

University of Colorado  
President's Award for Outstanding Academic Leadership  
in Undergraduate Student Success

Department of Aerospace Engineering Sciences

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## Aerospace Engineering Sciences (AES) Undergraduate Program

The Department of Aerospace Engineering Sciences offers an ABET-accredited Bachelor of Science (BS) degree program, currently serving 400 majors (Table 1). We have 28 tenure track faculty, 2 senior instructors, and 2 technical staff who are primarily responsible for the content and delivery of our program. A full time undergraduate advisor works with our undergraduates on course and career planning and is a liaison for prospective students and their families. Our faculty have been recognized on multiple occasions for their outstanding teaching and advising (Table 2).

**Table 1. Statistics on ranking, enrollments, and graduates over the past 5 years.**

Year	2008	2007	2006	2005	2004
USNews - College of Engineering Rank (among public)	33 (19)	34 (19)	36 (21)	33 (18)	29 (17)
USNews - Specialty Rank - Aerospace Engineering	16 (11)	18 (13)	17 (12)	17 (12)	13 (9)
Number of AES undergraduate majors	400	404	421	476	451
Number of AES BS graduates	70	58	66	73	53
Number of AES BS and BS/MS graduates with honors or high honors	8	4	11	3	0

**Table 2. Faculty and Staff Awards for Teaching and Advising**

Brian Argrow, Professor	Marinus Smith Award (2003) President's Teaching Scholar (2000) Boulder Faculty Assembly Excellence in Teaching Award (1996-1997) The Charles A. Hutchinson Memorial Teaching Award (1996) Engineering Teaching Excellence Award, W.M. Keck Foundation (1995)
Scott Palo, Assistant Professor	AIAA Rocky Mountain Section Educator of the Year (2007)
Donna Gerren, Senior Instructor	AIAA National Faculty Advisor Award (2007) Boeing Welliver Faculty Fellowship (Summer 2007)
David Klaus, Assistant Professor	AIAA Rocky Mountain Section Educator of the Year (2006) Boulder Faculty Assembly Excellence in Teaching Award (2007)

The AES curriculum is structured to balance technical depth with hands-on skills. Every one of our required core AES classes includes both lecture and lab components. The extensive lab activity is enabled by the facilities and support staff of the Integrated Teaching and Learning Laboratory (ITLL). Within the College of Engineering, our department utilizes this resource and the hands-on learning approach most extensively in ten 4- or 5-unit courses. Our commitment to this approach dates back to the late 1990's when, under the leadership of Chair A. Richard Seebass, we reformed our undergraduate curriculum to better reflect key requirements for quality education as identified by employers, alumni, students and faculty. Our primary goal is for students to have a strong understanding of the underlying theory, excellent professional skills, and some practical experience in applying these to aerospace problems. This goal was developed in collaboration with major aerospace industries, especially with The Boeing Company. It will become clear in the supporting documentation that we have been very successful in this – external reports show that our graduates have both the strong underlying technical abilities required for lifelong learning and advancement, and the professional skills to become immediate contributors to their organizations.

In the College of Engineering, the first year is common to all engineering departments with the exception that we require our students to take either the first year engineering projects course (GEEN 1400), which is optional for some majors in the college, or Gateway to Space (ASEN 2500), a more aerospace-focused version of the project course. In the sophomore year students take four 5-credit AES courses that lay the foundation for each subdiscipline within the major. Each of the sophomore courses is team-taught by two faculty members with

relevant expertise and supported by lab staff and teaching assistants. The courses each have 3 lecture hours and 4 lab hours per week. The lectures encourage pro-active learning and develop team working skills. The labs include open-ended experiments and design exercises in which students build essential skills in individual research, teamwork, technical writing, presenting, computing, experimental methods, design methods, and data analysis. In the junior year and senior year students build up their technical expertise in each of the aerospace disciplines and select professional area electives that allow for minors, double majors, and BS/MS coursework to be counted. With only one exception, the core technical courses are 4 credits with 3 lecture hours and 2 lab hours per week.

