SELF-STUDY REPORT

For

ABET EC 2000

Bachelor of Science
In
AERONAUTICAL ENGINEERING

Submitted to
The Engineering Accreditation Commission (EAC)
of
The Accreditation Board for Engineering and Technology (ABET)

June 2002

UNITED STATES AIR FORCE ACADEMY
USAF ACADEMY, CO 80840

Preface

This Self Study Report documents the Department of Aeronautics' preparation for an ABET visit and program review under EC-2000 Criteria. The period of preparation is 1996 to June 2002.

The Aeronautical Engineering program was evaluated by ABET in the Fall, 1996, under the old ABET program criteria. The Aeronautical Engineering program was given a "Next General Review".

The Aeronautical Engineering Program at the United State Air Force Academy

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Section A. Background Information

1.0 Degree Titles

The Aeronautics Department (DFAN) at the United States Air Force Academy (USAFA) offers one undergraduate degree, the Bachelor of Science in Aeronautical Engineering.

2.0 Program Modes

The Bachelor of Science degree in aeronautical engineering at USAFA is based on a four-year academic program. The four-year requirement is established by US Congressional law and is not subject to change.

2.1 Transfer Cadets

USAFA does not accept transfer cadets from other institutions. The Academy does participate actively with the other four US service academies in an intra-service academy exchange program, which allows cadets to participate in other service academy programs for one term (usually the first term of the junior year: see USAFA Curriculum Handbook, Service Academy Exchange Program, page 52.).

Admission to USAFA follows a well defined process administered by the Academy Admissions Office. Overall, applicants must have a record of outstanding achievement in academics, physical fitness, and character standards consistent with those of officership in the US Air Force. Additionally, each applicant must secure an appointment from one of the following US government sources: Presidential, Vice-presidential, or Congressional.

Section B. Accreditation Summary

Section B. Accreditation Summary, presents data pertaining to the Aeronautics Department's program in aeronautical engineering; guided by the principles embodied in ABET EC2000. Chapters 1 – 8 in Section B correspond directly to ABET Criteria 1-8. Each chapter begins by stating the applicable ABET EC2000 Criterion followed by a DFAN overview narrative, DFAN Program. Questions about his report should be directed to Dr. Thomas Cunningham at tom.cunningham@usafa.af.mil.

Chapter 1. Students

1.0 ABET Criterion 1.

The quality and performance of the students and the graduates are important considerations in the evaluation of an engineering program. The institution must evaluate, advise, and monitor cadets to determine its success in meeting program objectives.

The institution must have and enforce policies for the acceptance of transfer cadets and for the validation of courses taken for credit elsewhere. The institution must also have and enforce procedures to assure that all students meet all program requirements.

DFAN Program – Procedures for evaluating, advising, and monitoring cadets in the Aeronautical Engineering program are well established, and practiced routinely to ensure each cadet has the optimum opportunity to succeed in the program. The Aeronautics Department believes these procedures help ensure attainment of the Program Curricular Outcomes (Chapter 2). Recruitment and admission are discussed in paragraph 1.1, academic evaluation is discussed in paragraph 1.2, and advising and monitoring are discussed in paragraphs 1.3 and 1.4, respectively. Paragraph 1.5 describes opportunities for cadets to develop professionally, and paragraphs 1.6 and 1.7 present some cadet distinctions.

Transfer Credits - Cadets completing coursework elsewhere may be entitled to some academic validations in the USAFA program.

"Students who attend another college or university before coming to the Academy or who validate courses while here may earn validation or transfer credit that is included in the total semester-hour count. ...No quality points are awarded for transfer or validation credit. All transfer and validation credits may be applied toward graduation requirements, providing that the cadet completes a minimum of 133 semester hours in residence at USAFA."[#]

Validating is determined by the cadet demonstrating satisfactory understanding of the subject matter to the academic department responsible for such subject matter.

Procedures for accepting transfer credits are explained in the USAFA Curriculum Handbook, pages 3, 32, and 293.

1.1 Recruitment and Admission

1.1.1 Recruitment - The Aeronautics Department does not have, nor does it participate in direct cadet recruitment for the aeronautical engineering program. Instead, each semester, the scope of the programs offered at USAFA by each department is presented formally to the freshman and sophomore cadets during Majors Night (paragraph 1.1.4). Freshman and sophomore cadets also obtain information informally from the upper-class cadets in their squadron, and from the academic faculty.

[#] USAFA Curriculum Handbook, 2001-2002.

Acceptance into the aeronautical engineering program is based largely on demonstrated academic performance during the freshman year (paragraph 1.2, Evaluation).

Starting in the fall term, August 2002, the Dean of the Faculty will conduct a seminar program for the freshman cadets in which information on Air Force mission and operational functions, plus officer career opportunities and expectations will be discussed. These seminars will address Air Force critical career areas, which will likely influence the freshman cadets' choices for academic specializations at USAFA. Engineering is a critical career field in the Air Force, so the Dean's seminars may influence cadets to choose an engineering program at USAFA.

1.1.2 Admission - Admission to the United States Air Force Academy follows a well documented application procedure. Specific information on the application process and the admission criteria are presented in the Air Force Academy Catalog, pages 6-20. Selected applicants enter the Academy as fourth class cadets (freshmen) with no declaration for a major field of study. Starting with the Class of 2006, freshman cadets will indicate a preference for specializing in either a technical discipline (mathematics, basic science, or engineering), or in a non-technical area.

1.1.3 General Advisor – Prior to the Class of 2006, cadets selected an academic specialization before the middle of the third semester. Until then, each cadet is assigned a general advisor to aid with academic course selection, registration, and choosing an academic specialization. General advisors are USAFA faculty members who volunteer to serve as a squadron academic advisor for the freshman cadets assigned to that particular squadron. Upon selecting an academic specialization, academic advising responsibilities transfer from the general advisor to a faculty advisor in the department administering the chosen academic specialization.

Beginning with the Class of 2006, freshman cadets will declare one of two broad categories, technical or non-technical. Each cadet squadron will have two academic advisors, one for the technical specializations, and one for the non-technical areas. These advisors will help the freshman cadets determine an appropriate academic specialization. In the revised program, freshman cadets are required to declare an academic specialization before completing the second semester.

1.1.4 Majors Night - Majors Night, an event conducted approximately six weeks into each semester, is an opportunity for undeclared cadets to become familiar with the academic disciplines offered at USAFA. Similar to a job-fair, at Majors Night, each department present details and highlights the academic specializations it offers. Several faculty and upper-class cadets are available to discuss specific features of the programs.

Appendix I., Table D.1 presents a pamphlet prepared and distributed by the Aeronautics Department at Majors Night. This pamphlet contains information on the aeronautical engineering profession especially with regard to Air Force jobs and assignments. The pamphlet also provides an outline and flow chart of course requirements, research activities in the Department, and several motivational pictures of Air Force aeronautical engineering activities.

1.2 Evaluation

Evaluating cadet performance in the aeronautical engineering program is discussed below in paragraph 1.4, Monitoring. Evidence used to evaluate cadets desiring to enter the aeronautical engineering program is based on the following items:

1.2.1 GPA - The academic record of each cadet desiring to enter the aeronautical engineering program is evaluated by the Department Advisor in Charge (AIC). While no specific selection criteria exist, candidates having at least a 2.5 GPA at the completion of the freshman year, and a good performance in calculus, introductory physics, and fundamentals of mechanics of static systems are accepted. Cadets not having these general qualifications are evaluated on a case-by-case basis by the AIC and the Department Head. Cadets with marginal performance (GPA of 2.0 or less) at the conclusion of the freshman year are usually at risk for completing the aeronautical engineering program. These cadets are advised to select a different academic specialization at USAFA. Under extenuating circumstances, a cadet at risk-may be admitted into the program, but this cadet's progress is carefully monitored until the at-risk concern is eliminated.

Some cadets entering the Academy are required to take remedial mathematics (Math 130) or remedial English (Eng 110), and these cadets are also at risk for completing the aeronautical engineering program. The remediation courses put these cadets behind in the mathematics sequence, which means they will likely have course-overload semesters to catch-up and stay on track with the sequence of courses in the curriculum. A cadet in the aeronautical engineering program with no course validations must take at least six courses per semester beyond the first semester. The cadet must overload one semester by taking seven courses. Moreover, if a cadet with course validations had to take one or more remedial courses, at least two overload semesters are required to get on track.

In the revised curriculum, DFAN anticipates some relaxation on the overload situation, but the actual effects are yet to be determined.

1.2.2 Initial Interview - All cadets seeking entry to the aeronautical engineering program are interviewed by at least one faculty member. During the interview session, the faculty member ascertains the reason for the cadet's desire to study aeronautical engineering, and explains program requirements and career opportunities in the Air Force in the field of aeronautical engineering.

1.2.3 Program Prerequisites – Cadets entering the aeronautical engineering program begin their study of 300 level discipline-specific courses in the fifth semester by taking Aero Engr 341 and Aero Engr 351. The preceding four semesters are devoted predominantly to completing core courses and program prerequisite courses to include mathematics through differential equations, physics and chemistry, and three foundational engineering core courses, Engr Mech 120, Fundamentals of Mechanics, Aero Engr 315, Fundamentals of Aeronautics, and Engr 310, Energy Systems (introductory thermodynamics and propulsion). Note: A revision to the USAFA core curriculum will be implemented in August 2002. Establishment of Aero Engr 241, Aero-Thermodynamics, is one impact of the curriculum revision on the aeronautical engineering program. Aero Engr 241 replaces Engr 310. As such, it becomes the prerequisite thermodynamics course for cadets seeking entry to the aeronautical engineering program starting with the class of 2005.

1.2.4 Dash – 1 - On or about the day before Fall Semester classes begin, the annual Aero-Seminar, called the Dash – 1 seminar, is held to welcome cadets in the aeronautical engineering program. At the Dash-1 seminar, policy and program issues to include program objectives and outcomes are discussed, and a gateway examination is administered to the cadets entering the 5th semester of the program. In Air Force flying units, Dash – 1 is the vernacular term for the lead document in the series of manuals defining the technical details and operating procedures for every Air Force airplane. Dash – 1 for the USAFA Aeronautical Engineering program presents program specific information, and in this sense, it serves a similar purpose as the Dash-1 manuals do in Air Force operational units. The agenda for the fall 2001 Dash – 1 is shown in Appendix I., Table D.2.

1.2.5 Gateway Examination - The gateway examination is an assessment tool administered electronically using the USAFA intranet during the Dash -1. Used as an entry-level assessment instrument, the gateway examination contains questions designed to ascertain levels of understanding and weaknesses in basic aeronautics, thermodynamics, statics, and mathematics to include ordinary differential equations. A minimum score of 70 percent is satisfactory. Scores below 70 percent indicate a need for remediation on weaknesses identified by the examination results. Cadets are required to retake the Gateway examination as many times as necessary to obtain a passing score. As applicable, cadets meet with their respective faculty advisor to accomplish the necessary remediation.

The gateway exam was administered for the first time in the fall of 2000 as an in-class exam and then again in 2001 as a web-based exam. The cadet comments regarding the web-based version were positive. They liked knowing what knowledge and skills they were expected to bring with them into their next level of classes as well as the areas that they need to improve.

From a cadet perspective, the Gateway is informative and constructive because it is electronic and can be taken may times over, it is a non-threatening test on basic knowledge, it provides immediate feedback on knowledge understood as well as weaknesses needing remediation.

DFAN will continue to improve the Gateway Examination in order to better prepare cadets for success in the Aeronautical Engineering program. Used in conjunction with Academic Program Schedules (APS: paragraph 1.4.1) reviews, and faculty observations, DFAN finds the rate of cadet success in the aeronautical engineering program to be good; the record for completion as shown in Table 1. is about 91% for the past five years. Due to the Academy's fixed eight semester program, DFAN believes these evaluation and monitoring procedures help assure program success as well as help direct cadets predisposed to fail in the program to other academic programs better matched to their background and abilities.

1.3 Advising

1.3.1 Advising Structure - Figure 1 illustrates the advising structure in the Aeronautics Department with details for the Class of 2004. The structure for the other classes is similar.

Table 1. Cadet Completion Rates for the Aeronautical Engineering Program

Class	Number of cadets entering the Program	Number of cadets completing the program
1998	43	40
1999	47	46
2000	47	43
2001	33	28
2002	52	48

Overall advising responsibility resides with the Advisor-in-Charge (AIC) who provides the class advisors guidance on advising procedures and requirements, policy changes, degree requirements, section offerings, and registration. In addition to the AIC, a department faculty member is designated as the Class Advisor for the cadets in a particular year group. A team of other faculty members works with the class advisor to ensure that all registration and degree requirements are met. Each team advisor is assigned approximately 10 cadets.

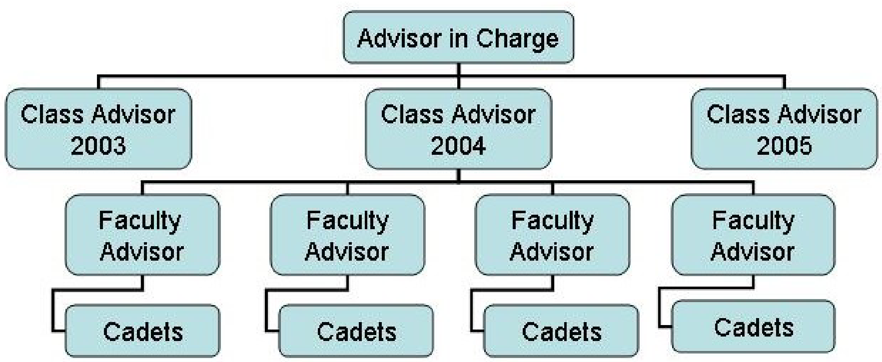


Figure 1 Advising Structure

1.3.2 Class Advisor - The class advisor along with supporting faculty advisors have responsibility for assessment and evaluation of the cadets in that particular year group. Working with the Department's Deputy for Program Accreditation (DPA), the class advisor administers the Gateway Examination at the annual Dash-1 seminar in August, evaluates the results, and establishes the procedures for remediation as needed. By conclusion of the fifth semester, the class advisor prepares and submits a report to the DPA documenting the Gateway Examination results.

At the start of the seventh semester and in coordination with the Curriculum Director, the class advisor and supporting faculty advisors, prepare the comprehensive examination that is given in January of the eighth semester. The Comprehensive Examination is a program assessment instrument similar in structure to the Professional Engineers Fundamentals of

Engineering (FE) examination; only the Comprehensive Examination focuses explicitly on the aeronautical engineering curriculum. The class advisor compiles the results and forwards the findings to the Curriculum Director, who in turn, distributes the results to TEBA and to the program Discipline Directors (see Section B. Chapter 3 for details on these groups). TEBA is the senior level committee in the Department that has responsibility for program accreditation. TEBA is discussed in Chapter 2.

Lastly, the class advisor and the faculty advisors prepare and conduct exit interviews with selected cadets in the graduating class. The exit interviews are part of the program assessment process.

1.4 Monitoring

1.4.1 APS - Monitoring cadet performance and academic development are important functions routinely performed by the faculty advisors. Monitoring begins with each cadet developing Academic Program Schedule (APS) with one of the academic advisors. The APS (Appendix I., Table D.3, Academic Program Schedule: Sample) presents the sequence of academic courses, military leadership courses, and physical conditioning courses needed for completion of both USAFA and the major program requirements. The Office of the Registrar (DFR) maintains and publishes electronic APS's for each cadet. Faculty advisors have access to and can make changes to electronic copies of the APS thereby keeping it current. Changes to the electronic copies must be approved by the AIC prior to amending the official APS maintained by DFR. Course grades are entered on the APS by DFR.

1.4.2 Grade Reporting - Cadet academic performance is reported twice each semester, at the mid-semester and at course completion. Academic advisors use mid-semester grades as assessment data to discuss academic performance issues with their advisees. Mid-semester grades are also used to identify problems in time to allow corrective actions to be made before course completion. Cadets are required to meet with their respective advisor at mid-semester to review performance issues and to discuss course registration for the subsequent semester.

