts and comments solicited on the School of AE Educational Objectives and Program Outcomes

Prof. Sankar,

I took some time and went over your ABET Objectives and outcomes information. basically, I compared your lists to the ones our department has recently developed.

Our list were sub divided into 3 categories. Goals (high level topical areas for the program), Program outcomes (measurable characteristics of graduates - basically following the ABET listof outcomes and linked them to the Program specific Goal areas),

and Detailed Program objectives (these are more specific MEASURABLE skills). I will attach a copy for your reference. Our faculty recently accepted this version for our ABET review.

Here are a few thoughts and observations regarding the Ga Tech lists:

1. I found it a bit perplexing how the **Educational Objectives can be defined in terms of skills that graduates will have 3-5 years AFTER graduation?** Are these skills measurable at the University, and moreover, they seem to depend of post graduation professional development - perhaps beyond the scope of ABET.

That being said, the actual objectives listed seem consistent with ABET policies and our own interpretations.

2. It is interesting that you call out **manufacturing and maintenance** in the emphasis subjects for analysis and problem solving. While this does indeed seem important, ABET reviewers may look for specific course examples where this is put into practice.

3. The words **EXPERIMENT or LABORATORY** do not appear anywhere in the Objectives or outcomes. interesting, noting that analysis and design appear repeatedly.

4. The phrase "**graphical communications skills**" is somewhat unusual. I assume you are referring to "Powerpointmanship" or technical presentation skills.

5. No specific mention of **computer skills** (software, programming, hardware, etc). We considered that to be of great importance (i.e. essential skills) to Aerospace engineering - worth calling out specifically. This may not be true in some other engineering fields.

Thanks for giving me the opportunity to look over your ABET attributes. having been only peripherally involved with Penn State's ABET preparations, it gave me the chance to think more thoughtfully about the process. Here at Penn State, my colleague, Prof. Bob Melton, had the responsibility to organize the committee on ABET 2000. he is more knowledgeable of the fine points in this newly revised *maze*...I mean process.

Please take the above as only constructive questions and feedback. I am fairly certain that you and your colleagues

have spent a good bit more time and energy formulating than I dedicated to the task of reviewing.

If you have any additional questions don't hesitate to contact me again.
(814) 863-0966, ecs@rcoe.psu.edu.

Have a good winter break!

over and out,

Ed Smith
Penn State

AIAA Student Branch Input:

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X-Mailer: QUALCOMM Windows Eudora Version 5.0
Date: Tue, 22 Jan 2002 22:56:58 -0500
To: sankar@aerospace.gatech.edu
From: Erik Kabo <erikkabo@bigfoot.com>
Subject: AE School Objectives - AIAA suggestions

Dear Dr. Sankar,

Clyde Watson has asked me to send you the AIAA suggestions to the AE School Objectives. I have attached them in Word .doc format. They are also posted on the web at <http://cyberbuzz.gatech.edu/aiaa/meetings/sankar.htm> . I hope these suggestions help. If you have any questions, please feel free to email Clyde or me.

Sincerely,
Erik Kabo
GT AIAA Secretary
gte938u@prism.gatech.edu

Undergraduate Educational Objectives

1. To provide students with a comprehensive education that includes in-depth instruction in aerodynamics, aircraft and spacecraft structures, flight mechanics, orbital mechanics, flight propulsion, and design of aerospace systems.

No complaints.

2. To prepare students for careers in A.E. by emphasizing analysis and problem solving; exposure to open-ended problems and design issues including manufacturing,

maintenance and fostering teamwork; communications skills; and individual professionalism.

These objectives are not being met. Also, we need more exposure to undergraduate research.

3. To provide adequate research and independent study opportunities that cultivate lifelong learning skills and nourish creative talents.

Again, more research opportunities are needed, as well as other opportunities that meet these criteria.

Expected Outcomes of the Undergraduate Program

1. The graduates of the undergraduate program in aerospace engineering will have an understanding of physics, chemistry and mathematics, and how they pertain to solving real world problems.

No comments.

2. They will have a firm understanding of engineering science fundamentals that enables the graduates to examine real world problems for the underlying physical principles, and decide on appropriate methods of solution.

Sounds good.

3. They will have the ability to analyze and design aerospace structural elements such as trusses, beams and thin walled structures.

This objective is not being met!

4. They will have the ability to analyze and design airfoils and wings, accounting for viscous and compressibility effects.

5. They will have the ability to analyze and design air-breathing and rocket propulsion systems.

Objectives are being met.

6. They will have the ability to analyze the flight dynamics of aircraft and spacecraft, and design flight control systems.

We would like an elective involving Unmanned Aerial Vehicles (UAVs).

7. They will have the ability to work in teams and design complex systems such as aircraft and spacecraft, from a preliminary design perspective.

More focus on spacecraft design is needed to meet this objective.

8. They will have good oral, written and graphical communication skills.

There are many concerns with this objective. Many times teachers do not meet this objective, so students often have trouble as well. Also, communication classes are a problem at this school due to the technical nature and lack of useful and interesting courses.

