

Aeronautics and Aerospace Engineering at The University of Alabama

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The Aeronautics and Aerospace Engineering program at The University of Alabama has a long and storied history. From its inception in the 1930's, this program has played an integral role in educating aeronautical and aerospace engineering students, in training pilots, in improving the economic development of the State of Alabama, and in conducting scientific research. The popularity of this program, like most aerospace engineering programs, has ridden the wave of defense spending and the economic times of the country. However, throughout its 70-year history, the aeronautics and aerospace engineering program at The University of Alabama has continued to be an important training ground for aerospace engineers from across the State, the region, and the nation. This chapter provides a glimpse into the history and the current status of this program.

Introduction

There has been an Aeronautical and Aerospace Engineering program at The University of Alabama (UA) since the early 1930's. Over its 70-year history, this program has graduated numerous students who have achieved successful careers in industry, education, the military, and government. These students have been able to utilize the technical education they received at UA in careers in a wide range of fields ranging from aerospace to ship building, from computers to business, and even in the medical field.

Aside from the job of educating future aerospace engineers, the aeronautical and aerospace engineering (AE) program at The University of Alabama has been involved with many, many research projects that have advanced the field of aerospace engineering, advanced the industrial development of the State of Alabama, and generally served the

aerospace community. These research projects have covered the spectrum of the aerospace engineering field including aircraft design, propulsion systems, computer simulation, aircraft performance, risk analysis, structural design and testing, federal regulation, education and others. There is virtually no aspect of aerospace engineering that has not been investigated at The University of Alabama.

Over the years, the AE program has prospered and maintained accreditation under twelve University of Alabama presidents¹. The AE program has enjoyed the support of these twelve distinguished gentlemen, and is currently

¹ These include: Dr. Richard Foster (1941), Dr. George Denny (1942), Dr. Raymond Paty (1942-1947), Dr. John Gallalee (1947-1953), Dr. Oliver Carmichael (1953-1959), Dr. Frank Rose (1959-1969), Dr. David Mathews (1969-1980), Dr. Richard Thigpen (1980), Dr. Joab Thomas (1980-1989), Dr. Roger Sayers (1989-1996), Dr. Andrew Sorenson (1996-2002), and Dr. Barry Mason (2002).

anticipating the opportunity to advance under the new president of The University of Alabama, Dr. Robert Witt.

The State of Alabama is a key player in the aerospace industry, and has been for many years. Fort Rucker, located in the Southeast corner of the state, is the “Home of Army Aviation” [1]. In addition, NASA’s Marshal Space Flight Center is located in the northern part of the state in Huntsville [2], as is Redstone Arsenal which is the home of the U.S. Army Missile Command. In 1958, the old National Advisory Committee for Aeronautics (NACA) became the National Aeronautics and Space Administration (NASA), and Huntsville became a focal point of space propulsion research. In fact, the demand for off-campus teaching in Huntsville increased to the point that the AE program began teaching and maintained off-campus classes until a school, The University of Alabama at Huntsville (UAH) was formed in 1969. Today, this university is a part of the University of Alabama system (UA, UAH, and the University of Alabama in Birmingham) and has taken on the primary role of continued education for engineers in the community. Originally, faculty from The University of Alabama (in Tuscaloosa) were utilized to handle teaching loads and faculty from the AE program were deeply involved with this endeavor into “distance education.”

Naturally, the AE faculty at UA has consisted of dedicated educators and researchers. However, they have also been heavily involved in service to the aerospace engineering community. For instance, the Southeastern Section of AIAA (now the Ala-Miss Section) originated when its first meeting was

held in 1949 at UA, largely through the efforts of John Hoover who later went to the University of Florida and worked until he retired some years ago.

The list of the alumni of the AE program is long and contains many prestigious individuals. Recently the College of Engineering created a list of Distinguished Engineering Fellows, and 22 graduates of the AE program were included in the list of 150.

Although it is impossible to detail the entire 70-year history of this program in such a concise form, this chapter represents an attempt to capture the flavor of this history, and to provide insight into the current program.