The focus of the senior year is the capstone senior design project sequence (for details, please see <http://www.colorado.edu/ASEN/SrProjects/>). This unique course provides senior undergraduate students with a mentored experience working on a requirements-based design project in self-directed teams. Projects provided by faculty or industry customers can be of two types: design of a new device, vehicle, or system, or design of an experiment to develop new technology or design principles. Fundamentals, techniques and tools learned in sophomore and junior courses are applied in a team environment to carry an engineering idea through to a testable prototype, and to develop an understanding of the technology. Students learn about systems engineering methodologies, design requirements, objectives and constraints, and assumptions for developing a project. They learn how to make trade studies and how to do a sensitivity analysis while developing engineering reasoning and teamwork skills. Teamwork and several oral presentations develop their communication skills. Each student takes on a leadership position: program manager, systems engineer, safety engineer, specialty lead (e.g. manufacturing, aeronautics), or chief financial officer. Each team is assigned two faculty advisors from the ten faculty members of the Project Advisory Board (PAB) pool. These advisors cover a wide range of technical skills. The Department is very proud of the strong faculty support of our senior design program.

The faculty, staff and students in AES are actively engaged in making continuous improvements to our program. Faculty and staff hold an annual retreat on the undergraduate program where we review the past year, make decisions about changes, and discuss the effectiveness of teaching approaches. For example, we have found that co-teaching adds tremendous value to the quality of key undergraduate courses. Professors teaching the sophomore courses have extensive discussions about their teaching, which has helped to set the stage for excellence at the higher course levels, culminating in a highly recognized capstone senior design course.

Our graduate students who serve as teaching assistants participate in the campus graduate teacher program. They organize weekly seminars on topics related to the appointments and their graduate studies, and invite undergraduates to further the vertical integration of research and teaching. Undergraduate student feedback is provided not only by FCQ and course surveys that we conduct, but also via a curriculum improvement team (CIT) comprised of 12-15 students representing all levels and student performance norms in the department. The CIT meets throughout the year to discuss the curriculum and once per semester with the Chair and the undergraduate advisor to assess concerns about requirements, teaching, and anything else their peers want to bring up. Their constructive feedback has been essential in our making changes to the scheduling of some of our courses and in providing advice to individual instructors.

Despite a heavy workload, AES students are incredibly active in extracurricular activities related to aerospace. The American Institute of Aeronautics and Astronautics (AIAA) student chapter boasts 55 student participants. They host speakers from industry each month in addition to sponsoring the Outstanding Senior Project awards each spring semester. Their faculty advisor, Donna Gerren, was recognized with the National Award for Outstanding Advisor in 2007 for her efforts. The Society for Exploration and Development of Space (SEDS) has 30 members and 100 students on its listserve, and has organized 12 events this year. The aerospace engineering honor society, Sigma Gamma Tau (SGT), currently has 29 active members. SGT offers free tutoring to aerospace students and its yearly events include a Trivia Bowl, Model Rocket Launch Competition and Balsa Airplane Endurance Event. There are 56 members in the CU Flying Club, which is sponsoring a popular ground school class on campus for aspiring pilots, as well as flying events. For the past five years under the direction of Prof. Brian Argrow, AES students have participated in the national Design-Build-Fly contest, coming in 5<sup>th</sup> out of 40 teams competing in April 2008 (and 7<sup>th</sup> place the year before).

## Student Academic Achievements

The students in Aerospace Engineering Sciences consistently demonstrate extraordinary academic leadership and achievement as measured by scholarships and awards, research accomplishments, and their service to the campus community. The undergraduate program is currently ranked 16<sup>th</sup> in the country by US News and World Report and is 11<sup>th</sup> among public institutions. We also tie for 7<sup>th</sup> with three other schools in graduating the highest number of undergraduate students in the field. Other measures of the academic success of our students (shown in preceding Table 1) are the number of students entering the combined BS/MS program, those graduating with honors from that program (22% BS/MS are graduating cum laude, magna cum laude, or summa cum laude in spring 2008), and the total number of students graduating with honors (23 out of 194 graduates, or 12% over the past 3 years). Over one-fourth of our undergraduate students (102) are on the Dean's List. Aerospace departments do not have a standardized test and students typically do not take the engineering professional exam, so we will rely on representative accomplishments in the areas of scholarships and awards, research, service, and career placement in evaluating the achievements of our students.