9. They will be well trained in the role of the engineer in society, and have an awareness of ethical, environmental and quality concerns in the engineering profession.

There is very little instruction involving this objective.

10. They will be trained to be life-long learners, pursuing and interested in independent study, research and development.

Again, more research opportunities need to be available to satisfy out interest.

Sigma Gamma Tau input:

Delivered-To: lsankar@ae.gatech.edu
Date: Tue, 11 Dec 2001 15:08:08 -0500
From: Jordan Drewitt <jdrewitt@resnet.gatech.edu>
Organization: Georgia Tech
X-Mailer: Mozilla 4.76 [en] (Win95; U)
X-Accept-Language: en
To: Lakshmi Sankar <lsankar@ae.gatech.edu>
Subject: Re: Sigma Gamma Tau input sought on revisions to AE
educationalObjectives and Expected Outcomes

Dr. Sankar,

I apologize for taking so long in responding to your input request. Here are a few thoughts from Sigma Gamma Tau about the Objectives & Expected Outcomes:

Outcomes:

ADD: "They will have the ability to integrate the topics of aerospace engineering with computational tools to create electronic models that portray the current use of technology in industry." This is just a sample that expresses how not only should we learn the different areas of aerospace (propulsion, aerodynamics, controls, structures, etc), but we should also apply modern computing techniques to study these issues, since that's where current industry is. Along those lines, there should be more emphasis on aerospace-specific tools such as CATIA that may be beneficial to students once they graduate (or even earlier).

ADD: Students also deal with experimental issues during several lab courses such as Experimental Fluid Dynamics, Structures Lab, Circuits & Electronics, etc. This should somehow be reflected in the outcomes.

On #6: Currently, the emphasis lies on classical controller design, and very little emphasis is placed on flight control systems. In a 15 week course, approximately 2 weeks are devoted to flight control systems, and on a very introductory level, in my opinion. This is not really a comment on the objective itself, but rather whether the objective is being met.

Objectives:

The objectives seemed complete

If I hear anything else I will gladly let you know the new opinions. Also, if you need me to run anything else by the members, please let me know. Once again, sorry for the delay.

Sincerely,

Jordan Drewitt.

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Lockheed Input:

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X-Mailer: QUALCOMM Windows Eudora Version 5.1
Date: Fri, 15 Feb 2002 11:55:11 -0500
To: academic.faculty@ae.gatech.edu
From: Lakshmi Sankar <lsankar@ae.gatech.edu>
Subject: Lockheed Fellow Dr. Pradeep Raj's Oral Input on AE Educational
Objectives and Expected Outcomes
Cc: pradeep.raj@lmco.com

Dear colleagues: As you know, we are collecting input from our constituencies on how/if our educational objectives and expected outcomes should be revised. Here is Dr. Pradeep Raj's input (given orally when he visited our School) this morning. He said he may be able to give us a written version as well. For those of you who may not know him, Dr. Raj is a Lockheed Fellow (the highest technical level one can attain within Lockheed), and actively manages all computational sciences activities at Marietta, Fort Worth, and Palmdale. He is also our alumnus.

These comments are on our original (circa 1997) objectives and outcomes.

Educational Objectives:

- a) He felt our educational objectives have the right balance on technical topics (objective 1), team/interpersonal skills (objective 2), and life-long learning (objective 3).
- b) "Integrity" is becoming an important issue in AE, especially as companies pursue teaming arrangements, and when there is pressure on engineers to do things quickly and cheaply. Add a word or two addressing integrity on educational objectives. While integrity is not something that can be taught, our courses and topics should address situations where integrity of an individual is compromised, and how to avoid such a compromise.

Expected Outcomes:

In the area of expected outcomes, he felt that our list is comprehensive, and adequate. Some topics to think about:

(i) autonomous systems are becoming very important. Next generation of engineers may need to be trained on them.

(ii) aircraft are "systems," Students to learn to study/model them at systems level, as well at disciplines level.

iii) Courses and topic coverage, where feasible, must be interdisciplinary and address interdisciplinary issues as well as discipline-specific issues. He cited multi-axis thrust vectoring as an example which requires knowledge of aerodynamics, propulsion, control, and structures (and those nozzle vanes can flutter!) He also cited supersonic transports where highly efficient aerodynamics will not necessarily lead to a best design. While we are already covering much of these in our courses, it won't hurt to point out in our expected outcomes that interdisciplinary issues are important. He also said we should teach our students to avoid jargons when interacting with other disciplines. As an example, L/D is lift/drag for most of us, but a weapons integration engineer (non-AE) may think we are talking about length of cavity to depth of cavity.

iv) He felt that what we are doing in computer science- requiring one course, while leaving the second course as a science elective option, is just fine. He did not see a need for requiring two computer science courses (much to my disappointment...). He also said continuing education is particularly important in computer science area, since languages are rapidly changing or becoming obsolete. Industries can retrain the engineers in a new language or technology, if we can equip our students with the ability to pick up new technologies and languages.

He may give us more written input later, but I just wanted to pass along his comments before I forget what he said.