1.4.3 Informal Monitoring - Monitoring cadet development occurs informally and routinely among the faculty members in the Aeronautics Department. Class sizes in the aeronautical engineering program, typically 40-60 cadets per class-year, are small enough to allow the faculty to observe and understand the performance of every cadet. These personal observations allow the faculty to recognize problems as they occur, and to subsequently discuss them with the cadets and the respective advisors. Additionally, academic advisors interact with the cadets' military commander (Air Officer Commanding, AOC) when a particular cadet's performance falls below standards. Academic and military supervision provide coordinated help in promoting the best environment and opportunity for cadets in academic trouble to succeed at USAFA.

1.5 Cadet Professional Development Opportunities

1.5.1 Officership - Irrespective of academic specialization, cadets at USAFA are officer-trainees seeking a commission in the Air Force. One of DFAN's program goals explicitly addresses this responsibility (Chapter 2, paragraph 2.6.6). Cadets enter the Academy typically as high school graduates, and develop into Air Force 2nd Lieutenants in four years. The aeronautical engineering program has opportunities for cadets to develop professionally outside the constructs of the curriculum, and the Department supports numerous research programs that routinely involve cadet independent research studies. Often cadet research projects lead to presentations at sponsor-meetings, and at cadet and professional conferences, some of which are shown in Tables 3 and 34.

1.5.2 CSRP - The USAFA Cadet Summer Research Program (CSRP) is a special professional development opportunity for cadets. Participation in CSRP is voluntary and selective. To be eligible, cadets must have a minimum Grade-Point-Average (GPA) of 3.0/4.0, and a minimum Military-Performance-Average (MPA) of 2.8/4.0, and external sponsorship. For CSRP applicants specializing in the aeronautical engineering program, sponsorship is often associated with the Department's research program. Table 2. shows the Department's CSRP participation for the summer of 2001 with those projects that led to follow-on independent cadet study courses (Aero Engr 499) highlighted.

Table 2. Aeronautical Engineering Cadets in CSRP, Summer 2001

CSRP Project	Sponsoring Agency
Hard Target Defeat Project	AF Research Laboratories, Weapons Test Center, Eglin AFB, FL
Unified Instrumentation Tests	NASA Langley Research Center, VA
Boeing Conceptual Theater Transport	AF Research Laboratories, Wright-Patterson AFB, OH
Fan Section of JSF's Engine	AF Research Laboratories, Wright-Patterson AFB, OH
Strike Eagle Spin Analysis	The Boeing Co, St Louis, MO
Weapons Separation	The Boeing Co, St Louis, MO
X-33 Reentry Trajectory	AF Research Laboratories, Wright-Patterson AFB, OH
Turbine Blade Heat Transfer	AF Research Laboratories, Wright-Patterson AFB, OH
Heat Transfer for Rocket Nozzles	AF Research Laboratories, Rocket Test Center, Edwards AFB, CA
CFD of Spinning Aircraft	Arizona State University, AZ
C-130 with the Back-Door Down	AF Research Laboratories, Wright-Patterson AFB, OH
Turbine Blade Heat Transfer	AF Research Laboratories, Wright-Patterson AFB, OH
X-38 Reentry Heating	NASA Johnson Space center, Houston , TX
Analysis of Organic Compounds	AFRL, Wright-Patterson AFB, OH
Visually Represent Axial Airflow	AF Arnold Engineering Development Center, TN
Aero-thermo Environment for Body-Flap	NASA Johnson Space Center, Houston, TX
Analyze Compressors using Neural Nets	Arnold Engineering and Development Center, TN
Analyze Problem Flow in a Wind Tunnel	Arnold Engineering and Development Center , TN
Interpret Instrumentation Readings	Arnold Engineering and Development Center, TN
Space-Based Laser	AF Research Laboratories, Phillips Laboratories, Kirtland AFB, NM
F-16 Flight-Test Data	Air Force Flight Test School, Edwards AFB, CA
Analyze Flight-Testing the AC-130H Gunship	Air Force Material Command, Air Logistic Center, Warner Robins AFB, GA
Low-Speed Flight Tests of the X-38	NASA Johnson Space Center, Houston, TX

For USAFA, CSRP is the equivalent to internships typically found in engineering programs at civilian institutions. CSRP cadets sponsored by the Aeronautics Department work on active, timely, and important government programs. These research programs often contribute directly to the military readiness of Air Force systems especially when CSRP cadets are able to continue their research in their senior year.

1.5.3 Professional Societies & Honor Societies - At the annual DFAN Dash – 1 seminar, cadets are informed about the AIAA Cadet Section, membership and participation in which are encouraged by the Department. Cadets regularly participate in the AIAA Regional Student Conference by presenting technical papers on their research. The AIAA Student Section also meets occasionally with the Rocky Mountain Section, the regional AIAA professional section.

The Department sponsors a section of Sigma Gamma Tau, the Aeronautical and Astronautical Engineering Honor Society, and annually inducts approximately the top 1/3 rd of the seniors and the top 1/4 th of the juniors.

The Engineering Division supports Colorado Zeta, the USAFA Chapter of Tau Beta Pi, into which approximately 1/4 th of the cadets in the aeronautical engineering are inducted per class.

1.6 Cadet Distinctions

The Aeronautics Department is fortunate to have cadets who excel beyond normal performance, and in so doing, bring distinction to themselves and the Department. Table 3 presents a few of the recent external awards that cadets have earned by doing research and independent studies in their respective programs. Numerous other distinctions are cataloged in a notebook that will be available for review during the ABET visit.

Table 3. Recent DFAN Cadet Distinctions in Research

Award	Agency	Title	Academic Year
1st Place	AIAA National Student Competition, Reno NV And AIAA Region V Student Competition	X-38 Rudder Configuration and Parafoil Cavity Investigation	2001 – 2002
2nd Place	AIAA Region V Student Competition	AN Experimental Investigation on Separation Over Turbine Blades at Low Reynolds Numbers	2001 – 2002
3rd Place	AIAA Region V Student Competition	X-38 Component Build-up and Directional Stability Analysis	2001 – 2002
Finalist	AIAA National Student Competition, Reno NV	A Wind tunnel Investigation to Reduce Drag Associated With External Protuberances on the AC-130H Gunship	1999-2000
1st Place	AIAA Region V Student Competition	A Wind Tunnel Investigation to Reduce the Drag Associated with External Protuberances on the AC-130H Gunship	1998-1999

Additional external recognitions of cadet research accomplishments are presented in Chapter 8.

1.7 Anecdotal Data on Cadet Performance

DFAN regularly receives reports of praise from external agencies where DFAN cadets have had opportunity to work. Classified as anecdotal evidence of quality performance, a few such testimonies are shown here; other such evidence will be available during the ABET visit. Table 34 in Section B., Chapter 8, presents awards cadets have won in cadet technical paper competitions.

Program engineers at the Alison Engine company commenting on the engine design work of cadet project team said, "I can't believe these guys are doing this level of work as undergraduates. We were able to discuss their engine design decisions as if they were our peers."

Mr. Rick Barton, NASA JSC Aero and Flight Mechanics Branch Chief (281-483-4650), who has supervised our cadets for several summers, recently commented, "Your cadets are consistently head and shoulders above those we have from other universities."

The Aeronautics Department receives many letters of compliment from agencies that have had direct association with DFAN cadets. While such comments pertain to the performance of particular individuals, when considered as a collection, they show a trend of cadet excellence sustained over several years.

Lt Col Steve Decou, Predator System Program Office Director, sponsored USAFA cadet research on Predator. After reviewing the cadets' work, he sent a message to his staff stating, "These guys [USAFA cadets] are doing excellent ….analytical work that we need to leverage."

Figure 2 Cadets Cheryl Johnston (left) and Tracy Nettleblad:
Wind Tunnel Research on NASA X-38 Reentry Vehicle

Chapter 2. Program Educational Objectives

2.0 ABET Criterion 2.

Each engineering program for which an institution seeks accreditation or re-accreditation must have in place:

(a) Detailed published educational objectives that are consistent with the mission of the institution and the criteria.

DFAN Program: The institutional educational objectives, called the DF Educational Outcomes (Appendix I., Table D.6), are seven statements that define the academic capabilities and the professional attributes desired in all cadets aspiring to be Air Force officers irrespective of academic specialization. At the engineering program level, educational outcomes are called Program Operational Goals (POG's) in order to have a connection to the connotation of military operations. The statements comprising the POG's are deliberately consistent with and support the USAFA mission (paragraph 2.2) and the DF Educational Outcomes. POG's statements for each Engineering Department are similar, and define the observable attributes desired in young USAFA engineering alumni up to three years following graduation. The engineering specialization for aeronautical engineering is identified in POG-1-, paragraph 2.6.1.

The POG's the aeronautical engineering program (DFAN-POG's) are published in the USAFA Catalog, a document that is sent to high schools and libraries across the United States. DFAN-POG's are displayed in the Department lobby and in the Aeronautics Laboratory, and they are published in the Aeronautical Engineering pamphlet that is distributed at Majors Night (Section B., paragraph 1.1.4). At the annual Dash-1 seminar (Section B., paragraph 1.2.4), the DFAN-POG's are discussed with the junior and senior ranked cadets. DFAN-POG's are discussed in detail in paragraph 2.6 below.

(b) A process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated.

DFAN Program: DFAN-POG's have been developed jointly by the Department Faculty and the Department's Engineering Program Advisory Council (EPAC: paragraph 2.8.4). The DFAN-POG's are reviewed periodically by the four elements of the Department's Program Constituency (paragraph 2.8). DFAN-POG's are also reviewed by the DFAN Advisory Panel during the Department's annual alumni-faculty meeting held each Fall.

(c) A curriculum and process that ensures the achievement of these objectives.

DFAN Program: The process that ensures achievement of the DFAN-POG's is embodied in the administration of the DFAN curriculum. Details of the curriculum are presented in Section B., Chapters 3, 4, and 8. Table 4 shows the 15 courses in the Aeronautical Engineering curriculum (excluding 2 technical electives) that are required of all cadets regardless of personal specialization in a particular track. The intent of Table 4 is to show where the knowledge and skills needed to prepare the cadets for attainment of the DFAN-POG's are provided in the curriculum. Additional details are presented in paragraph 2.6.

Table 4 DFAN Curriculum-POG's Correspondence

DFAN-POGs	Aeronautical Engineering Program Courses							
	AE315	AE 341/342/442	AE 351/352	AE 361 Engr310	EM 120/320/330	AE 471	AE 481	AE 482/483
1. Possess breadth of integrated, fundamental knowledge in engineering, basic sciences, social sciences, and humanities; and depth of knowledge in aeronautical engineering	X	X	X	X	X	X	X	X
2. Communicate Effectively	X		X	X		X	X	X
3. Work effectively on teams and grow into team leaders	X			X		X	X	X
4. Are independent learners committed to life-long learning						X	X	X
5. Can apply their knowledge and skills to solve Air Force problems both well and ill-defined.	X	X	X	X	X	X	X	X
6. Know and practice their ethical, professional and community responsibilities as embodied in the United States Air Force Core Values.	X			X		X	X	X

(d) A system of ongoing evaluation that demonstrates achievement of these objectives, and uses the results to improve the effectiveness of the program.

DFAN Program: The process for evaluating achievement of the POG's involves interaction with EPAC, surveys, and onsite visits and interviews with supervisors (paragraphs 2.9 and 2.10 below). This process is used to ensure that the DFAN-POG's are applicable and that the DFAN graduates are attaining the USAFA DF Educational Outcomes (Appendix I., Table D.6, and paragraph 2.7).

2.1 Duties and Responsibilities

The fundamental purpose of the Aeronautics Department is to conduct the aeronautical engineering program. However, the Department has other duties and responsibilities, which are defined below in paragraph 2.5. First, statements that define the Department's mission, vision and objectives are presented.

2.2 USAF Academy Mission Statement

Inspire and develop outstanding young men and women to become Air Force officers with knowledge, character and discipline; motivated to lead the world's greatest aerospace force in service to the nation.

The Academy is comprised of four primary mission elements: Academics, Military Leadership, Physical Conditioning, Ethics & Character Development. The Academics mission element, led by the Dean of the Faculty, Brigadier General David A. Wagie, consists of 19 departments grouped into four divisions: Basic Sciences, Engineering, Humanities, and Social Sciences. The Engineering Division, led by Colonel Cary A. Fisher, is comprised of five departments: Aeronautics (DFAN), Astronautics (DFAS), Civil and Environmental Engineering (DFCE), Electrical Engineering (DFEE), and Engineering Mechanics (DFEM).

DFAN, led by Colonel Douglas N. Barlow, is responsible for the aeronautical engineering program. Figure 3 illustrates this organizational structure.

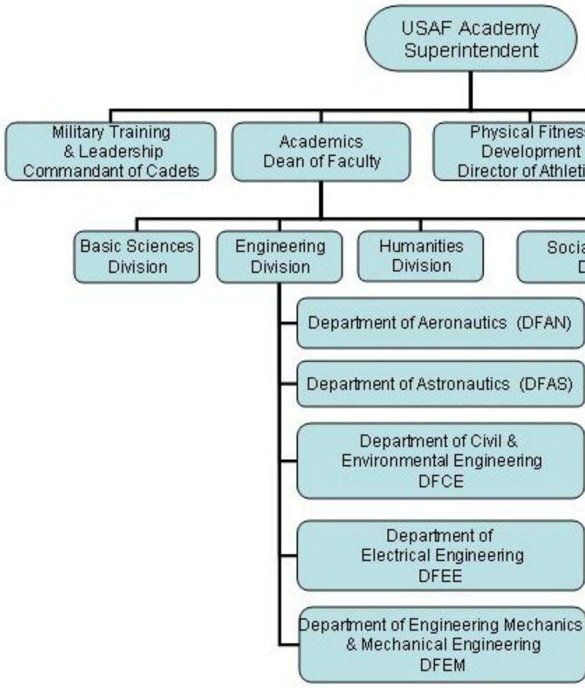


Figure 3 Directed Organization Chart

2.2.1 Ethics & Character Development – The Ethics & Character Development mission element is singled out here to demonstrate the Academy's commitment to instilling strong ethical behavior in its young cadet professionals. In fact, the Ethics & Character Development mission element is one feature that distinguishes the total Air Force Academy program. Appendix I., Table D.7, presents the eight character outcomes that are based on the Air Force Core values: (1) Integrity first, (2) Service before self, (3) Excellence in all we do. Like the DF Educational Outcomes, these eight character outcomes are institutional, life-long attributes desired in all Academy graduates irrespective of any personal specialization.

2.3 Department Vision Statement

Operate a preeminent department of aeronautics committed to producing second lieutenants of exemplary character and professional competence in aeronautical engineering; motivated and devoted to public service in the United States Air Force.

Since being established as an undergraduate program in aeronautical engineering in 1973, the Department of Aeronautics has maintained ABET accreditation. Moreover, the excellent performance of the alumni as entry level Air Force engineers combined with the comments made by visitors over the years qualitatively substantiate attainment of the Department's Vision. The aeronautical engineering program at USAFA is consistently ranked in the top of its peer group (institutions of higher education offering Bachelor of Science degrees only). Recently, US News and World Report ("America's Best Colleges," 2002 Edition) ranked the

USAFA aeronautical and astronautical engineering programs as number two in the nation for engineering schools not offering graduate degrees.

2.4 Department Mission Statement

Develop and inspire young men and women to become Air Force officers with a specialization in aeronautical engineering.

First and foremost, the mission of the Aeronautics Department is to contribute to the Academy Mission. As an agency in the Engineering Division, the Aeronautics Department is responsible for maintaining an accredited program in aeronautical engineering so that cadets desiring to study in this specializing can earn a Bachelor of science degree in this engineering discipline.

