Expectations for a New Aeronautical Engineering Technology Program

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Abstract

The lean nature of aviation in recent times has led to increased focus on economy and quality for all aspects of manufacturing and operations. At the same time, while the use of new technology has certainly resulted in higher quality products and performance, that same technology has left a gap in technical support, as inadequately trained personnel struggle to meet the challenges in the industry. In the past, the aerospace industry relied to a significant extent on the knowledge, skills, and abilities associated with the airframe and powerplant (A&P) certificate for maintenance and support of the vehicle, and also in many aspects of design and manufacturing. The increased reliance on developing technology and the critical value placed on quality and economy has created a need for a new class of support personnel in the aerospace industry. The qualified individual will continue to possess the experiential, hands-on skills associated with the A&P license, but will also have a firm grounding in engineering technology. The American Institute for Aeronautics and Astronautics (AIAA) recognized this evolving situation and, in response, developed and proposed a new set of outcomes-based criteria to ABET, the most widely-recognized accrediting body for engineering and technology programs. These criteria, adopted by ABET in 2005, define the curriculum entitled Aeronautical Engineering Technology. This paper will primarily focus on the knowledge, skills, and abilities that graduates of such a program currently under development at Purdue University will bring to the aerospace workforce. Attention will also be paid to the significant obstacles confronting academia as it struggles to prepare students with both practical and engineering-based capabilities.

Introduction

Purdue University is a public, doctoral-granting research university with five campuses throughout the state of Indiana [1]. In addition, there are also six statewide technology locations, which only offer various technology and engineering technology degrees. The main university campus is located at West Lafayette, Indiana, which is approximately one hour north of the state capital, Indianapolis. The main campus consists of undergraduate, graduate, and residential students, with an enrollment of approximately 38,000 total students. [2] Purdue University degree programs and plan of studies are divided among various schools or colleges, such as the College of Technology or the School or Nursing. Purdue University's College of Technology consists of nine departments:

- Aviation Technology (AT)

- Building Construction Management (BCM)
- Computer and Information Technology (CIT)
- Computer Graphics Technology (CGT)
- Electrical and Computer Engineering Technology (ECET)
- Industrial Technology (IT)
- Manufacturing Engineering Technology (MfgET)
- Mechanical Engineering Technology (MET)
- Organizational Leadership and Supervision (OLS)

As can be seen by the above list of departments, most offer a technology degree, but, there are a few that offer engineering technology degrees. These engineering technology degrees are accredited by the Accreditation Board for Engineering and Technology (ABET), Inc., which is a U.S. accreditor of college and university science programs. Under the larger ABET organization are four commissions, which accredit programs in the following disciplines: Applied Sciences, Computing, Engineering, and Technology. [3] Accreditation under ABET ensures that a program meets established quality standards for the discipline in question. [4]

The Aviation Technology department currently offers three degrees: aviation management (AM), aeronautical technology (AOT), and professional flight technology (FLT). The aviation management plan of study prepares students for careers in airline management, airport management, or air traffic control. Graduates of the aeronautical technology plan of study typically join the workforce in maintenance, maintenance management, or manufacturing support positions. The FLT plan of study prepares students for a career in flight for major or corporate airlines or general aviation, utilizing various airplanes and simulators. The FLT and AOT graduates earn a Bachelor of Science degree as well as FAA certificates specific to their area of study. For AOT students, this is the Airframe and Powerplant (A&P) certificate, which authorizes the holder to perform a variety of complex maintenance functions, inspections, and repairs to aircraft.

AOT graduates possess a wide variety of knowledge, skills, and abilities in regulatory matters, materials, manufacturing processes, electronics, powerplants, and nondestructive inspection methods. They also have developed skills in teamwork, project management, and communication. Some graduates pursue jobs where they directly utilize their A&P skills and certification in airline and corporate or general aviation, while others are highly valued in the aerospace manufacturing industry in a variety of engineering and engineering technology positions. For these jobs, the ability of the new hire to be immediately productive is important, as is the practical knowledge and skills gleaned from hours of working on aircraft as a student. Upon graduation, Purdue AOT students have these abilities; they are not, however, graduates of an ABET-accredited program.