The Early Years

The 1930’s was a decade of prosperity for the College of Engineering at UA. Lindbergh had crossed the Atlantic in 1927, and he returned to New York where he was greeted by the largest crowd to ever assemble there. Worldwide interest in aviation was increasing in spite of the Great Depression, and the College of Engineering responded to this growing interest in aviation to officially begin a new program of study in 1932. The program was called Aeronautical Engineering, and due to the support of UA and to the program’s success, it has evolved into the current AE program.

Dr. Frederick R. Maxwell, an experienced navy pilot and Electrical Engineering professor had been involved with teaching a class in navigation since 1929, and two years later (1931) fifty-nine students signed up for the as of yet unofficial aeronautical degree. By 1933,

there were 165 students in the new program, including the first five recipients of the AE degree.

Prof. Leslie A. Walker, a 1915 graduate of UA and a navy pilot, handled the teaching duties during the early years. Courses were largely limited to airplane maintenance, aerodynamics, and meteorology. A single airplane was available for study. However, a new building, Hardaway Hall, named for Prof. Robert A. Hardaway, was completed in 1936. Professor Hardaway was the first full-time College of Engineering professor. Hardaway Hall later provided a home for the AE program, and laboratory space for a wind tunnel and other equipment.

In 1936 Professor Otto H. Lunde, a college trained aeronautical engineer and pilot was added to the faculty as Head of AE. Professor Lunde helped expand the curriculum to include more advanced courses in aerodynamics, aircraft engines, and aircraft design.

In 1938, a senior student in aeronautical engineering developed a design for a wind tunnel, and it was built of wood. This low-speed wind tunnel continues to be used to this day. In fact, it serves as a focal point when alumni visit the campus because virtually every graduate of the program has had the opportunity to run tests in this facility. The wind tunnel designer, Edward J. Finnell, later became the student recruiter for the College of Engineering, and served UA in this capacity until he retired and passed away several years ago.



Figure 1: The low-speed wind tunnel was constructed in 1938, and is still in use today.

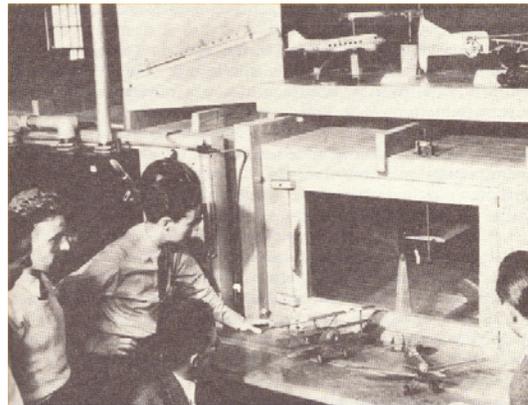


Figure 2: Students observing an experiment in the AE program's first wind tunnel, c. 1940.

One major mistake in the development of the AE program occurred in these early years. The Guggenheim Fund for the Promotion of Aeronautics offered to fund the construction of a wind tunnel. In addition, the proposed gift included a budget for the upkeep of the facility. Unfortunately, because money was so scarce as the Great Depression deepened, President Denny refused to erect a building to house the facility. Interestingly enough, Georgia Tech accepted the award in 1938, the facility

was constructed, and Georgia Tech continues to reap the benefits of this contribution even today.

The War Years

During the depth of the Great Depression the United States of course began preparations to enter World War II. As luck would have it, UA and the City of Tuscaloosa had cooperated in building an airport with a paved runway in the early 1930's. As war preparations broke the depression, the airport enabled the AE Department to start one of the first collegiate civil pilot training programs in the country. The success of this program created a model for a national plan for pilot training. Ultimately, more than 200 pilots were trained in the civilian program. One of the key people involved with the program was Professor Walker from UA's AE program. In time, Professor Walker was borrowed by the Civil Aeronautics Authority (CAA) to initiate similar programs at other universities. Walker wrote a series of textbooks used in the new and expanded training programs.