2.5 Department Objectives

The duties and responsibilities the Department of Aeronautics are defined by six objective statements:

2.5.1 Support the USAFA Mission - The Department of Aeronautics supports the USAFA Mission by conducting courses in the academic core, and by supporting numerous programs outside the academic mission element at USAFA.

2.5.1.1 Academic Core – Currently the USAFA Academic Core is comprised of 94 semester hours of academic courses that form the mission-oriented foundation for all academic specializations. Each of the four academic divisions (Figure 3) is responsible for providing instruction in courses rendered necessary for attainment of the USAFA mission. Descriptions for the courses in the academic core are presented in the USAFA Curriculum Handbook, Chapter 7. Course descriptions for the technical core course prerequisites for the aeronautical engineering program are shown in Appendix I, Section F.

The Department of Aeronautics is responsible for two core courses: (1) Aero Engr 315, Fundamentals of Aeronautics; providing cadets knowledge on the fundamental principles of aircraft flight and performance. (2) Engr 310, Energy Systems; providing cadets knowledge on the fundamentals of thermodynamics, heat transfer, and energy transfer processes, with an emphasis on the principles of jet propulsion. DFAN also shares responsibilities with other engineering departments to provide instruction for the core capstone engineering design course, Engr 410, Engineering Systems Design. In January, 2002, Engr 410 was eliminated from the core curriculum.

2.5.1.2 Non-academic programs - DFAN faculty voluntarily participate in a variety of extra-curricular activities that contribute to the development of cadets. Table 5 presents the major contributions. Section B., Chapter 5, Faculty, presents details on DFAN faculty involvement outside of the Department.

Table 5 DFAN Faculty Extra-Curricular Participation in Cadet Activities

Activity	Description
AAOC	Associate Air-Officer-Commanding: Assist the military officer and the non-commissioned training officer with military development activities
AAOCA	Associate Air-Officer-Commanding for Academics: Provide academic counseling and advising to cadets in a squadron
SPEA	Squadron Professional Ethics Advisor: Provide guidance to cadets on matters related to honor, integrity, and character development.
AIC	Advisor in Charge: Term used to identify advising activity to cadet athletic teams, clubs, and religious groups.

2.5.2 Maintain and administer an ABET accredited upper division undergraduate curriculum in aeronautical engineering - The Academy is accredited by the North Central Association (NCA), most recently in 1999. Since cadets specializing in aeronautical engineering are awarded the Bachelor of Science degree in Aeronautical Engineering, the Aeronautics Department is required to have its program reviewed and accredited by the Accreditation Board for Engineering and Technology (ABET).

Since its inception in 1973, the USAFA Aeronautical Engineering program has been accredited by ABET. The previous ABET visit in 1996 rendered the rating, Next General Review (NGR) for this program. DFAN now seeks to obtain and maintain ABET accreditation under EC 2000. The terminology, upper division, signifies 300 – 400 level courses taken by cadets in the second class (junior) and first class (senior) years.

2.5.3 Support the USAFA academic needs in the thermal-fluid sciences - DFAN provides leadership, course design, and instruction in four courses that comprise the thermal-fluid sciences for the Mechanical Engineering and Engineering Mechanics programs offered by the Department of Engineering Mechanics. Table 6 Thermal-Fluid Sciences Courses

Table 6 Thermal-Fluid Sciences Courses Offered by the Aeronautics Department

Course	Title	Description
MechEngr 312	Engineering Thermodynamics	Classical macroscopic treatment of thermodynamics with focus on engineering applications. Development and application of the 1st and 2nd laws of thermodynamics applied to systems and control volumes to include piston-cylinders, rigid tanks, engineering components (nozzles, diffusers, turbomachinery) and systems of components (steam power plants, engines, heat pumps, etc.). Steady and transient analyses using both property table and ideal gas relations. Foundations in engineering problem solving.
MechEngr 341	Fluid Mechanics	Description of fluid matter. Derivation of the governing equations. Application to hydrostatics, boundary layers, pipe flow, computational fluid dynamics compressible aerodynamics, and turbo-machines and pumps. Normal shocks and isentropic flow.
MechEngr 441	Heat Transfer	Conduction, convection and radiation heat transfer with emphasis on convective heat transfer. Thermal and momentum boundary layers. Analytical and numerical solution techniques applied to selected problems.
MechEngr 467	Energy Conversion	Application of the first and second laws of thermodynamics to the major energy converters including steam plants, internal combustion engines, and turbojet engines. Additional topics may include combustion analysis, energy storage, refrigeration and alternate energy sources.

Offered by the Aeronautics Department, shows these courses by abbreviation and number, title, and course description. The four courses are not part of the Aeronautical Engineering curriculum, and are mentioned here only to illustrate DFAN's curricular support to a neighbor department.

2.5.4 Maintain and support a highly competent staff – DFAN maintains a competent, motivated faculty comprised of masters and PhD level active duty military officers, and PhD-level civilians (see Section B., Chapter 5, Faculty, and Appendix I, Tables A.3 & A.4). Additionally, DFAN hosts visiting professors, visiting scholars, and visiting researchers, all of whom contribute significantly to the department mission (Chapter 5, Table 24). DFAN also maintains a competent staff of technicians and administrative personnel who routinely make essential contributions to the department mission.

2.5.5 Conduct relevant high quality research – The Department's commitment to research is based on four objectives: (1)To provide opportunities for cadets to grow and develop intellectually beyond the limits of the classroom. (2) To provide opportunities for the scholarly development of the faculty. (3) To provide technical assistance to the Air Force. (4) to make valued contributions to the aeronautical engineering profession.

The first two needs impact the aeronautical engineering program outcomes directly. With regard to objective-1, the Department strongly supports cadet independent research studies whenever such activity is appropriate for the cadet. Cadets participating in independent research often make contributions affecting the operational readiness and performance of the Air Force. For instance, several cadets over a period of three years performed independent research affecting a primary Air Force weapon system, the AC-130 gunship (see 2.5.6.5 below). Other cadet independent studies are being done to investigate drag reduction for NASA's X-38 "life-boat" aircraft, and the Air Force Predator , an unmanned reconnaissance aircraft.

Wirth regard to objective-2, the faculty must maintain professional competency though practice and application in the disciplines comprising the aeronautical engineering program in order to maintain a curriculum that is technically relevant to the needs of the Air Force and the profession. Table 7 shows recent technological contributions resulting from research performed by members of the DFAN faculty. Through such research, not only does the professional competency of the faculty improve, but also the boundaries of cadet learning are extended beyond the classroom by exposing and involving them in contemporary research. As discussed in Section A, Background Information, paragraph 3.3, and also in Chapter 1, paragraph 1.5, the department enthusiastically supports cadet research, especially through participation in the Cadet Summer Research Program (CSRP).

2.5.6 Support agencies external to USAFA - DFAN faculty members provide instructional support and specialized, invited research to help meet mission requirements for several other Air Force organizations.

Table 7 Recent DFAN Faculty Research

Research	Faculty Investigators	Description	Impact
AC 130 Gunship	Yechout	Reduce Aircraft Drag	Improve AF Combat Effectiveness
NASA X-38	Yechout	Stability Characteristics	Influence final design
Closed-loop flow control	McLaughlin, Cohen, Siegel	Link sensors with actuators	Drag reduction through boundary layer flow control
Plasma actuators	McLaughlin, VanDyken	Use glow discharge to add momentum to flow	High frequency, non-intrusive flow control
CFD	Morton, Blake, Forsythe	Total flow field studies for aircraft in flight	Computational flight testing for aircraft at high angles of attack
UAV	Bossert	Develop control law algorithms	Improve control and robustness of UAV's
Turbomachinery Boundary Layer	Byerley	Control laminar separation using innovative methods	Improve jet engine thermal efficiency
Synthetic Jet Actuators	Jefferies	Use piezoactuation for zero net mass flow control	Control potential flow and boundary layer behavior

2.5.6.1 Air Force Test Pilot School (TPS) - The Air Force Test Pilot School at Edwards Air Force Base, CA, is a premier flight training program into which only a few highly qualified pilots and engineers are invited to attend, about 40 per year. The purpose of TPS is to enhance and up-grade the flying skills of the selected pilots thereby qualifying them to be test pilots for new and modified Air Force flight systems. TPS is comparable to a Masters of Science level graduate school program for pilots seeking to develop advanced flying skills. As such, the program involves both academics and advanced flight training. DFAN supports the academic portion of the TPS program by providing instruction on aerodynamics, propulsion, and modeling and simulation. TPS values DFAN's instructional support, and the DFAN faculty members participating in this program are regarded by the TPS students as being among the best instructors in the TPS program.

2.5.6.2 Propulsion Short Course - The Aeronautics Department recently conducted four offerings of a propulsion short course at the Oklahoma City Air Logistics Center engine depot at Tinker AFB, OK. This day-long short course was designed by DFAN faculty member, Major Keith Boyer, and co-taught by Maj Boyer and other members of DFAN. Proactively developed to provide a motivational, informative big picture look at aircraft engines, the course has been embraced by attendees and high level managers at the depot. In fact, starting in 2003, it will be part of the required training for all new engine depot employees. The course is structured primarily for non-engineering personnel, program and item managers, budget analysts, and production and requirements specialists.

2.5.6.3 Aero-Propulsion Workshop – For the past 20 years or so through 1999, the Aero-Propulsion Workshop has been a biennial event hosted by the Department of Aeronautics. The target audience is program managers throughout the Department of Defense. Following a hiatus in 2001, the workshop is continuing in the summer of 2002 with a rejuvenated program and refocused set of workshop goals and outcomes. The weeklong workshop, entitled "Cycle Analysis of Gas Turbine Engines," is intended for government engineering personnel with current experience (1-2 years recommended) in a propulsion related field. DFAN faculty developed and structured the course and plays a pivotal role in many aspects of the workshop, to include lab tours and describing numerous engine hardware cutaways, leading a 3-part engine preliminary design computer exercise and hands-on lab with an F109 high by-pass turbofan. These aspects of the workshop, along with continued support by Dr. Jack Mattingly (Professor Emeritus, Seattle University) as the featured lecturer, and high quality guest speakers all contribute to the uniqueness of this workshop. The 2002 workshop (and future offerings) was sponsored by the USAF Propulsion Product Group Manager, an SES3-level government civilian and single manager for all USAF engine research, development, and sustainment issues. The PPGM was a guest speaker at the 2002 workshop.

2.5.6.4 Summer Scientific Seminar – The Summer Scientific Seminar is a one week introduction to engineering program for high school students desiring to learn about the engineering profession, and in particular, about the aeronautical engineering program at USAFA. The Summer Scientific Seminar is taught twice in June.

2.5.6.5 Technical Support to the Special Operations Command - The Special Operations Command has been seeking ways to improve the performance and effectiveness of the AC-130 gunship for several years. In 1996, the Special Operations Command requested help from the Aeronautics Department, the need being to find ways to reduce the drag of this aircraft so that it would burn less fuel and thereby have increased loiter-time over enemy target zones. In 1996, DFAN began conducting cadet-faculty wind tunnel research that has led to major design modifications of this contemporary weapon system. While research continues, the drag reduction modifications resulting from sustained cadet-faculty investigations have thus far led to increasing the loiter-time over the target by 20 minutes, an improvement significantly affecting combat operations. To quote General Charles Holland, commander of the U.S. Special Operations Command, "This work [the DFAN cadet-faculty research] offers a dramatic improvement in the operational capability and survivability of the gunship fleet."

2.6 Program Operational Goals (POG's)

The Aeronautical Engineering Program seeks to prepare cadets to become Air Force Officers who:

2.6.1 Possess breadth of integrated, fundamental knowledge in engineering, basic sciences, social sciences, and humanities; and depth of knowledge in aeronautical engineering – As leaders in the Air Force, especially in current times, officers must have knowledge and skills that are diverse, yet intertwined across the basic sciences, the humanities, the social sciences, and engineering. Thus, the USAFA academic program has a core of courses that all cadets take to acquire introductory knowledge and skills in these broad disciplines. For the aeronautical engineering program, the cadets also acquire knowledge and skills commensurate with a Bachelor of Science degree in aeronautical engineering. Consistent with the program criteria stipulated in ABET EC2000, Criterion 8, the curriculum of the Department of Aeronautics is defined by six disciplines: (1) Aerodynamics; (2) Flight Mechanics, Stability and Control; (3) Propulsion; (4) Aerospace

Materials and Structures; (5) Experimental and Computational Investigations; (6) Aircraft and Aircraft Engine Design. Discipline details are presented in Section B., Chapters 3, 4, and 8.

2.6.2 Communicate effectively - Using professional communication skills is crucial to the performance of Air Force officers. Accurate dissemination of information using modern electronic formats as well as oral and written reports directly impacts job-effectiveness and performance. In the aeronautical engineering program, developing cadets to become effective communicators is designed into the curriculum as a Program Thread (Section B., paragraph 4.2.1). The Communication Thread provides cadets continuous development in writing and speaking. Starting with a set of faculty defined elements for technical writing and oral reporting, cadets learn the individual communication elements in different courses across the curriculum. Then in the senior laboratory and design courses, they learn to put the elements together in complete written technical reports and oral presentations. Samples of cadet technical reports and oral presentations will be available for review during the ABET visit.

2.6.3 Work effectively on teams and grow into team leaders – Hardly, if ever, do Air Force officers work alone. As entry level officers, not only are DFAN graduates expected to be effective and contributing members of teamwork activity, but they are expected to have the skills to grow into team leaders. Early in a new career, junior officers can expect to have leadership responsibilities on multi-million dollar projects. Four years following graduation, these young officer-engineers will be promoted to the rank of captain giving them mission essential leadership responsibilities. Thus, the aeronautical engineering program deliberately engages the cadets in leadership and team work experiences in many of the courses in the curriculum, but especially in the design courses, Aero Engr 481, Aero Engr 482, and Aero Engr 483.

2.6.4 Are independent learners committed to life-long learning - The Aeronautics Department seeks to instill in its graduates an understanding that earning the Bachelor of Science degree is the beginning to life-long learning, and that possessing the ability to learn-on-your-own is crucial to effective performance as an Air Force officer-engineer. Few Air Force problems have single-fixed solutions. Air Force officer-engineers must know enough to work effectively on ill-defined problems, and most often, they must first acquire ample background information. The problems and issues confronting present-day Air Force aeronautical engineers are complicated and diverse, and often span many disciplines. For example, a problem involving an airframe condition or one involving a propulsion issue will likely include concerns for materials, structural stability, costs, political, safety issues, reliability and maintainability issues, and fleet-wide impact issues. The AC130 Gunship research (paragraph 2.5.6.5) is one such example. Moreover, entry level Air Force engineers are expected to brief senior officials with factual and accurate information. Thus, specific program features are included in the aeronautical engineering program to ensure that the graduates are effective independent learners.

2.6.4.1 Graduate School – Annually, several graduates of the Aeronautical Engineering program attend graduate school as their first assignment from the Academy. The Department's record for having graduates from the Aeronautical Engineering program be successful in graduate school is 100 percent. No graduate has failed to complete a graduate school program due to a lack of academic preparedness, or an inability to perform successfully in team work, research, problem solving, and independent research. Thus, the Department contends that its Aeronautical Engineering program is providing a proper and adequate intellectual background for cadets desiring to continue formal academic development at the graduate level. Moreover, faculty members at the Air Force Institute of Technology (AF in-service graduate school Wright-Patterson AFB, in Dayton, OH) state that Academy graduates tend to be the leaders in most class projects.

2.6.4.2 Independent Learning in Course Research – While independent learning activities occur throughout the curriculum three courses explicitly engage cadets in independent learning skills development as wells as in the process of performing research. The ability of cadets to seek out information and to learn new skills on their own is developed in a series of exercises conducted in Aero Engr 481. In addition, cadets accomplish extensive research in the senior laboratory course (Aero Engr 471), and in the two-sequence design courses (Aero Engr 481 and either Aero Engr 482 or Aero Engr 483). Often the design work in the major design courses (Aero Engr 482, Aero Engr 483) is based on meeting real customer needs. Aside from foundational material, no course in the curriculum presents all the knowledge and skills cadets need to accomplish good designs that meet all the requirements and constraints. Separately, each course in the curriculum provides foundations that cadets must use along with effective research to produce acceptable results.