ABET accreditation is the benchmark for engineering and engineering technology programs in the United States. In many cases, companies' hiring mandates are that only ABET-accredited program graduates may be hired into many positions. Only recently, however, has criteria been developed by the Technology Accreditation Commission (TAC) of ABET for Aeronautical Engineering Technology (AET) programs. Until this time, programs with such a title could pursue accreditation only under the wider ABET umbrella of "engineering technology". Now that this new program criteria has been adopted by ABET, AET accreditation will be accomplished under that specific criteria, which defines clearly the knowledge, skills, and abilities required of graduates.

For Purdue AOT, certain modifications will be made to the curriculum in order to bring it in line with the new AET accreditation requirements. In view of the success current and past graduates have enjoyed in engineering and support positions, however, the major focus for the ABET accreditation effort will be the documentation of accreditation criteria and the process of continuous improvement. ABET accreditation is viewed as the next step for the current AOT program, one which should improve the hiring opportunities for graduating students in the future. It is also anticipated that ABET accreditation will lead to increased cooperative research efforts with other disciplines throughout the university, and with outside entities, as well.

This paper will describe:

- Aerospace industry changes that have led to the need for AET programs.
- The new ABET program criteria
- Anticipated knowledge, skills, and abilities of students in this newly accredited discipline
- Significant obstacles confronting academia as it struggles to prepare students with both practical and engineering-based capabilities.
- Planned ABET initiatives for the newly developed degree program

Technological Changes in Aviation and Aerospace

The aviation industry has changed in areas of flight, maintenance, and manufacturing because of approved, changing technologies. For example, in older aircraft mechanical or steam gauges were used to display flight information to pilots. A typical gauge utilized is displayed in Figure 1. One can see that the gauge looks similar to a typical automotive mechanical gauge. The cockpit of a Piper Tomahawk airplane with various gauges of this genre that is utilized by the aeronautical technology students for repair and maintenance procedures at Purdue University is displayed in Figure 2.

Figure 1: Flight Mechanical gauge from website http://www.navfltsm.addr.com/vor-nav.htm. [5]

Figure 2: Cockpit of Piper Tomahawk airplane with mechanical gauges

Currently, steam gauge cockpits are quickly being replaced by glass cockpits, even in light airplanes. A glass cockpit is an aircraft cockpit that utilizes computer-controlled, liquid crystal display (LCD) units to display flight information. [6] A Boeing 737 aircraft with a glass cockpit is displayed in Figure 3.

Figure 3: Boeing 737 aircraft with glass cockpit from website
http://en.wikipedia.org/wiki/Image:Boeing_737-MMA_Cockpit.jpg. [7]

One can see the many, distinct differences between the mechanical gauge cockpit in Figure 2 and the glass cockpit in Figure 3. These major differences in flight instrument displays affect not only the flight crew, but, also those involved with the maintenance and trouble-shooting of these instruments. For example, when trouble-shooting a mechanical gauge, a technician would check the gauge connection, connecting wires, and mechanical components of the gauge. For the glass cockpit, a technician would also be required to have computer hardware knowledge and experience along with an understanding of the software program, in order to properly trouble-shoot an existing problem. The technician would also be required to learn the entire system design in order to understand how each component works in relation to the others for effective trouble-shooting purposes. This type of systems-level knowledge is typically found in an engineering technology program and itself has led to changes in knowledge and skill requirements for aviation technicians and the maintenance staff, in general.

The instrument displays changes are only one of many changes that have taken place recently in the aviation industry due to the implementation of new technologies. The methods utilized to manufacture these new technologies have also changed the requirements for aviation and aerospace manufacturing staff. For example, the Boeing 777 is the first jetliner to be digitally designed and pre-assembled using three-dimensional computer graphics. [8] This new design and manufacturing process requires aviation technologists to be knowledgeable in utilizing computer graphics and drafting software programs.

Similar advances in technology, materials, and inspection methods have led to fundamental changes for the entire aircraft. These changes alone have driven the need for support personnel with different and larger skills sets than were required in the past. More importantly, engineering programs have focused increasingly on the science of their discipline, which makes it impossible for students to build the practical skill sets that engineers from two generations back possessed upon graduation. Specialization has also fed this problem, just as it has in the practice of medicine. The aerospace industry finds itself with new hires that lack the wide range of knowledge and skills that engineering and engineering technology jobs require. The industry made this issue clear to ABET, which then directed a request for specific program criteria to the professional body in its number most closely aligned to the discipline under discussion, the American Institute for Aeronautics and Astronautics (AIAA).