### Scholarships

Table 3 lists the national level scholarships won by AES students in the last three years and Table 4 shows the distribution of Engineering College scholarships awarded to our students. In the past two years the Aerospace department has been the top funded department in the college for scholarships, placing as the second-most funded department three years ago. In each of these years aerospace undergraduates received more than 18% of the total award funds that are available to the College of Engineering.

Table 3. National Scholarships awarded to AES students

Goldwater Scholarship	Farheen Rizvi	2007
Goldwater Scholarship	Ashley Moore	2006
Astronaut Scholarship	Erin Reed	2006
Astronaut Scholarship	Ashley Moore	2005

Table 4. CU Scholarships awarded to AES students

Academic year	Available Engineering scholarship funds	% of scholarship funds received by AES students
2006-2007	\$215,205	18%
2005-2006	\$224,269	19%
2004-2005	\$188,671	18%

### Research

Many AES students are actively engaged in research as undergraduates through such programs as Engineering Excellence Fund (EEF), the Undergraduate Research Opportunities Program (UROP), Discovery Learning Apprenticeships (DLA), and through paid positions in faculty research labs, the Colorado Space Grant College, and the Laboratory for Atmospheric and Space Physics.

In the last three years, three AES students have been selected as the *College of Engineering Outstanding Graduate for Research*: - Arseny Dolgov (May 2007), Matthew Osborn (Dec 2007), and Ashley Moore (May 2006).

Student research work has also been recognized by the following best paper awards:

- S. Lawrence-Simon, S. Wilson, and Christina Wolfskill, - first place in the team category for their paper, "KRAKEN: Kinematically Roving Autonomously Controlled Electro-Nautic." AIAA Region V Student Paper Conference (April 2008)
- D. Berman, C. Hatcher, and Lindsay Marek - second place in the team category for their paper on "The Micro Air Reconnaissance, Launch and Imaging System (MARVLIS)." AIAA Region V Student Paper Conference (April 2008). They will next compete in the national competition in Orlando in January 2009.

- G. Dvorkina, J. Shelton, A. Dolgov, N. Driver, K. Eberhart, M. Edwards, J. Jannetto, E. Kohut, - first place in the team category for their paper, “Self Organizing Aerial Reconnaissance System.” AIAA Region V Student Paper Conference (April 2007)
- L. Kanner, Brent Lewis, Rich Rieber, Hwapyong Ko, and David Owen - Best student paper, “MaCH-SR1: Development and Characterization of Hybrid Rocket Technologies through Undergraduate R&D.” Joint Army-Navy-NASA-Air Force Liquid Propulsion Subcommittee (May 2007)

AES undergraduate student research projects sponsored by the Engineering Excellence Fund in the last three years have included the following:

- Wing integration of an antenna in a small Unmanned Aerial System
- Mission operation for a science and educational payload on-board the International Space Station
- Development of MATLAB software for tracking loop current eddies in the Gulf of Mexico
- Design and manufacture of a composite wheel for an aircraft
- Design and construction of a research LIDAR system
- Application of a commercial fluid solver into the undergraduate curriculum

Many of our students are employed as assistants with the Colorado Space Grant Consortium (CSGC) and the Laboratory for Atmospheric and Space Physics (LASP), and their contributions are highly valued. William Possel, Director of Mission Operations & Data Systems at LASP, describes the dedication of the 10-15 AES students in a support letter as follows:

“The Aerospace Engineering Science (AES) students are critical to our spacecraft and instrument operations at LASP. ... Your students continuously demonstrate the extraordinary leadership, capabilities, and talents in the AES department.”

Director of CSGC Chris Koehler writes in his support letter:

“The aerospace students in our program bring excellent technical and analytical skills to our programs which range from freshman level high altitude balloon experiments to senior level small satellite design, construction, test and launch. Through the aerospace department’s curriculum, aerospace students significantly contribute both technically and as leaders.”

AES students are very actively engaged in UROP sponsored research, as illustrated in Figure 1. Although they represent only a tiny portion (400 students) of the Boulder Campus undergraduate population (over 22,000), AES students have been awarded 10-20% of the UROP awards, receiving approximately 5% of the available research budget.