The loss of Professor Walker was a mixed blessing in that it left UA short-handed, but allowed for the hiring of Professor Colgan Bryan. Professor Bryan had met Walker in Washington where he learned about the flight training at UA. Later Professor Bryan worked in a similar program at Roanoke, VA, sponsored by Roanoke College in Salem, Va. He was certified to teach ground subjects such as navigation, aerodynamics, aircraft engines, etc.; subjects vital to flight training. As preparation for the war increased many students were either drafted into or

volunteered for military service. Due to the need to build and maintain air power, AE students were allowed to remain in school and graduate. Also, AE instructors and those involved in flight training were in critical demand.

Professor Bryan reported for duty in the fall of 1942. The war caused a major change in the distribution of students among the engineering departments. As the war approached AE enrollment increased from 148 students in 1937 to 268 in 1940, to 383 in 1943. Naturally, the Dean of the College of Engineering, Dean Davis, was worried about the ability of the faculty to handle the increased volume. When the United States entered the war in 1941, fully 40% of the engineering enrollment was in the AE program.

The AE program was faced with a daunting task to satisfy the need for pilot training and AE education for several reasons. These reasons included Professor Walker's death, Professor Maxwell's return to military duty, Professor Lundes' departure, and a greatly increased demand for an effective pilot training program. Professor Bryan met the challenge with the help and cooperation of the entire university. Professors were borrowed from other departments and temporary instructors were hired to satisfy the demand of the aviation community. In those days, Bryan and others worked long hours, seven days per week. Thousands of English and British soldiers completed pilot training at UA with only one accidental death: a student pilot crashed his airplane while showing his skill near the home of a girlfriend. Interestingly enough, Professor Bryan is still involved with educating young

people at UA where he continues to teach the AE program's senior seminar.

As mentioned above, pilot training was a high priority for the program during these early years. The one paved runway at the local airport plus five practice fields served as adequate practice areas for pilot training. Thousands of acres of land owned by the Mental Health Department were made available for flying activities, and new airfields were made from cotton patches and cow pastures in the area by cutting the grass and removing the debris.

As the war activities decreased the AE program shifted its focus from pilot training to the scientific aspects of aircraft design. In 1948 Franz R. Steinbacher was appointed to be the head of the AE program. Graduate courses in aerodynamics, supersonic flow, and structures (plates and shells) were planned. Research was emphasized and a research contract from NACA for \$5,000 was received. Professor Steinbacher left UA after a short stay but his plans for increasing research were continued by other faculty. The need for graduate education was stressed, and it remains an important part of the AE curriculum today.

1950 to 2003

Dr. Frank A. Rose became president of UA in 1958 and Dr. Vernher von Braun's group of rocket scientists arrived in Huntsville, AL, in 1950. The AE staff immediately became involved in space activities, and Dr. Rose fully supported their efforts. The low salaries of the day were increased and a very positive attitude prevailed. During a six year period from 1958-1964, the College

of Engineering's budget increased 170%, and the number of faculty increased from 53 in 1957-1958 to 63 in 1958-1959 [3]. An 80% increase in faculty size between 1957 and 1963 lifted faculty morale, and the AE program enjoyed increased productivity. Research activities, graduate work, and laboratory facilities benefited immensely. The average salary of a full professor increased from about \$5,000 in 1953 to \$8,500 in 1958 and to \$10,200 in 1963.

Professor Bryan became Chairman of the AE Department in 1952 after Professor Steinbacher resigned. One of the key contributions Professor Bryan made during this time was to recruit, hire, and maintain a very loyal and talented faculty. Many of these professors ended up spending their entire careers at UA and only recently retired. Professors Ray Hollub, Earl Bailey, and George Weeks have retired during the last five years, and continue to reside in the Tuscaloosa community. Professor Rey was eligible for retirement but passed away before he retired. These loyal and talented gentlemen educated many, many engineering students, most of whom continue to work in the industry today.

Faculty members in the AE program continue to receive many honors, engage in research, are active in professional groups, and support a well established department. Professor Bryan, at age of 93, continues to work as a part-time member of the faculty where he teaches the senior seminar in which students continue to benefit from his many years of experience.