2.6.4.3 Other Independent Learning Activity - Although not performed by all cadets in the program, the successful graduate school performance of the program alumni, and the successful performance of cadets participating in CSRP (Section B. paragraph 1.5.2) is external evidence indicating that the Aeronautical Engineering program is providing its cadets with proper independent learning skills.

2.6.5 Can apply their knowledge and skills to solve Air Force problems, both well and ill-defined – Few if any Air Force engineering problems are well defined, and thus, an emphasis is placed on framing and resolving ill-defined problems in the Aeronautical Engineering program. All content-specific courses expose cadets to both well defined and open-ended problems so that along with learning knowledge, cadets also develop abilities to cope with ill-defined problems. However, the thrust of learning to frame and resolve an ill-defined problem is concentrated in the senior experimentation course (Aero Engr 471), and the two senior-level major design courses (Aero Engr 481 and Aero Engr 482/483). More often than not, these courses involve cadets in real Air Force problems, but at a level and scale that is appropriate for their academic program. Skills development relevant to ill-defined problems include the design method, teamwork, leadership, an ability to perform effective research, and an ability to communicate professionally. These engineering design skills are woven throughout the curriculum as discussed in Section B., Chapter 4.

2.6.6 Know and practice their ethical, professional, and community responsibilities as embodied in the United States Air Force Core Values – In the profession of arms, high standards for ethical and moral behavior are cornerstones for unit effectiveness. Even in non-combat circumstances, the behavior of military officers must be above reproach because both the American public and the military itself demand it. All four USAFA Mission elements engage cadets in processes that train them to live honorably as military professionals. These processes include the cadet honor code, intramural sports, and a variety of academic and military training courses. Instruction on engineering ethics occurs in Aero Engr 481, Introduction to Aircraft and Propulsion Design.

2.6.6.1 Cadet Honor Code - At USAFA, all cadets live by and are bound by the Cadet Honor Code:

"We will not lie, cheat, or steal, nor tolerate among us anyone who does. Furthermore, I resolve to do my duty, and to live honorably, so help me God."

For many cadets, living under the honor code is an extension of their respective family environment they left upon entering the Academy. For others, living under the cadet honor code is a new and maturing way of life. In spite of a few infractions, living four years under the cadet honor code at USAFA for most cadets instills in them a sense of pride and honor, and that as military professionals, they are respected, honorable members of society, that they are trustworthy, and that as they progress through life, they live by the Air Force core values. All members of the Department of Aeronautics, faculty, staff, and cadets are expected live by these core values. DFAN knows of no graduate of the program who has violated these principles and life-standards.

2.6.6.2 Academic and Military Professionalism Courses on Ethics - Cadets learn and develop standards for ethical behavior by taking a set of courses as shown in Appendix I., Table D.8. In order to live by ethical standards, cadets not only learn the standards, but they take courses that expose them to life situations that allow them to understand the relevance and application of ethical standards.

2.6.6.3 Ethical Standards in Engineering - There is no single course in the aeronautical engineering curriculum devoted singularly to engineering ethics. However, Philosophy 310, Ethics is a core course requirement, and ethics is presented here and again in the two-course senior design sequences Aero Engr 481, and Aero Engr 482/483.

2.7 Mapping to Institutional Educational Outcomes

Table 8 shows the correspondence between the DFAN-POG's and the DF Educational Outcomes defined (Appendix I., Table D.6). Paragraph numbers for the DFAN-POG's are identified in parentheses. A green circle means DFAN makes a direct association between the POG and a DF Educational Outcome. A broken-green circle means the association is inherent. For example, DFAN believes one can not be an effective problem solver without also being intellectually curious in the problem, hence the broken-green circle for this association. Likewise, cadets cannot be good military professionals without also being good communicators and good teamwork members.

In the profession of arms, the Air Force strives to maintain high ethical, moral standards, so a correspondence between DFAN-POG' 6 and DF Educational Outcome 7 is shown as green.

Table 8 DFAN-POG's Correspondence to the Institutional Educational Outcomes

		Aeronautical Engineering Program Operational Goals					
		1 Fundamental Knowledge (2.5.1)	2 Communication (2.5.2)	3 Teamwork (2.5.3)	4 Independent Learning (2.5.4)	5 Solve AF Problems (2.5.5)	6 Know & Practice Ethic Responsibilities (2.5.6)
DF Educational Outcomes	1 Fundamental Knowledge	●					
	2 Intellectually Curious				◍	◍	
	3 Problem Solvers					●	
	4 Communicators		●				
	5 Teamwork			●			
	6 Independent Learners				●		
	7 Military Professionals		◍	◍		●	●

As mentioned in paragraph 2.2, Ethics & Character Development is one of the four primary mission elements at USAFA. Accordingly, the Aeronautics Department exposes cadets to the principles embodied in the Core Values through the routine practices of its professional faculty, and through numerous out-of-class conversations with cadets. As mentioned in paragraph 2.6.6, exposure to ethical engineering practices is included in the senior level two-course design sequence.

2.8 Constituency

The DFAN program constituency is comprised of two internal, and two external elements (Figure 4). The internal elements are the faculty and the cadets. The external elements are the DFAN alumni, and the Air Force Supervisors who are represented by the Engineering Program Advisory Council (EPAC: paragraph 2.8.4 below). DFAN-POG's have been developed and are reviewed interactively with EPAC.

2.8.1 Faculty – The DFAN faculty have primary responsibility for the aeronautical engineering program. As such, the faculty ensures that the curriculum is designed and administered effectively so that cadets completing the program will demonstrate attainment of the DFAN-POG's in their practice as engineering-officers in their first assignment following graduation. The DFAN Program Accreditation Oversight Committee is called TEBA (Section B., paragraph 3.6). TEBA consists of seven senior faculty members who have

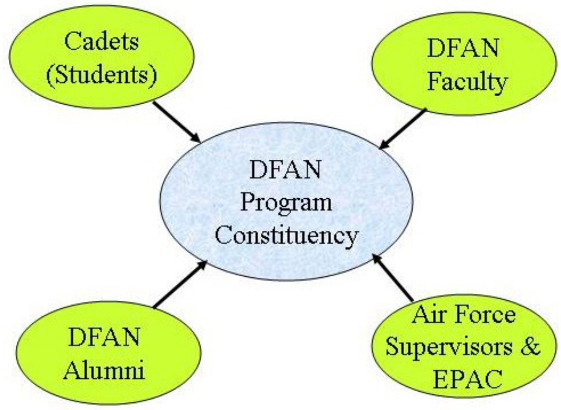


Figure 4 DFAN Program Constituency

responsibility for ensuring that the Program Curricular Outcomes (PCO's: Section B., paragraph 3.1) are appropriate so that every cadet completing the Aeronautical Engineering program will have the knowledge and skills needed to demonstrate attainment of the DFAN-POG's. TEBA is also responsible for ensuring that both the DFAN-POG's and the DFAN-PCO's are consistent with ABET EC-2000 Criteria 1-8, and being met. The DFAN faculty annually reviews the DFAN- POG's for current Air Force applicability. The DFAN faculty also participates in evaluating the recommendations made by EPAC.

2.8.2 Cadets - The cadets are the products of the aeronautical engineering program. As such, they voluntarily provide input on the effectiveness of the program with respect to attaining the PCO's, which in turn, affect attainment of the POG's. Prior to graduation, the senior class cadets are invited to complete an exit survey, and also to participate in an exit interview that is scheduled by the class advisor. Additionally, the Department maintains an Aero Council that consists of two or three class representatives from both the junior and senior classes. The Aero Council meets once or twice each semester with faculty members to discuss academic and administrative issues, and to pass along new information on the program and Department policies to their respective classes.

2.8.3 Alumni - Graduates one to three years out comprise the Alumni constituency. These engineers are surveyed at the two and three year points to determine their opinions on the effectiveness of the aeronautical engineering program with respect to how well it prepared them. Since the aeronautical engineering program deliberately seeks to prepare the graduates for practice according to the POG's, DFAN alumni survey data provide valuable information for evaluating program effectiveness.

2.8.4 Air Force Supervisors & EPAC - The Engineering Program Advisory Council (EPAC) for the aeronautical, astronautical, engineering mechanics and mechanical engineering programs at USAFA presently consists of 16 Air Force commanders, chief scientists, and senior-level engineers and program directors, all from Air Force agencies to which the graduates are likely to be assigned. The EPAC members represent the Air Force operational expertise in the engineering disciplines of aerodynamics, aerospace materials and structures, air-breathing and rocket propulsion, flight mechanics, stability and control, aircraft design, aero-thermodynamics, orbital mechanics, space communications and satellites. Appendix I., Table D.9, shows the cover page of the EPAC Charter (D.9a) and a listing of the current members (D.9b). The Charter and Summary reports of the meetings will be available for review during the ABET visit.

EPAC meets (now biennially) at USAFA to review the DFAN-POG's, evaluate assessment data, and offer recommendations for improvements. During the formative years, EPAC met annually.

EPAC continues to be the major and most important constituent for defining, reviewing and assessing the POG's. The brief history presented below describes the evolution of EPAC, and the primary contributions to date. DFAN maintains an EPAC notebook containing the EPAC Charter, minutes, assessment data, meeting agenda, and executive summaries.

2.8.4.1 EPAC History - In 1998, DFAN recognized a need to establish an external board of visitors that could help define program objectives with a special curricular focus important to Air Force needs. The original panel consisted of 2 Air Force senior aerospace engineers who reviewed a set of draft program objectives and program outcome statements. In 1999, the panel doubled in size to four members, and DFAN held its first annual advisory panel meeting at USAFA in December 1999, at which time DFAN's plan to implement ABET EC2000 was reviewed. Broadening the scope of the advisory panel to include representatives from other Air Force engineering agencies that could better represent all disciplines in the aeronautical engineering program was among several panel recommendations. Much discussion on acceptable wording for program objective and outcome statements was also debated. Other important panel recommendations were that defining these statements had to be a top priority, that a similar set of statements should be developed for each course in the program, and that course statements had to be connected directly to program statements. Issues concerning assessment were discussed. Lastly, much time was devoted to discussing the ABET Criterion 3, a-k, outcomes. A general consensus was that all outcomes were good and desired, and that most should be assessed in senior design experiences, the exception being (b), "an ability to design and conduct experiments, as well as to analyze and interpret data;" this outcome had to be assessed in cadet-performed laboratory studies.

In 2000, the advisory panel had grown to 12 members, and the name, Engineering Program Advisory Council (EPAC) was created. The second annual EPAC meeting was held in Dec 2000, and the programs in engineering mechanics and mechanical engineering were included. At this time, EPAC had members who represented the major Air Force engineering facilities to which graduates of the aeronautical, engineering mechanics and mechanical engineering programs could be assigned. The major development of this annual meeting was the formalization of the statements defining POG's.

The September 11th terrorist attack on the United States caused the Fall-2001 meeting to be postponed to March 2002. At the March meeting, an EPAC Charter was approved, minor word changes to the POG's were recommended, and a plan for performing routine assessment of graduates and supervisors of graduates was drafted. The Astronautics Department became the third department to join the EPAC team.

2.9 Assessment of DFAN POG's

The current DFAN process for assessing attainment of the DFAN POG's has evolved from several years of trial and modification. While assessing the performance of its graduates seems like a straightforward activity, actually it has been difficult. Many of the DFAN graduates (about 50% per class) enter pilot training instead of engineering jobs in the Air Force. Regarding DFAN-graduates going directly into graduate school, some enter non-engineering programs instead of engineering graduate programs. Thus, assessing the performance of these graduates with respect to the DFAN-POG's may not apply since they have followed non-engineering career paths upon graduating.

Maintaining accurate addresses has been another difficulty. However, now that the Air Force World Wide Web network maintains current addresses on fulltime Air Force employees, locating and using electronic surveys is expected to help resolve the "bad-address" problem. Lastly, until the formation of EPAC and its participation in the assessment process, DFAN had no reliable method to interact with supervisors. The enthusiastic support provided by EPAC offers the opportunity to eliminate this problem.

In short, DFAN has been working on developing a reliable process for assessment of DFAN-POG's, and the revised process described below (paragraph 2.9.2) is the result of Department's commitment to continue to evaluate its own effectiveness and to make improvements to the program.

2.9.1 DFAN-POG's Assessment Data Thus Far - DFAN has obtained assessment information from surface mail surveys. While survey responses have been about 30% on average, the results were not particularly helpful because the responses overall lacked detailed information. Thus, these data have been used primarily to ascertain trends. The most helpful assessment data have come from the on-site supervisor visit conducted in coordination with EPAC in August 2001 (see paragraph 2.9.1.1 below).

DFAN received a supervisor's evaluation on three cadets participating in 2001-CSRP; the evaluation is presented in Appendix I., Table D.10. Even though these cadets had yet to complete the 7th and 8th semesters in the program, their performance as indicated by the supervisors shows attainment of the DFAN-POG's, a finding that is typical for CSRP cadets.

Synopsis: To date, there exist no data that show weaknesses or deficiencies in any graduates, or in any aspects of the DFAN program. To the contrary, all performance data show that DFAN graduates perform exceptionally well in their duty assignments. Thus, even though DFAN seeks to improve its POG's assessment process, DFAN believes the aeronautical engineering program prepares cadets well to graduate with the knowledge, skills and capabilities needed for their performance as young Air Force officer-engineers.

2.9.1.1 Data: Assessment and Evaluation – Table 9 is a tabulated summary of the primary assessment and evaluation of the performance of the graduates relative to the DFAN-POG's. The results for an electronic graduate survey (Pilot Survey: paragraph 2.9.2.3 below) that is

Table 9 DFAN-POG's Assessment Data Summary

		POG'S-1 (knowledge)	POG'S-2 (Comm.)	POG'S-3 (Teamwork)	POG'S-4 (Indep Learning)	POG'S-5 (Solve AF Problems)	POG'S-6 (Ethics)
1998 Survey		S-	S	S	S	S-	S+
1999 Survey		S-	S	S	S	S-	S+
On Site Supervisor Interviews (2001)	**ASC**	S (C)	S+	S+	S	S-	S+
	AFRL/VA	S	S Oral C Writing	S+	S+		S+
	AFRL/PR	S	S	S+	S		S+
	AFIT	C	S Oral C Writing	S+	C	S-	S+
Electronic Survey (June 2002)		TBD	TBD	TBD	TBD	TBD	TBD

being developed and administered in June 2002 as a pilot for the revised process will be available during the ABET visit. In Table 9, performance relative to each DFAN-POG is rated according to: S=satisfactory. C=concern, meaning performance assessed by supervisors is acceptable, but changes in the program have been suggested that could strengthen that particular POG. Concerns can also be identified by graduates realizing that elements in the program might be improved to better prepare graduates for the workplace. W=weakness, meaning that performance as assessed by supervisors is marginal and needs to improve. D=deficient, meaning performance assessed by supervisors is below standards or nonexistent. Plus signs denote excellence in performance. Minus signs denote satisfactory performance with a mild concern.

Performance related to DFAN-POG's is mostly satisfactory. Many ratings are S+. The data reveal no deficiencies or weaknesses. Interestingly, while supervisors find the graduates have equal or better basic engineering knowledge compared to their peers from other institutions, Academy graduates excel in the categories of teamwork and professional ethics, DFAN-POG's 3 and 6, respectively, which are also Institutional Outcomes. Supervisors from the Air Force Aeronautical Systems Center presented results that show USAFA graduates consistently meet all POG's, and do it better than their peers from other commissioning sources (ROTC and OTS).