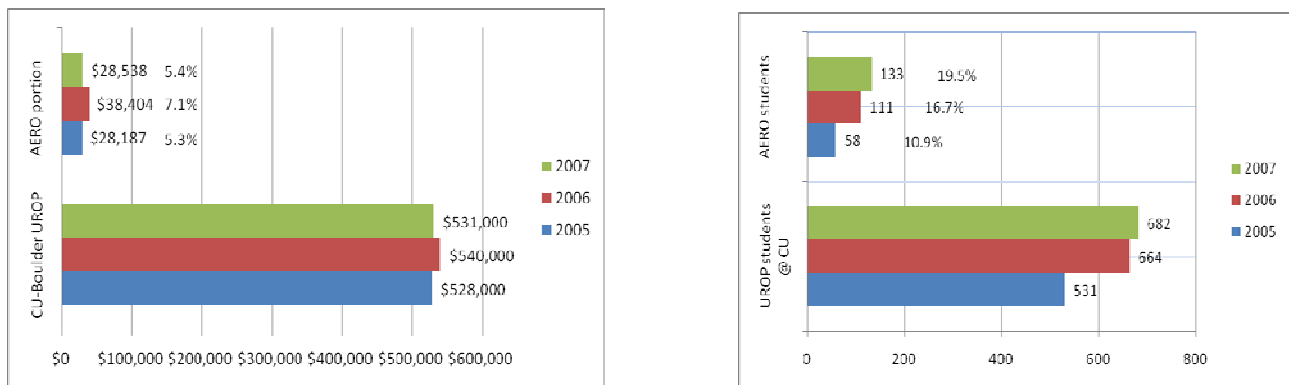


Figure 1 - Left: Funding of Aerospace (AERO) undergraduates in comparison to the available CU-Boulder UROP funding. Right: Number of AERO students who received funding from UROP compared to the number of students awarded UROP funding at the CU Campus.

At the college level, many AES students are selected for the Dean-sponsored Discovery Learning Apprenticeships (created in 2004), as illustrated in Table 5. Their work has not been limited to aerospace engineering projects. Some students chose to work with faculty from other academic departments. For example,

- Jacob Niece worked with Dean Rob Davis (ChBE) on Particle-Particle Collisions and Agglomeration
- Jeremy Ralph worked with Professors Liz Bradley (CS) and Jean Hertzberg (ME) on Planar Jet Control
- Mrinal Shukla worked with Professor Bob McLeod (ECE) on Control Software for Optical Instrumentation
- Eric Simley worked with Professor Ken Strzepek (CEAE) on GIS support for Climate Change Impact Project
- Kimberly Kroh worked with Professor Robin Shandas (ME) on Advanced Ultrasound-Based Biomedical Imaging. (Note: Kimberly's work is profiled at: <http://engineering.colorado.edu/activelearning/kroh.htm> )
- Ben Brown works with Professor Tobin Munsat (Physics) on Derivation of Velocity Fields from Images of Plasma Turbulence
- Sheldon Coutinho works with Professor Mike Eisenberg (CS) on Mechanical Linkage Displays for Drawing Mathematical Curves

Table 5. Discovery Learning Apprenticeships

Semester	#Projects Offered	#Students Applied	#DLAs offered	#Aerospace Students Accepted (AES student %)
AY 2004-2005	59	56	35	10 (28%)
AY 2005-2006	37	48	25	6 (24%)
AY 2006-2007	56	65	35	4 (11%)
AY 2007-2008	54	56	35	4 (11%)

Our students attribute their success in their post-graduate lives to experience gleaned from such projects:

“The process of designing, building, and testing our own projects, along with the time and funding management, gave me my first look into the acquisition process the NAVY uses to procure aircraft and weapons systems every day” (J. Uchida, B.S. 2004, support letter).

### Service involvement

AES students are exceptional in their commitment to service in the university - especially at the college level through the University of Colorado Engineering Council, Engineering Ambassadors, Peer Advocates, Engineering Fellows, and High School Honors Institute. The engineering student government, University of Colorado Engineering Council (UCEC), representing 6 departments and 5 programs in the college, has 12 executive positions of which 7 are currently filled by AES students (= 58%). The Engineering Fellows of the College of Engineering and Applied Science is an honorary service organization created in the fall of 2004. They are a select group of academically successful, service-oriented undergraduate students of the College who actively seek to promote academic excellence in the College through peer academic support. Of the 47 past and current fellows, almost a third (15) are AES students.