During the last half-century, the fate of the AE program was intricately woven

with the Mechanical Engineering and Engineering Science and Mechanics programs at UA. At one time or another, these three programs have existed as three separate departments, as a single combined department, and as two departments of virtually every possible combination. Most recently, the Engineering Science and Mechanics Department was merged with the Aerospace Engineering Department, thereby forming the Aerospace Engineering and Mechanics (AEM) Department that thrives today.

The Current Program

The AEM Department at UA provides both undergraduate and graduate degrees. Specifically, the department offers the following degrees: (1) BS in aerospace engineering, (2) MS in aerospace engineering, (3) MS in engineering science and mechanics, and (4) PhD in engineering science and mechanics. In addition, the AEM Department offers an MSAE degree via distance education (the QUEST program [4]). Students receive video tapes of class lectures then interact with faculty and other students via the internet, faxes, and electronic mail. Aside from these degree programs, the department is responsible for teaching a variety of service courses for the college including the following undergraduate courses: (1) statics, (2) dynamics, (3) mechanics of materials, and (4) fluid mechanics, and the following graduate courses: (1) matrix and vector analysis and (2) partial differential equations.

The current faculty consists of thirteen full-time faculty and two temporary instructors; each of the fifteen have terminal degrees [5]. The qualifications

of the faculty have changed dramatically over the years. In 1942 there was one faculty member with an earned PhD in the entire College of Engineering at UA, Dr. Taylor, who taught drawing. In 1957 only 14% of the faculty in the college held PhD's. By 1965 48% of the faculty in the college held terminal degrees. Like with most engineering programs, the educational attainment of the AE faculty has changed with time, reflecting more diversity to strengthen the AE curriculum and to allow for full coverage of the discipline for the students. The AEM Department also has two named professorships: (1) the AEM Cudworth Professor, Dr. Stan Jones and (2) the Jordan Chair (currently unfilled) named after William D. Jordan who was the head of the Engineering Mechanics Department at UA for over 20 years.

Of course, the collective qualifications of the faculty are not the only thing that has changed over the years; the curriculum has changed markedly. From the early years when pilot training was the focus, to the post-war years when aircraft design was placed at a premium, to the modern curriculum which includes classes on spacecraft [6], the curriculum in AE at UA has been constantly monitored and tweaked in an effort to provide students with the tools and knowledge to succeed in the current marketplace. Aside from adding and replacing individual courses, the AE program at UA has also acknowledged the interests of engineering technical societies (specifically the AIAA) in improving the image of the engineering profession and the desire for more and more engineers to become licensed.

Currently, every student completing a degree in AE is required to take the

Fundamentals of Engineering Exam. In addition, UA has recognized the desire of employers to hire students with strong communication skills, the ability to work in teams, and a detailed knowledge of problem-solving and the design process. To this end, these aspects of a student's education have been addressed both in individual courses and across the curriculum. The process of monitoring and adjusting the curriculum has been an ongoing process, and the curriculum in the AEM Department is up-to-date and strong. Graduates of the program are well-prepared both to take jobs in industry and to attend graduate school; our graduates have gone on to succeed at prestigious graduate schools across the country.

Students in the undergraduate AE program are eligible to participate in at least two honors programs. First, they can participate in the University Honors Program. This program offers qualified undergraduate students a special academic challenge. Honors classes have limited enrollment, placing emphasis on interaction between students and faculty. Second, they can participate in the Computer-Based Honors Program [8]. This nationally acclaimed program focuses on getting students involved with faculty across the campus to work on various research projects. Many AE students have participated in both programs over the years. In addition to these two programs, the AEM Department has recently developed a program under the University Scholars Program by which students can complete both an undergraduate degree in aerospace engineering and a masters degree in either aerospace engineering or engineering science and mechanics via the use of dual course credit. This

program is in its initial phases but should prove inviting to extremely bright entering freshmen.