Regarding concerns, most are directed at: (1) Writing skills, and (2) Problem solving skills and independent learning. DFAN recognizes a need to incorporate procedures into the program that will strengthen the graduates' abilities to excel in these categories as well as the other categories. Regarding improvements in writing skills development, DFAN has developed a new plan to teach cadets technical writing skills across the aeronautical engineering curriculum. This plan is called the Communication Thread, and it is discussed in detail in Section B., Chapters 3 and 4. The Communication Thread will be implemented in August 2002.

On the concern expressed by ASC regarding POG-1, the issue pertains to providing cadets more exposure to fracture mechanics and life-cycle fatigue analyses. While these particular supervisor-comments are useful, the comments are pertinent to one agency only, and not meant to be an indication of a deficiency or weakness in the DFAN program. Presently, the aeronautical engineering curriculum is full, so unless major curricular changes are made, coverage of these topics will remain subjects that cadets can study in depth as electives. Moreover, an introduction to these topics is now presented in Aero Engr 481.

DFAN believes that the concerns pertaining to problem solving skills and independent learning shortcomings are inherently tied to a broader pedagogical issue that extends well beyond the aeronautical engineering program. In the vernacular, the issue may be called, "spoon feeding," the pedagogy of classes in which content material is taught and tested without engaging cadets in self-study or independent learning. In such classes, cadets develop attitudes that conflict with developing intellectual curiosity and independent learning habits. DFAN has no quantitative evidence to ascertain how prevalent the spoon-feeding pedagogy is at USAFA, but anecdotal evidence suggests that it occurs in many classes. For some cadets, this limits their intellectual development whereby they are unable to demonstrate the use of good problem solving skills. A graduate school professor at AFIT stated that often USAFA graduates excel in project leadership compared to their peers from other undergraduate programs, but the USAFA graduates generally need at least one complete school term, on average, to adjust to the "learn-on-your-own" environment of the graduate school program.

Another snippet of evidence on this issue is seen in the cadet comment below. At the time, this cadet was taking the mechanical engineering thermodynamics course from an instructor who emphasized developing independent learning and problem-solving skills along with teaching content knowledge.

"This has certainly been one of my toughest courses here at the Academy, because I had never seen most of the material before…. Your teaching style is a bit different than most other teachers as well. Most instructors will "spoon feed" the cadets all the material they will need to understand for the course. I think you have expected us to get into the books and do some learning on our own beyond the topics we cover in class. For most classes, all the learning occurs in the classroom, and the textbooks are only used for homework problems…..."

DFAN is concerned that some supervisors have cause to render some graduates as lacking independent learning skills, and good engineering problem solving skills upon graduating from the aeronautical engineering program. DFAN accepts the premise that opinions on this shortcoming may be tied to a preponderance of "spoon-feeding" classroom experiences. Resolving this issue may be difficult because it extends beyond the aeronautical engineering program. On the other hand, DFAN believes that the cadets who perform well in the senior design course sequence (Aero Engr 481 and 482/482) are not included in these criticisms because the evidence obtained on cadet performance in the design courses is conclusive: there is no spoon-feeding and the cadets consistently demonstrate critical thinking and good problem solving skills. Nonetheless, the concern is valid input from the constituency, and DFAN is addressing it. To begin, starting in Aug 2002, DFAN will conduct a series of faculty seminars on classroom pedagogy, one topic being on critical thinking skills developments in engineering courses.

2.9.2 Revised DFAN-POG's Assessment Process - Figure 5 illustrates the revised DFAN-POG'S assessment process that consists of two cycles; the initial cycle that will establish the process; the standard cycle that will be phased in as the initial cycle progresses toward conclusion. The initial cycle spans 1.5 years, after which each standard cycle spans 2.5 years. Of course, changes would be made between the cycle spans if evidence were discovered requiring change, or if change were ordered by USAFA senior leadership.

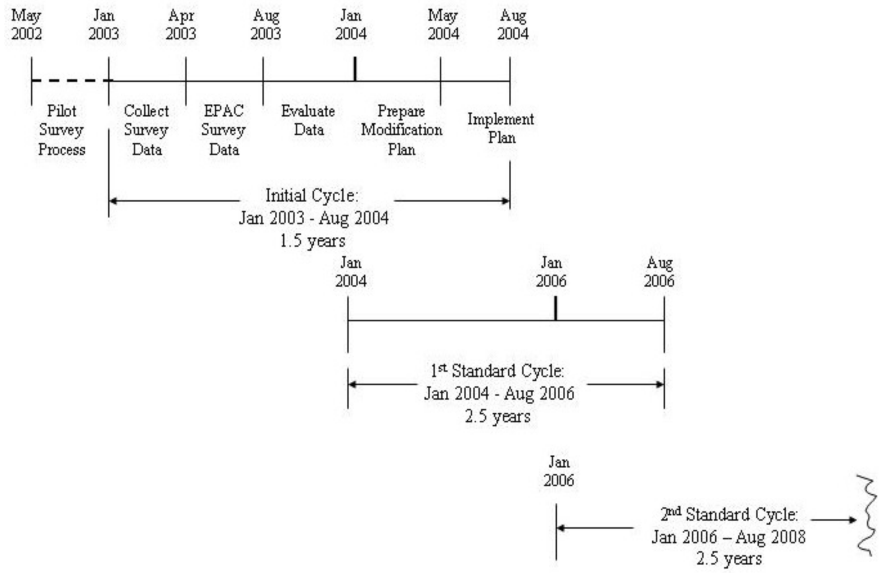


Figure 5 Revised DFAN-POG's Assessment Process

The lengthy cycles are deliberate for two reasons. First, changes will be based on assessment survey data collected for two classes thereby minimizing the affect of anomalous data from one particular sampling. Second, the assessment evidence collected to date (hard and anecdotal) indicates that the aeronautical engineering curriculum consistently prepares its cadets to demonstrate satisfactory performance with respect to the DFAN-POG's, the two concerns pertaining to communications skills development, and problem solving-independent learning skills development as previously discussed.

The initial cycle contains one complete assessment-evaluation-implementation cycle. Partway through the Initial Cycle, the 1st Standard Cycle begins in January 2004, and subsequent standard cycles start each January-even numbered years (Figure 7).

The Initial Cycle will assess data pertinent to two classes, 2001 and 2002. Standard cycles will assess and evaluate data for three graduating classes starting with the graduating class two years prior to the cycle date, e.g., for the January 2004 cycle, the assessment will pertain to the classes of 2002, 2003, and 2004; note that in January, 2006 , the class of 2004 will be responding to the electronic assessment survey. Also note that the data for each even-number class overlaps two cycles; the class of 2002 overlaps both the Initial and 1st Standard Cycle; the class of 2004 overlaps both the 1st and 2nd Standard Cycles, and so on.

2.9.2.1 Initial DFAN-POG's Assessment Cycle - Figure 6 illustrates the details of the initial cycle. The process begins in January 2003 by administering an electronic survey to DFAN graduates in the class of 2001. The start of each electronic survey reaches back two years allowing graduates who attend and complete graduate school, or undergraduate pilot training

(UPT) to respond to the survey with regard as to how well the DFAN program prepared them to be successful in their respective graduate school programs.

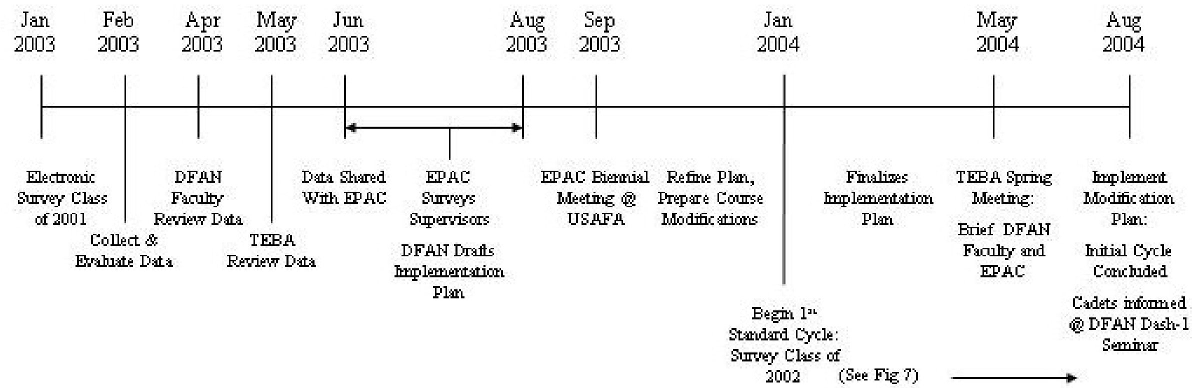


Figure 6 Initial Cycle: Revised DFAN-POG's Assessment Process

Following the administration of the electronic assessment survey in January, the data are evaluated and reviewed during the spring term. At the end of the term, a report documenting DFAN's evaluation of the data is shared with EPAC. During the summer (Jun – Aug) EPAC is requested to perform a survey of the supervisors based on a list identifying graduates and organizations. In the Fall term (Sep – Oct, typically) EPAC convenes at USAFA to review both graduate and supervisor assessment data. Review of DFAN-POG's is also done at this meeting.

Following the EPAC Biennial meeting, DFAN begins refining a plan to implement changes agreed upon at the EPAC meeting. Details to include changes to courses are developed for final TEBA review at the spring meeting. Changes to courses are directed by the applicable Discipline Director, and are reviewed and approved by the DFAN Curriculum Committee prior to TEBA review. Following TEBA review, the implementation plan is approved by the Aeronautics Department Head to be enacted in August 2004, the start of the Fall term. At the annual DFAN Dash-1 meeting, the cadets affected by the changes are informed about the implementation plan. Note that enactment of the implementation plan in August 2004 completes the initial cycle.

2.9.2.2 Standard DFAN-POG's Assessment Cycle – The Standard Cycle (Figure 7) assessment process begins January 2004 with an electronic survey of graduates in the class of 2002. Since the assessment data for the class of 2004 will be included in the Initial Cycle process, these data (class of 2004) will only be analyzed, evaluated, and documented in an interim assessment report in the 1st Standard cycle. The assessment process repeats with electronic surveys being done in January 2005 for the graduates in the class of 2003, and again for a third time in the cycle in January 2006 for the graduates in the class of 2004. The assessment data for all three classes contribute to the development of the implementation plan that is enacted in the Fall term, August 2006. The 2nd Standard cycle (Figure 7) starts with the electronic survey being administered in January 2006 to the graduates in the class of 2004.

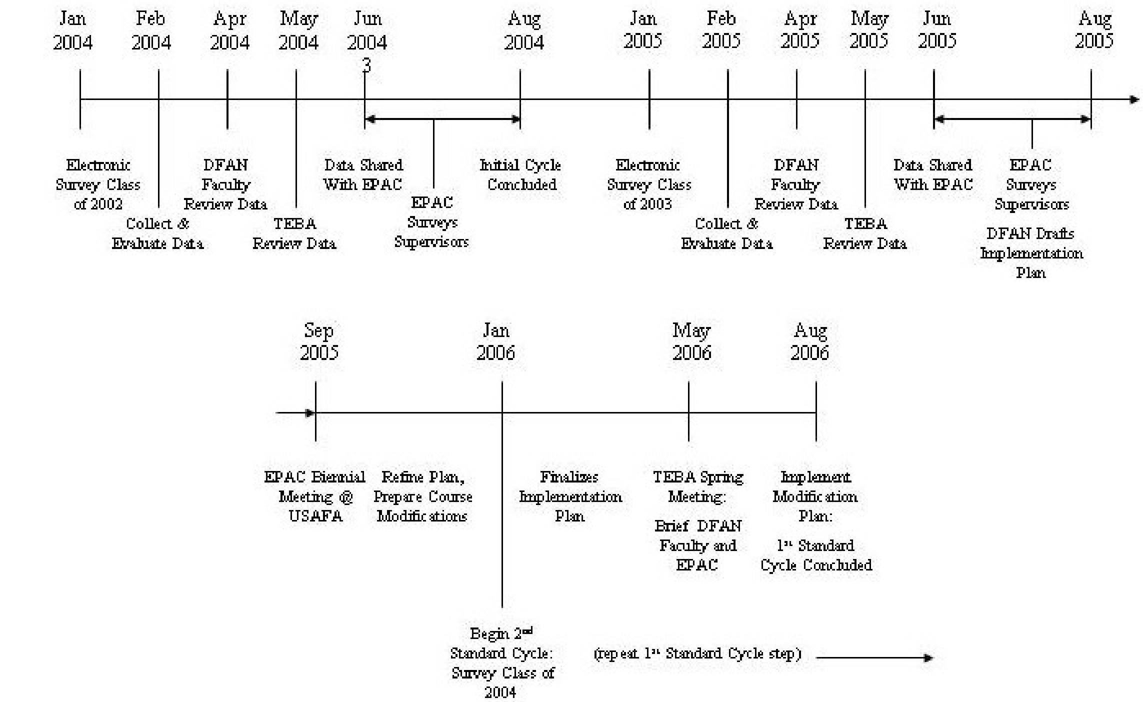


Figure 7 Standard Cycle: Revised DFAN-POG's Assessment Process

2.9.2.3 Pilot DFAN-POG's Assessment Cycle - Figure 8 illustrates the Pilot Cycle that spans the period May 2002 – Dec 2002. Appendix I., Table D.11 shows the electronic survey. The purpose of the pilot cycle is to test the process. The electronic survey will be

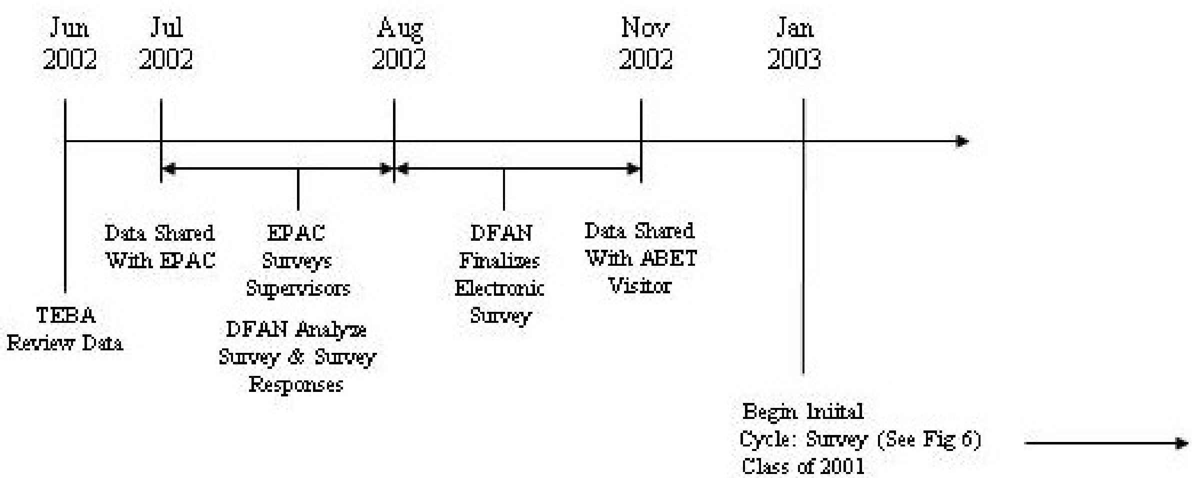


Figure 8 Pilot Cycle: Revised DFAN-POG's Assessment Process

administered in June 2002, the data will be processed to include a report to EPAC, and a mock-implementation plan will be drafted used to evaluate implementation of the standard cycle.

ascertain the effectiveness and impact of the revised assessment process. However, primary interest in the pilot cycle lies in testing the electronic survey, evaluating the appropriateness and usefulness of the survey questions, and evaluating the responses. The findings will be available for review during the ABET visit.