In 2006, AES student Shivali Bidaiah received the Outstanding Freshman of the Year scholarship from the Multicultural Engineering Program (MEP), and one of our current first year students, Tiana Miller-Jackson, was just selected by MEP as the outstanding freshman because of her enthusiastic involvement in outreach and her positive attitude and accomplishments in her first year at the university.

Some other examples of aerospace student leadership abilities are exemplified by one student serving as Co-Vice President of the Engineering Council and Engineering Advocates, and another student's participation in the IBM ECITE Camp as a mentor for children to raise their interest in mathematics, engineering, and science. Lelei Finau-Starkey, the College Director of Outreach and Recruiting, writes in her letter of support for this award, “I am constantly impressed with aerospace students; they eagerly and readily volunteer to assist the College in any way necessary and I receive a steady stream of positive feedback from prospective students, parents, and other guests of the College regarding their interactions with aerospace engineering sciences students.....I could go on and on

citing examples of bright, service-oriented aerospace engineering sciences students who are willing (and very importantly, able) to effectively interact with the general public and excite others about engineering.” Her letter is included in the supporting materials and it gives specific examples of students who have made a difference.

In the last three years, two AES students have been selected to receive the **College of Engineering Outstanding Graduate for Service Award**: Erin Reed (2006) and Matthew Edwards (2008). To illustrate the kind of service these students provide, here is an excerpt from Matt Edward’s nomination letter:

*Matt has been an organizer and participant in Space Grant, Engineering Fellows, and the Residence Hall Program. As an Engineering Fellow, Mr. Edwards volunteered to promote academic excellence in the college of engineering by tutoring, advising, and mentoring AES students. He has been very active in the Residence Hall Association at the campus, regional, and national level, serving in many leadership roles to improve student life and coordinate with the campus administration. He has served on nine campus committees and councils including co-chairing the Alcohol Task Force and the Quality of Life Task Force. He was the director of the highly visible Shoulder to Shoulder T-Shirt campaign, aimed at promoting campus unity. Matt has won numerous awards for his service activities, including the CU Boulder Outstanding Student Leader (2006), National Association of College and University Residence Halls National Communications Coordinator of the Year (2006), and Residence Hall Student of the Year (2004), and the College of Engineering and Applied Science Outstanding Graduate for Service (2008). Matt Edwards is a student who not only cares deeply for the university and our students; but he acts personally to make a difference.*

### **Career Placement and Advancement**

Aerospace Engineering Sciences students at UCB are pleased with their undergraduate education, with 84% stating that their program of study “definitely met their educational goals”, and they feel well prepared to continue in graduate school (Alumni Survey Summer 2007 – ASEN).

Nearly all students receive job offers before graduating—in May 2007, of 53 Aerospace students graduating only eight did not yet have jobs lined up. Of those eight, four had multiple offers from which they had not yet chosen and the other four were not looking for a job (Claire Yang, Aerospace undergraduate advisor). Graduates begin employment with average annual salaries over \$56,000 and 71% are “very” or “extremely satisfied” with their jobs (Post-Graduation Survey May/Aug 2006 – ASEN). Employment opportunities range from jobs in private industry (Boeing, Lockheed Martin, Northrup Grumman), to positions in the military and/or in government agencies such as NASA and JPL, with 89% reporting that they exert leadership on the job (Alumni Survey Summer 2007 – ASEN). On a 5 point scale, Aerospace alumni from the Summer 2007 Survey categorize the level of complexity of systems they are involved in designing as 3.91, and rate the overall importance of their personal contribution to a successful design of these systems as 3.82.

Aerospace graduates attribute much of their success to their undergraduate education, as indicated below by quotes from letters received from alumni or, in one case, from an alumna’s supervisor (quoted less extensively in **Senior Projects**).

#### **Jennifer Uchida (B.S. 2004)**

CU’s Aerospace program takes many approaches towards learning and equips their graduates with the valuable tools necessary to excel in the work force. ...I learned to trust my own thought processes and predictions, which is a skill I use often in the test and evaluation world. The technical writing skills I walked away with from reporting on test results, has proven to be one of the most valuable assets in my career.