Like with most things, the make-up of the student body in AE is also very different today than in the past. Currently, there are 91 students enrolled in the AE program. Of these, 20 (22%) are female. Of the six students who hold office in the student chapter of the AIAA, three are females (50%). This represents a marked improvement in increased diversity since the first female, Ms. Rose Rabinoyitz, graduated from the program before World War II.

Recruiting quality high school students is a continued emphasis of the AEM Department. This effort is based largely on providing prospective students with the kind of personal attention they can expect throughout their tenure at The University of Alabama. Of course, scholarships are an important part of any recruiting effort. The AEM Department regularly makes a number of scholarship offers including the Colgan Bryan scholarship.

The current AEM Department has made a concerted effort to increase the involvement of industrial partners in the process of educating students, impacting local industry, and making advances in scientific research. For instance, the department has a very active Industrial Advisory Board composed of thirty-eight members from industry and government [7]. This group meets twice per year and assists the AEM Department in:

- maintaining ABET accreditation;
- establishing an Endowed Scholarship Fund;

- provide laboratory equipment through donations, purchase or obtain surplus equipment as necessary to support the departmental programs;
- student recruitment;
- other tasks as deemed necessary to support the department.

- Experimental Stress Analysis Lab;
- Computational Mechanics Lab;
- Genetic Algorithms Lab.

Current Facilities

Like at all research institutions, the AEM Department at UA continues to grow its research programs, and endeavors to tie these efforts to both undergraduate and graduate education. The faculty are involved with numerous research projects including: (1) a project with the FAA to develop a highly-accurate, very low-weight gyroscope for the FAA and (2) project NOVA which is a NASA-sponsored project to assist in the development of K-12 science and math teachers. These two projects provide an indication of the range of projects ongoing within the department.

Of course to perform quality research, universities must develop and maintain modern facilities. The AEM Department has a variety of modern laboratories used both for research and teaching. These facilities include:

- Jet Propulsion Lab;
- Aerospace Structures Lab;
- Computational Fluid Dynamics Lab;
- Experimental Aerodynamics Lab;
- Flight Dynamics Lab;
- Mechanics of Materials Lab;
- Structural Design and Testing Lab;
- Intelligent Control Lab;



Figure 3: The Intelligent Control Lab is utilized in the development of small aircraft.



Figure 4: The Experimental Aerodynamics Lab includes wind tunnels capable of achieving speeds of up to Mach 5.



Figure 5: The Flight Dynamics Lab includes both helicopter and fixed-wing simulators.

From its beginnings in which a single aircraft and one low-speed wind tunnel made up its core research and teaching facilities, the AEM Department has built facilities and infrastructure that allow it to conduct research and teach students to the highest standards. One interesting project of note involved Dr. Earl Bailey of AE and Dr. James Dudgeon of the Electrical Engineering Department. These two were involved with the development of an early flight simulator for the U.S. Army. Some of the same technologies used in the development of the simulator were later applied to the study of wind shear problems in aircraft. Their efforts applied the latest computer technology to the teaching of aircraft guidance and control. In addition, the test apparatus that was developed used color graphics and displays, a molded plastic cockpit and computer-generated navigational aids. Although this project may seem mundane by today's standards, the simulator they designed, built, and tested was at the leading edge of simulation research at the time, and their simulator remains a part of the current Flight Simulation Lab today.

There are, of course, numerous other projects in which the faculty in AEM are involved. For instance, the NASA Faculty Fellowship program for Marshall Space Flight Center is co-managed by UA and UAH. Also, the department is heavily involved with the management of the Alabama Space Consortium program.

The quest for better and better facilities is ongoing. The most recent construction project in the College of Engineering is a students' project building. This building will be used exclusively for students from across the college to work on projects for classes, research projects, and student organization-sponsored competitions. Students from the aerospace engineering program are looking forward to having a better place to work on the aircraft they produce as part of their senior projects.