ABET Accredited Aeronautical Engineering Technology (AET) Degree Program

The AIAA recognized that advancements in flight navigation equipment, aviation maintenance and manufacturing have created a need for a new class of support personnel in the aerospace industry. In response to this need and the call from ABET, the AIAA developed a new set of outcomes-based criteria for the aviation education community, which provided detailed expectations for Aeronautical Engineering Technology programs. The draft criteria were then forwarded to ABET for consideration and modification. New program criteria were subsequently approved and adopted by ABET in 2005 to define the proposed curriculum program entitled Aeronautical Engineering Technology (AET).

An ABET accredited degree program (associate or bachelor) requires both program educational objectives and program outcomes. Program educational objectives are broad statements that describe career and professional accomplishments that graduates can achieve, while program outcomes are statements that describe the knowledge or skills students are expected to acquire, from the degree program, in order to achieve the program educational objectives. [9] The criteria created by the AIAA are the program educational objectives. These educational objectives state that the newly proposed bachelor degree of AET must demonstrate that graduates can apply the following concepts to analysis, development, and implementation of aeronautical/aerospace systems and processes:

a. Technical expertise in engineering materials, statics, strength of materials, applied aerodynamics, applied propulsion, and either electrical power or electronics.

b. Technical expertise having added depth in a minimum of three subject areas chosen from: manufacturing processes, vehicle design and modification, engineering materials, electro-mechanical devices and controls, industrial operations, and systems engineering including the appreciation of the engineering design cycle and the system life cycle relating to the manufacture and maintenance of aeronautical/aerospace vehicles and their components.

c. Expertise in applied physics having an emphasis in applied mechanics, plus added technical topics in physics and other science principles appropriate to the program objectives. [9]

One can see from viewing the criteria that applying technical expertise to analysis or design is a common thread among all three. The aviation industry entails a plethora of technological sciences and processes and this allows aviation technologists to choose which areas to focus. Also, the technological advancements of each area, from electronics to materials to manufacturing, force the support personnel to also become experts in one of those areas. Of critical importance, as well, is the fact that under these ABET criteria portions of the FAA-approved Airframe and Powerplant curriculum may be used in the AET program of study. This is of fundamental importance as it allows the AET program to build the engineering technology curriculum on the foundation of practical knowledge and skills. The FAA-approved Part 147 curriculum mandates a minimum of 1900 hours of study in preparation for the Airframe and Powerplant test administered by an FAA designated mechanic examiner (DME). Study includes both lecture time and laboratory experience in subjects that involve both airframe and powerplant matters. ABET mandates a minimum of 124 credit hours for baccalaureate programs, a requirement which has already had an impact on department-wide curriculum decisions.

When the four-year program is completed, students will have knowledge of and experience with regulatory matters, materials, fabrication, electronics, wiring, powerplant, overhaul, repair, and inspection processes and procedures, and the overall aircraft. Additionally, students will study a number of topics in a course entitled “Design support analysis”, including lifecycle issues, design supportability, design philosophy, and financial subjects. Students will also study statistics, and will enroll in a senior design capstone course in which practical skills and engineering technology will come together in a team project setting.

For all of this coursework and the entire curriculum, program outcomes (commonly referred to as the “a – k”) are specified. These state that all engineering technology program must demonstrate that graduates have:

a. An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,
b. An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
c. An ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,
d. An ability to apply creativity in the design of systems, components or processes appropriate to program objectives,
e. An ability to function effectively on teams,
f. An ability to identify, analyze and solve technical problems,
g. An ability to communicate effectively,
h. A recognition of the need for, and an ability to engage in lifelong learning,
i. An ability to understand professional, ethical and social responsibilities,
j. A respect for diversity and a knowledge of contemporary professional, societal and global issues, and
k. A commitment to quality, timeliness, and continuous improvement. [9]

Clearly, these criteria are important requirements for any successful individual, no matter the industry or the discipline. The graduates of this new aeronautical engineering technology (AET) program should become experts in their area of choice, or in other words, fulfill the educational objectives, by performing such tasks as solving technical problems, interpreting experiment results, and applying current knowledge to emerging technologies. It is expected that a graduate of this program will be able to not only maintain aircraft vehicles, but also be able to improve the maintenance and support processes by developing methods with higher quality and efficiency. The aeronautical engineering technologist will also become increasingly important in the design and manufacturing of the vehicle, because of his or her ability to understand the implications of design on future support issues. Given the significance that support plays in the future operation and cost of the vehicle, expect technologists with these capabilities to become more involved at all stages of the vehicle life cycle.