2.10 Process for Reviewing Program Operational Goals

DFAN's process for reviewing the POG's involves a biennial faculty review, and regular interactions with EPAC as illustrated in Figure 9. Also, information obtained from alumni

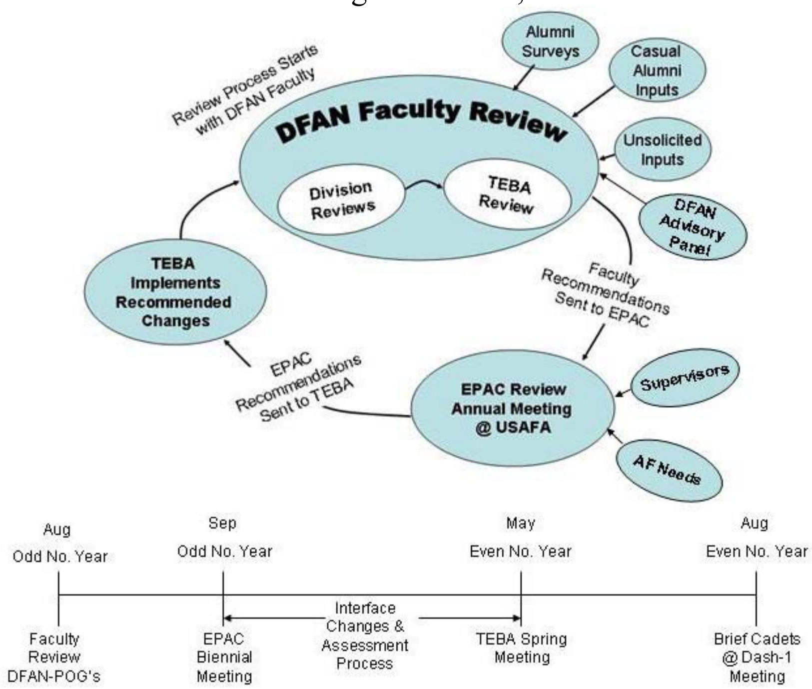


Figure 9 DFAN POG'S Review Process

surveys, casual contact with alumni, and unsolicited inputs from engineering practitioners are used to evaluate the appropriateness of the DFAN-POG's.

2.10.1 Biennial Faculty Review - During the fall term of odd-numbered years (2001, 2003, etc.), DFAN faculty members review the DFAN-POG's and make recommendations for amendments. Faculty reviews begin at the department division level where the faculty members assigned to a particular Division discuss the POG's. Summaries of the inputs from each Division are given to the Director of Program Assessment, who in turn, presents the division recommendations to TEBA. TEBA is the senior Department leadership responsible for ensuring that the aeronautical engineering program is compliant with institutional, departmental, and ABET EC2000 outcomes, objectives and operating procedures. TEBA is discussed further in Section B. paragraph 3.6. After reviewing the faculty inputs for changes to the DFAN-POG's, TEBA forwards these recommendations to EPAC for external review.

2.10.2 EPAC Review - EPAC review of the existing POG'S statements along with the faculty recommendations are considered against the current Air Force needs in the applicable engineering disciplines. During the biennial fall EPAC meeting at USAFA, the DFAN-POG's along and the performance criteria for each are discussed with regard to field-assessment practices and evaluation of assessment data. Also at the annual EPAC meeting, impacts stemming from revisions or pending changes to Air Force needs, institutional issues, and changes to existing ABET EC2000 Criteria or policies are discussed. As applicable, recommendations for amendments to the DFAN-POG's and the performance criteria are documented in the annual EPAC Memorandum. Copies of the EPAC Memorandum for past meetings will be available for review during the ABET visit.

2.10.3 History on the Development of the DFAN-POG's – The six DFAN-POG's presented in paragraph 2.6 above were formalized at the Fall 2000 EPAC meeting. These statements have resulted from an on-going effort that began in 1997, to have explicitly worded program goal statements that met the needs of our constituency, that were consistent with our institutional mission statement, and that were compliant with criteria of EC2000. The initial program objectives reported in 1997 were nearly identical to the DF Educational Outcome statements. As such, they were not explicit to the aeronautical engineering program, they lacked concern for assessment, and they lacked collaboration with a constituency. In 1998, DFAN drafted seven program-specific statements which formally started the development process for establishing program educational objectives as outlined in ABET Criterion 2. In 1999, these initial program statements were reviewed by the newly formed advisory panel (the forerunner to EPAC), and again in 1999. The statements at that time were viewed as being good, but unnecessarily wordy. A survey of graduates was conducted in 1999, again showing a similar criticism: good, but wordy statements. Revisions were drafted, and then presented to EPAC in the Fall, 2000. The major result of this meeting was a consensus for the current wording. Efforts now are underway to define performance criteria for each program goal. The intended use of the performance criteria is to define detailed measurable capabilities that can be readily assessed by supervisors of the alumni of the aeronautical engineering program.

2.11 Summary

DFAN's primary process for assessing and evaluating the performance of its graduates with regard to DFAN-POG's will continue to involve surveys conducted by DFAN and EPAC. DFAN will also conduct on-sight interviews with supervisors on an as-appropriate basis. This assessment process is in place and is being used to improve the DFAN program. Improvements will also be made to the assessment process through practice and regular evaluation of the administrative procedures. DFAN has responsibility for assessing the graduates since they are the products of the program. EPAC has responsibility to obtain assessment data from the supervisors, since these are the people who employ the graduates.

DFAN anticipates that future revisions to the DFAN-POG's will be minimal and occur only when a shift in Air Force policy or needs for entry level officer-engineers are identified.

DFAN is pleased with the assessment findings thus far. The evidence supports the reputation of the program: A nationally ranked undergraduate program in aeronautical engineering. The graduates are highly regarded and highly desired by the Air Force gaining agencies to which DFAN graduates are assigned.

DFAN accepts the need to improve technical writing skills in its cadets, and has developed a plan to be implemented in August 2002.

DFAN accepts the need to develop methods to improved problem solving skills and independent learning skills in the graduates. The expectation is that the faculty seminars on pedagogy that will start in August 2002 will help instructors develop classroom methods that will improve critical thinking skills in the cadets.

Figure 10 Lt Col Brenda Haven Explaining Jet Propulsion Fundamentals To Cadets

Chapter 3. Program Outcomes and Assessment

3.0 ABET Criterion 3

Engineering programs must demonstrate that their graduates have:

a. an ability to apply knowledge of mathematics, science and engineering (**5**).
b. an ability to design and conduct experiments, as well as to analyze and interpret data (**4.2**).
c. an ability to design a system, component, or process to meet desired needs (**4.8**).
d. an ability to function on multi-disciplinary teams (**4.0**).
e. an ability to identify, formulate, and solve engineering problems (**4.8**).
f. an understanding of professional and ethical responsibilities (**4.5**) .
g. an ability to communicate effectively (**4.8**).
h the broad education necessary to understand the impact of engineering solutions in a global and societal context (**3.5**).
i. a recognition for, and an ability to engage in life-long learning.(**3.8**).
j. a knowledge of contemporary issues (**3.5**) .
k. an ability to use techniques, skills, and modern engineering tools necessary for engineering practice (**3.5**).

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: cadet portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

DFAN Program – In 1997, DFAN drafted nine statements that defined the educational outcomes for the aeronautical engineering program. After faculty and EPAC review, the nine statements were adopted as the DFAN Program Curricular Outcomes (PCO's). Last fall, 2001, DFAN reviewed, modified and reduced the nine original PCO's to the six statements presented in paragraph 3.1 below.

While the term PCO is different from ABET terminology, Program Outcomes, the meaning is the same: PCO's define the educational knowledge, skills, and capabilities desired in the cadets specializing in aeronautical engineering. DFAN uses several assessment instruments to evaluate cadet performance with regard to PCO attainment, and these are discussed in paragraph 3.5.

While DFAN-PCO's are specific to the aeronautical engineering program (paragraph 3.2), they also have been defined to support the Institutional Educational Outcomes (paragraph 3.3), and to be compliant with the ABET Criterion 3, a-k Outcomes (paragraph 3.4). DFAN believes that the aeronautical engineering program address all a-k Outcomes, but some have a higher priority as shown by the number in bold type at the end on each outcome statement (5 = high priority, 1= low priority). These ratings are simple averages of several individual faculty ratings.

Once the program-level objectives and outcomes were defined, DFAN recognized the need to develop course-level educational objectives, each with outcomes with assessable criteria for each course in the curriculum. Phased in over two semesters, this activity started in the fall semester of 1997 and was completed in January 1998 with the courses offered that semester. Since then, each set of course statements are routinely reviewed and updated as necessary at the start of the applicable semester. This process is discussed further in paragraph 3.7.1 below. Moreover, once course educational outcome statements were defined, DFAN recognized the need to define and implement an administrative process to review and coordinate course-level outcomes with program-level outcomes to ensure that each course contributed to program outcomes while simultaneously being compliant with ABET EC 2000. The initial process involved a structure of sub-teams called, Process Action Teams (PATS), which, in practice, proved to be ineffective. Subsequently, in 2000, the DFAN PATS were replaced with the administrative structure discussed in paragraph 3.6. below, which is being used now to assess and evaluate the DFAN program.

Course-level educational outcomes provide guidance for instructors and Cadets, as well as establishing direct ties to PCO's. For more than 15 years, DFAN has used a process called, Course Director Debriefings (CD-Debriefs), to assess and evaluate the effectiveness of DFAN courses. Now with educational outcomes defined for each course, the process of course assessment has been strengthened. Presently, CD-Debrief records are maintained by the DFAN Discipline Directors and Course Directors both in hard copy and electronic formats; these records will be available for review during the ABET visit.

Descriptions for, and results obtained from application of different assessment instruments are presented in paragraph 3.5. The assessment process used by DFAN is described in paragraph 3.6. Following this, paragraph 3.7 describes how changes in the curriculum occur, and the summary in paragraph 3.8 presents changes that have taken place thus far.

The DFAN curriculum is comprised of six disciplines: (1) Aerodynamics. (2) Aerospace Materials and Structures. (3) Propulsion. (4) Flight Mechanics, Stability and Control. (5) Experimental Investigations. (6) Design. Required and elective courses for each discipline are discussed in Section B., Chapter 8, Program Criteria. The curriculum flow chart for the current program is shown in Section B. paragraph 4.2, Figure 16. The flow chart for the revised curriculum is presented in Chapter 8. Figure 39.

During the ABET visit, Discipline Director Notebooks, Course Notebooks, the Gateway Examination Notebook, the Comprehensive Examination Notebook, and the Survey Notebook will be available for review. The Discipline Director Notebooks contain copies of the CD-Debriefs for the courses in each discipline. A sample CD-Debrief is presented in Appendix I, Table D 13a-g.

3.1 DFAN Program Curricular Outcomes

Cadets satisfactorily completing the USAFA aeronautical engineering program will have shown that they can:

3.1.1 Use fundamental knowledge to solve aeronautical engineering problems commensurate with a Bachelor of Science degree. - The entire upper division of the DFAN curriculum (300 and 400 level courses) is designed to provide cadets an educational background commensurate with a Bachelor of Science degree in aeronautical engineering. Relative to ABET Criterion 3, the subject knowledge acquired by cadets earning grades of C or better in all courses of the curriculum pertains directly to outcomes (a), (e), and (k).

Assessment of this PCO is also done by the comprehensive examination and instructor observations.

3.1.2 Plan and execute experimental investigations, and interpret and analyze data from such investigations to formulate sound conclusions. - While cadets obtain exposure to the importance of experimental data in several courses, Aero Engr 471, Aeronautical Laboratory, is exclusively designed to provide cadets detailed knowledge on the experimental process as well as the capability to analyze and use experimental data to make decisions. In the later half of the course, two or three person teams plan, design, and conduct an experiment to meet a specific need defined by a project sponsor. Each cadet team must produce, analyze and interpret experimental data, make decisions on the validity and value of the data, and report the findings in both a technical written report and an oral presentation. As an aside, approximately 25-30 % of the cadets continue their Aero Engr 471 project in the cadet summer research program (CSRP) and Aero Engr 499, Independent Research courses. Relative to ABET Criterion 3, Aero Engr 471 strongly supports attainment of Outcome (b), as well as (e) and (k), and (g).

3.1.3 Develop and evaluate an engineering design that meets customer needs. - While every course in the aeronautical engineering curriculum contributes to the PCO's, the centerpiece of the curriculum is Aero Engr 481, Introduction to Aircraft and Propulsion System Design. DFAN contends that engineering design is a process in which the participants (cadet-engineers here), use their knowledge and skills interactively as they pursue optimum solutions to ill-defined problems. In addition to possessing fundamental knowledge spanning a variety of disciplines, cadet-engineers must learn how to apply such knowledge to real problems. They must be taught how to identify requirements and constraints as well as to distinguish between the information that is known versus information needed. Additionally, DFAN contends that the cadet-engineers must also learn how to actively participate in team work, and to be proficient at communicating technical information succinctly and accurately. Moreover, they must possess sensitivity for societal, political and economic impacts of suggested solutions.

For the cadets specializing in the aeronautical engineering program, Aero Engr 481 provides these foundation abilities. As shown in Figure 16, Aero Engr 481 is the center of the curriculum flow chart, highlighted for emphasis, and fed by the top 300-level courses of four program disciplines. Cadets take Aero Engr 481 in the 7^{th} term, after which they continue their development in engineering design by specializing in either an aircraft design project (Aero Engr 482) or an aircraft engine design project (Aero Engr 483). Coming into Aero Engr 481, cadets have performed research in other courses, they have begun to develop as independent learners, they have learned foundations in technical communication and teamwork, they have performed some experimentation and analyzed empirical data, and they have acquired fundamental technical and non-technical knowledge. Then in Aero Engr 481, they learn how to use such knowledge and skills, and to acquire additional knowledge and skills needed to accomplish a design that meets customer needs. Lastly, Aero Engr 481 exposes cadets to impacts that engineering designs have on global, societal, political and economic issues. In the 8^{th} term, they use their educational wherewithal to accomplish a design for a real engineering need. Further details are presented in Section B., Chapter 8, paragraph 8.7, and in Appendix I, TableE.1.

3.1.4 Use oral and writing skills to communicate effectively. - DFAN emphasizes communication skills development because as future Air Force officers, possessing mediocre communication skills upon graduation is unacceptable. Throughout the curriculum, cadets are exposed to, and develop through practice good oral communication abilities. Interestingly, assessment data obtained from grad-surveys, from instructor observations, and from some supervisors indicate that cadets need to possess better technical writing skills. Accordingly, DFAN has created a new pedagogical approach to improve technical writing skills. Defined as a Program Thread (see Section B. paragraph 4.3.1), cadets learn individual aspects of technical writing in different 300-400 courses in the curriculum. Then in the three senior courses, Aero Engr 471, Aero Engr 481, Aero Engr 482/483, the cadets practice putting the pieces together to write complete technical reports. Program Threads are new to the curriculum. The communication program thread will begin in the Fall-2002 term. DFAN's goal is to have its graduates evaluated by supervisors as being competent in all forms of technical communication.

3.1.5 Work effectively as a member of a multidisciplinary team. - DFAN views the terminology, *multidisciplinary teams*, with two separate interpretations, one pertaining to technology, the other pertaining to the profession of military service. For technology, multidisciplinary team is taken to mean a team consisting of members representing all six disciplines of the aeronautical engineering curriculum. In this sense, cadet teams in the senior design courses (AE 482/483) will address technological issues concerning the aerodynamics, materials and structures, flight mechanics and stability, and propulsion aspects of the design problem. For the other interpretation, DFAN considers the professional interpretation of *multidisciplinary team* to mean Air Force officers who routinely work on problems involving a variety of non-technical issues often intertwined with technical features. As such, cadets in the aeronautical engineering program work on military-leadership problems with cadets specializing in other programs. In this regard, all cadets at USAFA, regardless of academic specialization, work on multidisciplinary teams and military leadership problems throughout their four year academy experience. Thus, DFAN contends that Aero Engr 471 and the two course senior design sequence Aero Engr 481 and 482/483 directly support attainment of the technical aspects of Outcome (d), and that all other aspects of multidisciplinary teamwork are inherent in the total USAFA program.