#### **Mark Shannon, supervisor (of Lauren Kanner, B.S. 2005)**

Lauren has worked for me at Ball Aerospace & Technologies Corp. for over two years in the capacity of a Spacecraft Systems Engineer. ... Her performance in this capacity has been superior to her peers, as verified by her promotion 6 months ahead of her peer group. ... The practical experience gained from

Senior Design Projects has provided a good background in planning and executing engineering design and test management. ... This availability of leadership opportunities at CU has given Lauren confidence and experience that has helped me at Ball.

### **Sonja Leftwich (B.S. 2006)**

I have been given several honors since I started working for Lockheed Martin in 2006—the most notable of which was an early promotion to a Level 2 Engineer ... after less than 1 year of full time employment). ... My undergraduate experience as an Aerospace Engineering student at UCB was an amazing preparation to the engineering industry ... The intense lab work, high expectations and quality instruction of my AES classes molded me into the engineer I am today.

Finally, Aerospace Engineering Sciences alumni report an ever-increasing number of awards received throughout their careers in industry, government labs, and the military, from a Lockheed Martin NOVA Award for Teamwork (the highest award given to LM employees), to coveted NASA awards, to Air Medal and Air Force awards, and even a patent pending (Table 6, below).

Table 6. ASEN Award Recognition from Alumni Survey of Summer 2007

<b>Self-Reported by Alumni (each block is a separate individual)</b>
NASA Group Achievement Award for Thermal Protection System Inspections (June '07), Johnson Space Center Group Achievement Award for P3/P4 Truss Installation (Oct 06), United Space Alliance Performance Awards (Team: Jan '07, Individual: Nov '05), United Space Alliance Employee of the Month - Community Service (Dec '05)
Lockheed Martin Special Recognition Award for outstanding execution of engineering responsibilities leading to the reduction of risk in launching a payload from the East coast.
Graduated Lockheed Martin Engineering Leadership Development Program.
2 Performance Recognition Payments for work performed on the STP-1 mission, Certificate of commendation for work performed on the STP-1 mission, Spot award for contributions on Concept Development Studies
Air Medal, Air Force Achievement Medal, Air Force Outstanding Unit Award, Iraq Campaign Medal
Spot Award for work done on Mars Telecommunications Orbiter proposal
Lockheed Martin NOVA Award for Teamwork, 2006. (This is the highest award given to LM employees.) US Government-level Director's Award, 2006. Customer-level Directorate Award, 2006. LM Special Recognition Award for Excellence, 2006. LM SPOT Award for Excellence, 2007. President's Volunteer Service Award, 2005 & 2006.
NASA and JPL Certificate of Recognition in appreciation of support of the encounter with comet Wild 2 on behalf of the Stardust Project. NASA Public Service Group Achievement Award for the 2001 Mars Odyssey Spacecraft Team in recognition of extraordinary contributions to the exploration of Mars, conducting flight operations efficiently and effectively, and enabling full mission success on schedule and under budget.
Patent Pending for a rocket engine design at Pioneer Astronautics
From <a href="http://engineering.colorado.edu/assessment/Alumni/2007.05/ABET">http://engineering.colorado.edu/assessment/Alumni/2007.05/ABET</a>

### **Summary**

The AES department is very proud of the academic quality and accomplishments of our undergraduates and our undergraduate program. Even though we could not satisfy all requirements listed in the award request we have provided solid evidence regarding the exceptional quality of our undergraduate program, a quality that we see increasing each year. The anecdotal evidence from employer comments, our students' letters and their future career paths, along with the statistics above, clearly point to the undergraduate program excellence which qualifies us for the President's Excellence Award. Our national ranking is consistently high in a very competitive field. Our faculty are widely recognized for their teaching excellence. Increasing numbers of aerospace students receive best paper awards and scholarships based on their work as undergraduates. Moreover, Aerospace students receive an above average percentage of research scholarships (apprenticeships) offered by the College and the Boulder Campus, some of which are not held within our department, indicating our program's multidisciplinary nature. And, finally, our students are most motivated to serve the academic community by their unselfish and

disproportionately high involvement in College affairs. In one sentence: the faculty of AES are very proud of their excellent and rapidly growing success in undergraduate education.