It is also expected that an AET graduate will be an effective problem solver. He/she will be able to observe a problem or issue, conduct an experiment on this issue and then interpret and apply those experimental results to a solution. This problem solver will, in turn, also be committed to continuous improvement. This graduate will also understand that in order to be successful in his/her career, he/she will engage in lifelong learning by attending conferences, enrolling in technical courses, or learning about emerging technologies, in order to solve existing issues or develop new ideas, processes, and products.

The AET graduate will also be an effective communicator as well as a strong team member in whatever role is required. Many job positions today, in any industry, require effective communicators as well as individuals who can work on teams, whether in a design, maintenance, or manufacturing team, working to solve an issue or to improve existing operations. This individual will also be an effective team player by showing respect for diversity in the workplace and understanding how these differences can attribute to even greater successes.

An AET graduate will be qualified for and be able to succeed in a variety of engineering or engineering technology jobs. This advent of this curriculum may also change the way employers view aviation maintenance personnel and how maintenance departments are created and structured. Various new job positions may be created from these graduates with knowledge and experiences with emerging technologies and with excellent interpersonal skills. Most importantly, however, these graduates will be able to fulfill the existing gap in technical support, where inadequately qualified personnel now struggle to meet current challenges in the aviation industry.

Academic Obstacles

One of the significant hurdles to this initiative involves the instructor-intensive nature of the new program, as it is defined under this accreditation initiative. The Part 147 airframe and powerplant (A&P) curriculum is a fundamental underpinning of the future AET program, because it enables students to build essential skills and develop practical knowledge of the discipline. The A&P curriculum, however, presents challenges in the university environment for more than one reason. First, the program hours are very high due to the 1900 hours of study required under Part 147. A three credit hour course in this program, for instance, may require a two-hour lecture and two divisions of a 3-hour laboratory, for a total contact load of 8 hours per week. A three credit hour course in many disciplines, on the other hand, equates to only 3 contact hours. Generally speaking, the A&P courses must be taught by faculty members who have the required A&P credentials. Furthermore, the pool of faculty candidates who have the required A&P credential and experience and who also meet the additional university requirements is not large. Add to that the fact that it would be recommended that some number of future faculty come from an ABET-accredited engineering technology program as well, and the challenge becomes even larger. Nevertheless, the program potential is enormous, and recruiting efforts to date indicate that qualified people do exist who are interested and willing to teach in this discipline.

As is always the case, making change is difficult, and that is never more true than at a university with tenured faculty. The decision to move forward with significant curriculum change is one that demands unanimous support among the general faculty. Change of this order requires that each faculty member be willing to take a slightly different approach to the courses they teach as is necessary to reach the goal of ABET accreditation. Very little incentive exists to entice cooperation and necessary change; the change must come about through wholesale commitment to the betterment of the program. AOT at Purdue University has evolved continuously from its beginnings five decades ago, and, by all appearances, the AOT staff is - to a person - willing to do so again.

Current and Future ABET Initiatives

Accreditation requires collection of data concerning the efficacy of the program as defined under the program specific criteria. Currently, an ABET committee comprised of five faculty members in the aeronautical technology group is defining the a-k objectives in order to successfully track these items per each student. Once the objectives are defined and understood by the entire AOT faculty, then two to three objectives will be assigned as is appropriate to each of the courses in the discipline and observations of performance will then be made and recorded. These data will then be recorded in a matrix, which will be reviewed by the ABET committee to determine if the objectives are being met. If not, decisions will be made about how to improve performance, and changes will be made, as necessary. An overall curriculum evaluation is currently underway in order to determine where change should be made, and specifically how and where the criteria will be supported in the program. Also, future interdisciplinary research and course opportunities among the other ABET accredited Technology and Engineering departments, particularly the Aeronautics and Astronautics department, have been discussed among various faculties within each of those departments.

Conclusion

The implementation of emerging technologies in the aviation industry has created a gap in technical support staff. It is expected that the graduates of an ABET accredited, aeronautical engineering technology program will decrease this gap by coming to the workforce ready to produce, and equipped with both practical knowledge, skills, and experience, and a fundamental understanding of engineering technology as it applies to their discipline. As this new curriculum initiative weds the practical skills with engineering knowledge it will face significant obstacles in academia. Nonetheless, it is the view of the future AET faculty at Purdue University that this program of study should bring significant benefits to the aerospace industry and to technology students alike in the near future.

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