3.1.6 Demonstrate the skills to engage in independent learning. - Air Force problems are most often ill-defined. As entry-level officer-engineers, graduates of the Aeronautical engineering program will work on such problems. Even with the scope of knowledge acquired from the curriculum, graduates will never have enough information, or enough knowledge, to pursue problem solutions without performing research. Knowing how to obtain needed information follows directly from identifying known and unknown information pertinent to a problem. Moreover, as young entry-level officer-engineers, DFAN graduates are expected to develop into team leaders (DFAN-POG 4), and as such, they must develop independent learning skills and a positive attitude towards being intellectually curious while they are in school. Being independent learners is perhaps as much an attitude issue as it is a skill, but knowing how to identify needed information, and then how to obtain it are skills that are taught in several courses in the curriculum. Application, and thus assessment and evaluation of such skills are features of Aero Engr 471, and the two course senior design course sequence, Aero Engr 481 and 482/483.

3.2 Correspondence to DFAN Program Operational Goals

Table 10 shows the correspondence between the DFAN-POG's and the DFAN-PCO's. The colored circles of green, yellow, and red indicate the level of association, green being direct, red being indirect, and yellow being somewhere in between. The PCO's are performance outcomes realized by evaluation of measurable criteria; that as a set completely support attainment of the DFAN-POG's. There are no omissions in the DFAN program. Every DFAN-POG is supported directly by one or more PCO's, and many are indirectly supported as shown in Figure 10. The two yellow circles signify that since PCO-1 contains foundations in communications skills and principles of ethical practice, so POC-1 supports DFAN-POG's 2 and 6, respectively. However, the association is not as strong as the associations shown in green, which are direct, hence, the yellow circles. POC-3, Design, strongly supports attainment of all DFAN-POG's; developing good engineering design abilities in the cadets is a priority of the Aeronautical engineering program. Open circles show implied associations.

Table 10 Correspondence Between DFAN-POG's and PCO's

		DFAN Program Operational Goal (POG's)					
		1 (knowledge) 2.6.1	**2** (communication) 2.6.2	**3** (teamwork) 2.6.3	**4** (Indep. Learner) 2.6.4	**5** (Problem Solver) 2.6.5	**6** (Ethics) 2.6.6
DFAN Program Curricular Outcomes (PCO's)	**1** (BS-Level Knowledge) 3.2.1	● (green)	● (yellow)	○		● (green)	● (yellow)
	2 (Exp Data) 3.2.2	● (green)	● (green)	● (green)	● (green)		
	3 (Design) 3.2.3	● (green)	● (green)	● (green)	● (green)	● (green)	● (green)
	4 (Com. Skills) 3.2.4		● (green)			● (yellow)	
	5 (Multi-dis.-team) 3.2.5		○	● (green)		● (green)	
	6 (Indep. Learner) 3.2.6	● (yellow)			● (green)	● (yellow)	

3.3 Correspondence to Institutional Educational Outcomes

Since over half of the DFAN faculty are active-duty military on 3 – 4 year rotations, one-year appointments outside of the department are impractical. However, equally important, these individuals come into the department with recent experience in government laboratories, program offices, or operational units. This high turnover rate, unique to the service academies, by its very nature provides faculty enrichment, as well as helps ensure program relevance. Remaining paragraphs in this section address other means by which the department seeks faculty enrichment.

DFAN PCO's also correspond directly to the Institutional Outcomes, Table 11. DFAN does not have a statement that explicitly uses the wording, intellectual curiosity, but the interpretation of "being intellectually curious" is inherent in DFAN-PCO's 3 and 6, because to be successful in design activity, one must also be intellectually curious about the technological need for the design as well as the incumbent issues pertaining to requirements, constraints, approaches and technology. Similarly, to be an effective independent learner, one must also be intellectually curious. Thus, DFAN is satisfied that all DFAN-PCO's properly and completely correspond to the Institutional Educational Outcomes.

Table 11 Correspondence between Institutional Outcomes and PCO's

		DF Education Outcomes						
		1 (knowledge)	**2** (intellectual curiosity)	**3** (communication)	**4** (ill-defined problems)	**5** (teamwork)	**6** (indep. Learner)	**7** (military professionalism)
DFAN Program Curricular Outcomes	**1** (BS-Level Knowledge) 3.2.1	●			●			●
	2 (Exp Data) 3.2.2	●			●			
	3 (Design) 3.2.3	●	●		●			●
	4 (Com. Skills) 3.2.4			●				
	5 (Multi-dis.-team) 3.2.5					●		
	6 (Indep. Learner) 3.2.6		●				●	

3.4 Correspondence to ABET Criterion 3, a-k Outcomes

Table 12 shows the course correspondence between the DFAN curriculum and the ABET EC-2000 (a-k) Criteria. As shown in paragraph 3.0, DFAN places priority on Outcomes (a) – (g) and (k), hence, these eight outcomes are emphasized in the aeronautical engineering program. The other three outcomes (h), (i), (j), knowledge of contemporary issues, knowledge of global impacts and being predisposed to life-long learning are elements inherent in being a military professional. These particular outcomes are developed in depth in the Academy's academic core courses. The Aeronautical engineering program provides rigorous academic development opportunities explicitly in these broad areas, but clearly the DFAN faculty administer a program designed to address the priority outcomes as identified by the level 4 and 5 indicators shown in paragraph 3.0.

Table 12 Correspondence between DFAN PCO's and ABET Criterion 3, a-k Outcomes

DFAN PCO	**Upon successful completion of the USAFA program in Aeronautical Engineering, cadets will have the ability to:**	ABET Criterion-3 Outcomes
1	Use fundamental knowledge to solve aeronautical engineering problems commensurate with a Bachelor of Science degree	a,e,k
2	Plan and execute experimental investigations, and interpret and analyze data from such investigations to formulate sound conclusions.	b,e,k
3	Develop and evaluate an engineering design that meets customer needs	c,f,h,j
4	Use oral and writing skills to communicate effectively.	g
5	Work effectively as a member of a multidisciplinary team	d
6	Demonstrate the skills to engage in independent learning	i

3.5 Assessing and Evaluating DFAN PCO's

DFAN obtains program assessment data from a variety of sources. Two sources of priority, however, are the Curriculum Assessment Process (CD-Debriefs) and the Comprehensive Examination (paragraph 3.5.2). The CD-Debriefs are used to assess and evaluate performance pertinent to the course specific outcomes. The Comprehensive Examination is directed towards knowledge, skills and abilities at the program level. Following the explanation for these processes, other sources for assessment inputs are described.

3.5.1 Curriculum Assessment Process – Assessing and evaluating the educational effectiveness of each course in the curriculum is illustrated in Figure 11. The process, shown in the Semester Cycle node, is performed each term for the courses conducted in the previous term. Six to eight weeks into the semester, each course director prepares and presents a briefing to the discipline directors in the DFAN Curriculum Committee. The CD-Debriefs (paragraph 3.5.1.1) follow a structured format that links the course to PCO's, POG's and the ABET Criterion 3, a-k Outcomes. The slides also present details on changes made,

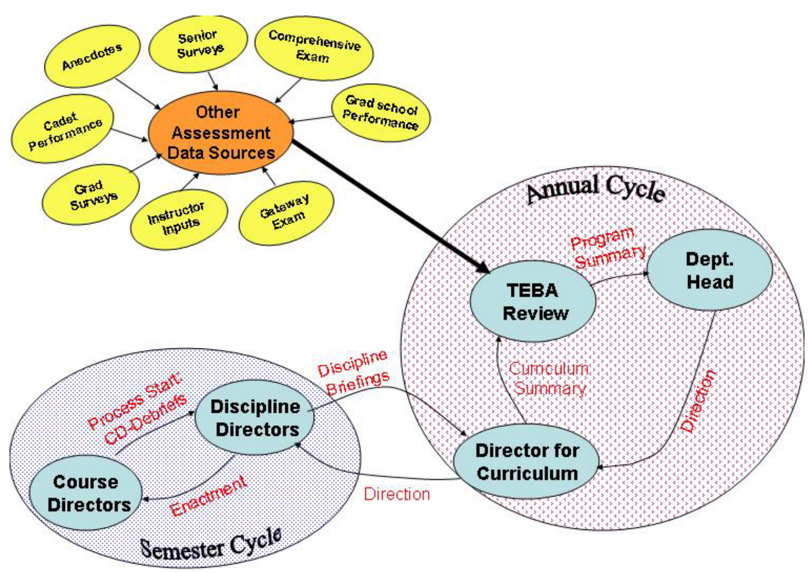


Figure 11 Curriculum Assessment Process

assessment activity, and results. Descriptions for the required slides in a presentation are presented Table 13. As an example, Appendix I., Table D.13a-g, shows the latest presentation for Aero Engr 361 Propulsion I. Colored dots are used as quantifiers: Green means satisfactory, yellow means concerns or weaknesses exist, and red means deficiencies exist.

The bridge between the Semester Cycle and the Annual Cycle occurs between the Discipline Directors and the Director for Curriculum. At approximately the middle of the Spring term, the Discipline Directors brief the status of their respective discipline to the DFAN Director for Curriculum. Following this, at the annual Spring TEBA meeting, the Director for Curriculum presents a report on the State of the Curriculum. Under direction of the Director for Program Accreditation, TEBA compiles this report with other assessment data to make recommendations for program changes, which in turn, are presented to the Department Head for direction. Enactment follows a return path from the Department Head to the Director for Curriculum, then to the Discipline Directors, and finally to the Course Directors who enact the changes in the courses.

3.5.1.1 CD-Debriefs – Over the past several semesters, DFAN has iterated on the design-format of the CD-Debrief slides, the objective being to have a set of slides that allow for a proper assessment of each course in the curriculum. Table 13 presents an explanation for the required slides. The cover slide shows the course, course and discipline directors, and the colored dots indicate the status for both assessment and performance. Subsequent slides present details to include course objectives and outcomes, linkage to other courses in the curriculum, and status on assessment.

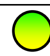
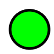
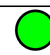
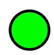
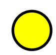
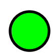
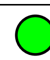
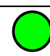
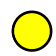
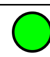
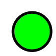
Table 13 CD-Debrief Chart Explanation

Slide No.	Title	Description
1	Cover	Shows the Course, term, and Overall Past and present Assessment Standings: green =satisfactory, yellow=concerns or weaknesses, red=deficiency
2	Linkage	show catalogue description, course goal, prerequisites, and target courses (the subject content of this course used in future courses).
3	Outcomes Map: ABET EC 2000, Criterion3, a-k Outcomes	Maps educational outcomes of course to ABET EC2000 Criterion 3, a-k Outcomes.
4	Outcomes Map: DFAN POG's	Maps educational outcomes of course to DFAN-PCO's.
5	Assessment/Evaluation	Identifies assessment criteria for each course educational outcomes, the assessment instrument used, and average cadet performance indicators: green-satisfactory, yellow = concern or weakness, red = unacceptable performance.
6	Tracking	Lists problems and remedies. Tracks problems from previous briefings to ascertain improvements
7	Statistics	Presents grade statistics, plus fullness indicator level

The fullness indicator (see last slide in Appendix I., Table D.13a-g) is an internally developed spreadsheet used by course directors to estimate the course workload. Instructor estimates for the time required to complete each assignment along with inputs from cadets stating time spent on particular projects are put into the spreadsheet. The fullness indicator is computed as a total-time-estimate for course work. The workload becomes a number expressed as, "per cent of available time used," based on an expected commitment by each student of 100 minutes outside of class for each 50 minute class period. Numbers on the order of 95% full are acceptable, whereas 99% or more indicate that the course maybe overloaded, and corrective action on assignments needs to be done.

3.5.1.2 Discipline Status – Table 14 presents a summary on the assessment status of each discipline as of May 2002. The column labeled Assessment indicates the relative degree to which the outcome is being assessed, whereas the column labeled performance identifies the degree of acceptance in cadet performance. As before the green = satisfactory, yellow = concerns or weaknesses exist, red = deficiencies exists. The assessment category pertains to whether or not all discipline outcomes are being satisfactorily assessed, where as the performance category pertains to attainment of the outcomes

Table 14 Discipline Status

Discipline	Assessment	Performance
Aerodynamics		
Flight Mechanics, Stability and Control		
Propulsion		
Aerospace Materials & Structures		
Experimental Investigations		
Aircraft & Aircraft Engine Design		

The half green-yellow circles for the Aerodynamics discipline identify the fact that curricular changes are being implemented in this discipline. Yellow for performance in the Propulsion Discipline is due to difficulties cadets have in identifying and understanding performance trends for engine cycle analyses. Cadets also have demonstrated a lack of understanding of some compressible gas dynamics flows such as Raleigh and Fanno flows. Yellow for performance in Experimental Investigations relates to the cadets' misunderstanding of measurement uncertainty. Corrective actions for these yellow-items are being addressed within the respective disciplines.

The green-yellow indications for the Aerodynamics Discipline signifies uncertainty due the curricular changes pending in the discipline (see Chapter 8., paragraph 8.2.4). Otherwise, both Assessment and Performance in the Aerodynamics Discipline are green.

3.5.2 Comprehensive Examination – The DFAN Comprehensive Examination (CE) consists of 76 multiple choice questions pertaining to subjects taught in the Aeronautical engineering program. The CE has been used by DFAN for more than 15 years to determine the graduates' overall knowledge of the engineering principles taught in the curriculum. The CE is given twice, initially to the junior-level cadets in the beginning of their 5th semester, and again (the same set of questions) in the 8th semester when the cadets have nearly

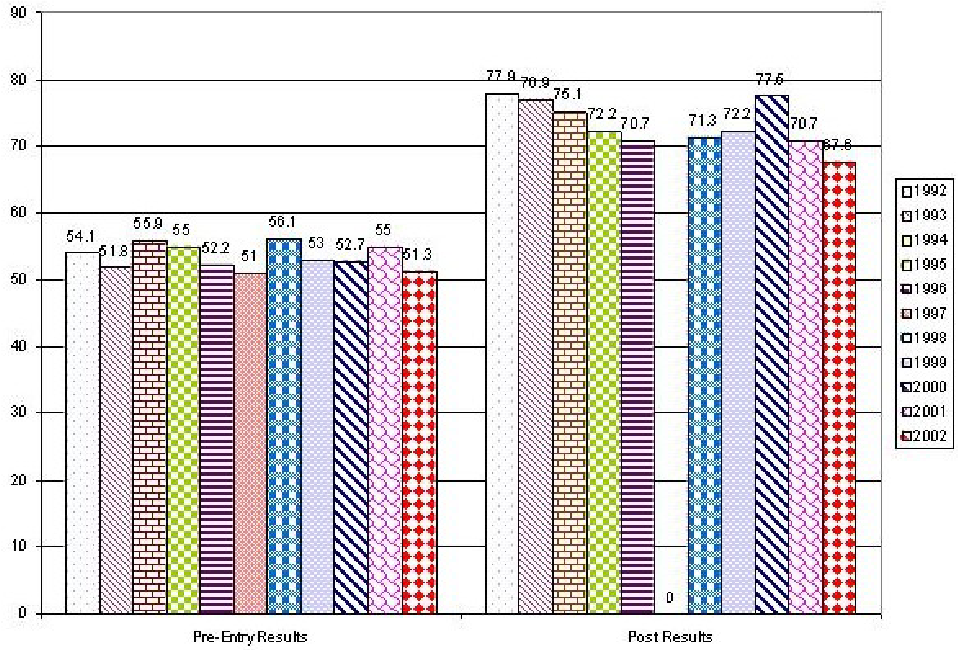


Figure 12 Comprehensive Examination Historical Results: 1992-2002

completed all course work. Figure 12 shows the average percentages for the initial and final offerings for the classes spanning the past decade. On average, performance from the initial to final offering increases from about 50% to 70% on average. No post-result data are available for the Class of 1997, hence the zero scores, but the expectation is that the class average for this group would have been consistent with the other data.