Accreditation

Both the College of Engineering and the AE program in particular have an impressive record in the area of accreditation. In 1937 the Engineers' Council for Professional Development (ECPD) accredited six of the eight programs in the college; one of the six was the AE program at UA. This honor placed the College of Engineering among the top 12% of the schools in the United States. Of the eighteen southern schools examined by ECPD, UA had the highest number of accredited programs originally approved, providing national respectability and prestige. Perhaps more impressive is the fact that the AE program at UA has been continually accredited since 1937 (66 years), a source of strength, pride, and national prestige.

The College of Engineering was most recently evaluated by the Accreditation Board for Engineering and Technology (ABET) in the Fall of 2001. At this time the AE program was again fully accredited.

The current AEM faculty is well aware of this history of maintaining its accreditation. Naturally, this is a great source of pride for everyone involved in the program including faculty, administrators, and students. This record is indicative of the emphasis placed on providing an excellent undergraduate education in AEM at UA. In addition, many of the faculty in the AEM, and in the College of Engineering, serve as ABET reviewers, thereby visiting and evaluating programs across the country.

Alumni

The list of alumni from the program is long and includes numerous prestigious individuals. To provide a flavor of the quality of the alumni, five are mentioned here. First, Mickey Blackwell was a 1962 graduate of UA. He went on to a distinguished career with Lockheed Martin Corporation where he retired as Executive Vice President.

Second, Lieutenant Colonel James Kelly was the first graduate of the distance education program in the department, and also the first alumnus to go into space. Kelly earned a master's degree in aerospace engineering in 1996 and piloted the space shuttle Discovery for the first time in March 2001. He was a U.S. Air Force Academy graduate in 1986 and an F-15 pilot until he was selected for astronaut training ten years later. Also, he spent 307 hours in space while serving as the Discovery pilot in

2001. Interestingly enough, Lt. Col. Kelly was scheduled to pilot the space shuttle a second time on March 1, 2003 – a mission that is subject to change based on the tragic loss of the space shuttle Columbia on Feb 1, 2003.

Third, Jack Lee (BSAE 1958) was appointed Deputy Director, NASA – George C. Marshall Space Flight Center in Huntsville in 1980 after serving with the Spacelab Program. He completed the Advance Management Program at the Harvard School of Business in 1985. He continues his involvement with AEM today as a member of the Industrial Advisory Board.

Fourth, Carl W. Albright, Jr. (BSAE 1967, J.D. 1970) is one of a number of AE graduates who have used their education to benefit the Tuscaloosa community. Mr. Albright served as Municipal Court Judge from 1975-1980, and served as President of Amsouth Bank Corporation until his recent death. His many respected professional activities and community activities are indicative of the strength of character of many alumni from the AE program.

Fifth, William Lawler is a prominent member of the UA class of 1962. He began his career with Boeing Aerospace in Seattle. While with Boeing, Mr. Lawler worked as the lead structural dynamics engineer for the Saturn V/Apollo launch vehicle; as the senior dynamicist for the Space Shuttle; and as the senior specialist engineer with the Assault Breaker missile program. After a brief stint with Northrop Grumman where he was deeply involved in the development of the B-2 "Stealth" Bomber, he returned to The Boeing Company as the vice president and

general manager of Business Development and Strategy for the Military Aircraft and Missile Systems Group. He assumed his current post as the vice president and general manager of strategic operations and planning for the group in 2000.

It is tempting and somewhat ego-boasting to enumerate the most prestigious members of a program's alumni. However, it is also important to note that many of the alumni of the AE program have gone on to be successful (if not prestigious) members of the aerospace engineering field. This program has graduated many, many engineers who have gone on to be successful in industries across the State of Alabama, and across the United States. It is these engineers upon which the reputation of the program has been built.

Summary

Aerospace engineering has a rich and prominent history in the College of Engineering at UA. Over its seventy-plus-year existence, the program has educated numerous engineers, been a leader in scientific research, and contributed to the economic development of the State of Alabama and the Nation. Alumni of the program continue to be leaders in the fields of aerospace engineering, computer programming, business, medicine, and others.

Naturally, the program has changed over the years. This paper outlines some of the history of the program, and provides a flavor of the rich history that is AE at UA.

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