With the adaptation to ABET EC 2000, DFAN began to identify shortcomings with the CE. Foremost, questions on the CE were not explicitly tied to the DFAN-PCO's, so using the results for detailed program evaluation was difficult. Second, the majority of the questions pertained to academic details taught in two program prerequisite courses, Aero Engr 315, Fundamentals of Aeronautics, and Engr 310, Energy Systems. The question imbalance was such that less than 25% of the questions pertained to subject material taught in the upper division courses, and in fact, the content for some courses was completely missing. Third, there was no coverage for mathematics or basic science knowledge. Fourth, the final CE offering is given near the end of the 8th semester (near graduation), so results obtained from this assessment may be skewed by cadet attitude. At this point, the cadets have nearly completed the program, and their thoughts are understandably focused more on graduation than on another "academic test." In light of these concerns, DFAN decided to revise the CE assessment process, and the structure of the examination.

3.5.2.1 CE Revision - CE revision has resulted in two distinctly different assessment examinations. The initial CE has been replaced by the Gateway Examination (see Section B. Paragraph 4.4.2). The Post CE offering is being replaced by an entirely new examination that focuses on the subject material presented in the 300 – 400 level courses taught in semesters 5 – 8. The CE is somewhat comparable to the Professional Engineering FE exam, only the focus is on assessing the PCO's of the aronautical engineering program.

The process used to create the new CE involved each of the six DFAN program disciplines. A matrix was developed that listed the educational outcomes of the discipline, questions that addressed particular outcomes, and an explanation as to why each question is a valid assessment question. A draft of the new CE has been written and given to members of the class of 2002 as a pilot-offering. The results from the pilot-offering are being used to improve the questions and evaluate the effectiveness of this newly designed instrument. The new CE will be used as a primary program assessment instrument starting with the class of 2003. The CE discipline matrices are included in the Course Director Notebooks. The matrix for the Flight Mechanics, Stability and Control discipline is presented in Appendix I, Table D.14, as an example.

3.5.3 Senior Surveys – Senior survey date shown in Table 15 are comparable to exit interviews. Cadets in the senior class are invited to complete a brief questionnaire (Appendix I., Table D.15) on their perspectives on how well they believe the aeronautical engineering program has prepared them to perform as engineering professionals. DFAN uses these results to help detect shortcomings in the program (see Table 15). Interestingly, the issues pertaining to communication skills development were identified here as well as elsewhere

Table 15 Summary: Senior Survey Data

	General Evaluation	**Comment**
Ability to Demonstrate POG's in workplace	Overall high self-confidence to perform in the workplace according to POG Statements	On a scale of 1=low, 5=high, grads rate themselves between 4.5 and 5 in all categories. Shows strong self-confidence in professional abilities. Only minor concern for communication skills, but comments are generally: "I can always working on improving my communication skills." **DFAN Action:** Communication Skills confidence is expected to strengthen through application of Communication Thread.
Attainment of Program Curricular Outcomes	Overall high self evaluation on attainment of all Program curricular Outcomes	On a scale of 1=low to 5=high, cadets rate themselves at 4.5 in most categories except develop and evaluate engineering designs, ability to discuss the impact of engineering design on global and society issues, and ability to make moral and ethical decisions. **DFAN Action**: More data needed to understand cadet concerns for an apparent lack of confidence in abilities to perform well in experimental work, and engineering design. Course performance in these subject areas is satisfactory. Cadet concern on moral and ethical issues is believed to be related to confidence. Cadets have high moral standards, and are expected to make ethical decisions. DFAN needs to engage the cadets in more open discussions on these issues in all courses.
Knowledge of Program Operational Goals	Generally low	Overall, POG's not known, or not understood **DFAN Action**: From time of first interest in the aeronautical engineering discipline, faculty advisors will devote time to describing the expectations in job performance once on active-duty as an Air Force officer-engineer. Concepts will be repeated presented and discussed in the annual Dash-1 seminar, and elsewhere as opportunity arises.
Knowledge of Program Curricular Outcomes	Generally low	Overall, PCO's not known, or understood. **DFAN Action**: DFAN will engage cadets more interactively in discussing both program and course educational outcomes.
Miscellaneous		Program is good. Provides cadets diversity in subject material. Program needs more electives.

(see paragraph 2.9.1), and DFAN believes implementation of the Communications Thread will mitigate this issue. Also interestingly, an overall lack of knowledge or understanding of program objectives and program outcomes, plus program structure, was identified. DFAN intends to strengthen the cadet's knowledge on the POG's, PCO's, as well as their understanding for the program structure and purpose of each course in the curriculum.

3.5.4 Aero Council - The Aero Council is comprised of six cadets in the aeronautical engineering program, three representatives for each class elected by their respective class peers. The Aero Council meets twice each term with members of the DFAN faculty in an informal setting to discuss program specific contemporary issues. In addition to being an avenue for information exchanges, DFAN regards the Aero Council as an assessment instrument because often the information on program issues leads to changes in policy that improves cadet learning. One such issue concerned cadets having after-duty-hours access to the Aeronautical Laboratory so that project teams could work on their respective topics during times the laboratory was closed. Once this issue was identified by the Aero Council, a policy was enacted to provide after-duty-hour access to the laboratory.

3.5.4.1 Aero Council Survey – Starting with the Class of 2002, the Aero Council conducted an e-mail Survey of Peers, cadets enrolled in the Aeronautical engineering program. A summary of results is presented below in Table 16, and the cadet summary is presented in Appendix I., Table D.16.

Table 16 Summary: Aero Council Survey Data

	PCO	Applicable PCO
Attributes of the major where cadets have the most confidence	1. Knowledge	PCO-1
	4. Communication Skills	PCO-4
	5. Teamwork	PCO-5
Attributes of the major where cadets have the least confidence	1. Knowledge & Problem Solving	PCO-1 (conflicting responses)
	2. Plan & Conduct Experiments	PCO-2
	3. Design to meet customer needs	PCO-3
Program Strengths	Facilities Faculty Diversity of courses Opportunities for research	
Program Weaknesses	Workload Connection between course	
Knowledge of Educational Outcomes	Essentially none, or placed no significance on them	

3.5.5 Institutional Surveys – Of the Institutional surveys conducted at USAFA, three in particular are important to DFAN, the Climate Survey, Graduate Survey, and End of Course Critiques.

3.5.5.1 Climate Survey – The Climate Survey is administered by the Department of Behavioral Sciences & Leadership to the USAFA Faculty each year during the Spring term. The survey is voluntary. The survey assesses faculty opinions on overall program quality, Department performance, and job satisfaction. Although the Climate Survey (CS) is not explicitly a program assessment instrument, the findings pertain directly to the effectiveness and attitudes of the faculty, which do affect program effectiveness. Thus, the Climate Survey is included here as an assessment instrument providing data on the performance of the DFAN program.

DFAN is pleased that the Climate Survey data consistently reveal high morale and high job satisfaction for the DFAN faculty, and equally high ratings as a top performing department at USAFA (see Appendix I., Table 17 a-b). The 2002 survey data show that as a department, DFAN ranked 2nd out of 20 departments in faculty perceived effectiveness, and 3rd of 20 in overall job-satisfaction. When compared only to the other engineering departments, DFAN ranked above average in all categories. Moreover, as Table D.17 shows, the attitudes and opinions of the DFAN faculty have steadily been increasing from 1998 when the Department seemed to be at a low.

3.5.5.2 Graduate Survey: Class of 2001 - The Graduate Survey (GS) is administered annually by the Department of Behavioral Sciences & Leadership to the graduating class of cadets. DFAN recognizes the GS as being an attitude dependent assessment instrument. The GS seeks to ascertain from cadet opinions issues related to the quality of academic instruction, subject relevance, and the quality of faculty advising and mentoring. Survey results are compared to the respective averages for the Engineering Division. Results for DFAN, Class of 2001, are presented in Appendix I., Table D.18a – d. Along with the survey questionnaire and numerical data, results for the Class 2002 will be presented during the ABET visit if they are available.

The GS questionnaire is presented using the Leichner scale. As an example, question 27 is,

I am proud of what I accomplished in my academic major,”

and the responses are:

A = Strongly Disagree (1),.......... C= Neutral (4),..........g=Strongly Agree (7).

Table D.18a shows that overall the cadets perceive the academic workloads in the Aeronautical engineering program to be high compared to the other engineering programs. This finding is consistent with the Aero Council Survey. DFAN believes that while the cadet opinions on the comparatively high workload is not likely to diminish, cadet attitude towards the workload can become acceptable by spending more time advising and discussing academic requirements of the program, cadet responsibilities, and the crucial need to develop and use good study habits. This effort begins each fall in the DFAN Dash-1 seminar. Also, implementation of the revised curriculum offers opportunity for more electives, and fewer core course requirements (for example, no foreign language requirement) will afford cadets more opportunity to devote to Aero Engr courses.

Table D.18b presents results that show the cadets believe that the Aeronautical engineering program prepares them well to meet the Institutional Educational Outcomes.

Table D.18c shows data that indicate DFAN can improve in the areas of academic advising and mentoring. For the class of 2001, DFAN appears to be below the Engineering average. Since these data were released, DFAN has increased both faculty advising and faculty mentoring practices. DFAN awaits the findings for the class of 2002 to ascertain if the changes have resulted in improvements. Moreover, TEBA continues to discuss practices that will also improve cadet attitudes toward faculty mentoring and advising.

Table D.18d presents data that is overall satisfactory with regard to how the cadets believe the program has contributed to their personal character development. However, even though the average response for the question, "I will abide by the spirit of the honor code after graduation," is above the Engineering average, DFAN is curious as to why the score is not 7. DFAN intends to engage cadets more actively and openly in discussions on honor in hopes of uncovering concerns the cadets may hold. DFAN's goal regarding this question is a perfect response of 7.

3.5.5.3 End of Course Critiques – The End-of-Course Critique (EOCC) is an Institutional assessment instrument administered the Department of Behavioral Science & Leadership for every section of every course instructed at USAFA. A sample of the EOC is present in Appendix I, Table D.19, and some historical results are presented in Table D.20. Cadets complete the EOCC near the end of a course.

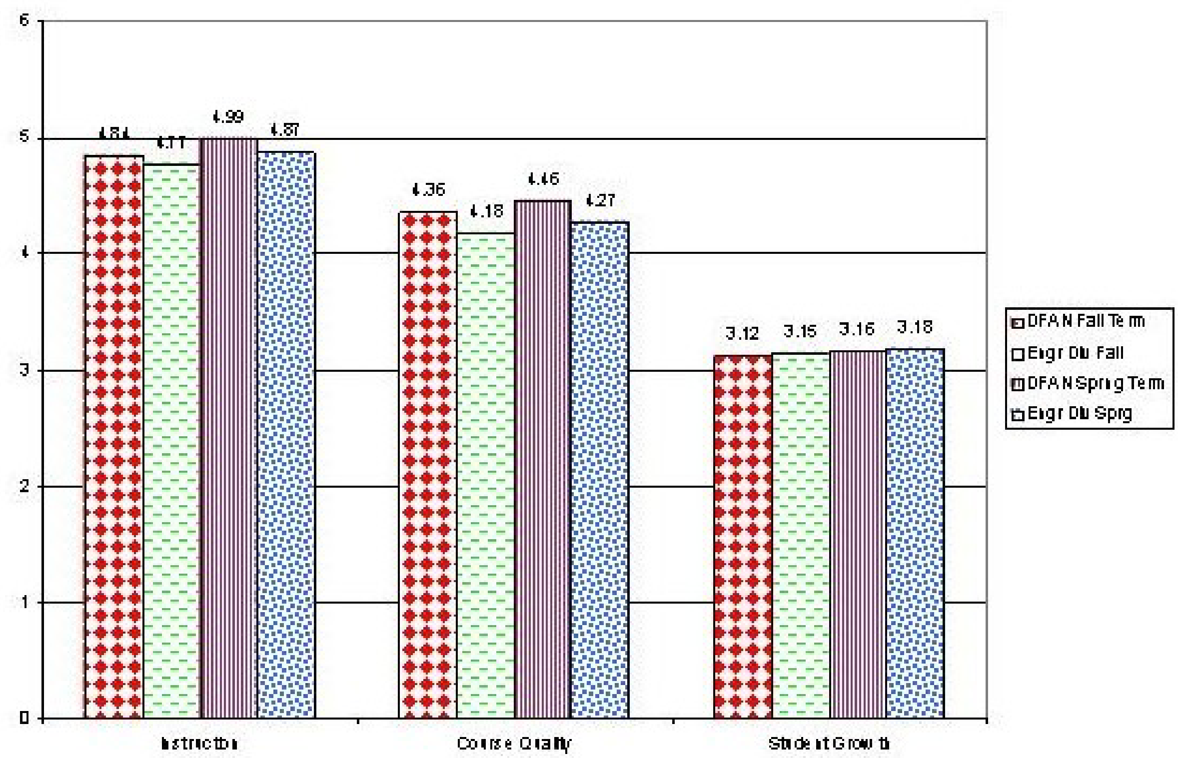


Figure 13 Summary: End Of Course Critique Survey for 2000-2001

The EOCC has five parts: (1) Instructor Performance. (2) Course Performance. (3) General. (4) Semi-demographic data. (5) Additional Items. Figure 13 shows the average results for aeronautical engineering courses taught in Academic year 2000 – 2001 with regard to quality of instruction, quality of the course, and cadet intellectual growth. Compared to all other courses in the Engineering Division, performance in DFAN course is rated higher in quality of instructions and quality of course, and about on par in the cadet growth category. When evaluated as contributions on an institutional level, **cadets consistently rate the quality of DFAN instruction and courses much higher than they do all other USAFA courses** (Appendix I., Table D.20).

DFAN recognizes that the EOCC data are strongly attitudinal, and as such, they may be useful only for identifying trends. DFAN accepts these observations as being positive towards program evaluation: (1) Overall, the cadets like the aeronautical engineering program, and the instructors. (2) Overall, the cadets believe that the program helps them to grow intellectually. (3) Overall, the program helps them to develop into being top entry-level Air Force officers. Beyond these three points, DFAN sees no evidence or trends to suggest problems or shortcomings in the program.

3.5.6 Cadet Recognitions – Cadets in the aeronautical engineering program receive numerous awards from external agencies as well as from other Academy mission elements. DFAN uses cadet awards and special recognitions from external agencies as evidence on program quality and performance. Three categories of merit are: National Scholarship winners, special awards, and cadet competitions.

3.5.6.1 National Scholarships – Cadets in the aeronautical engineering program often win national scholarships. In 2000, Jammie Himsl won a Truman Scholarship, a Tau Beta Pi fellowship, and was a finalist for a Rhodes Scholarship, and won a Harvard scholarship for the Kennedy School of Government. In 2002, Charles Trickey won a Marshal Scholarship. Paul Calhoun: MIT Draper Fellowship. Brian Stiles: Rice Scholarship. Matt Rabe: MIT Draper Fellowship. Fellowships and National Scholarships for cadets in other year groups are tabulated in a Cadet Kudos Notebook that will be available for review during the ABET visit.

3.5.6.2 Awards – In the class of 2002, Cadet William Johnson received the Colorado Engineering Council (CEC) highest award, the silver medal, for his exceptional performance in academics and research. Cadet Charles Trickey was the Academy's overall to graduate is all mission elements, as well as the top element leader in the cadet wing. Cadet Paul Calhoun was the top graduate in academic order of merit, and several cadets in the program graduates with top intercollegiate athletic awards.

3.5.6.3 Cadet Competitions – Cadets in the aeronautical engineering program routinely compete and win in annual AIAA Cadet Paper competitions (Chapter 1 Table 3.)

3.6 Administrative PCO Assessment Structure

TEBA is the central body in DFAN responsible for the assessment process with respect to both program-specific issues and ABET EC 2000 Criteria. TEBA is chaired by the Director for Accreditation, and is comprised of Department senior leadership and directors. Ensuring program compliance with a particular ABET EC 2000 Criterion is assigned to a particular TEBA member as a program responsibility.

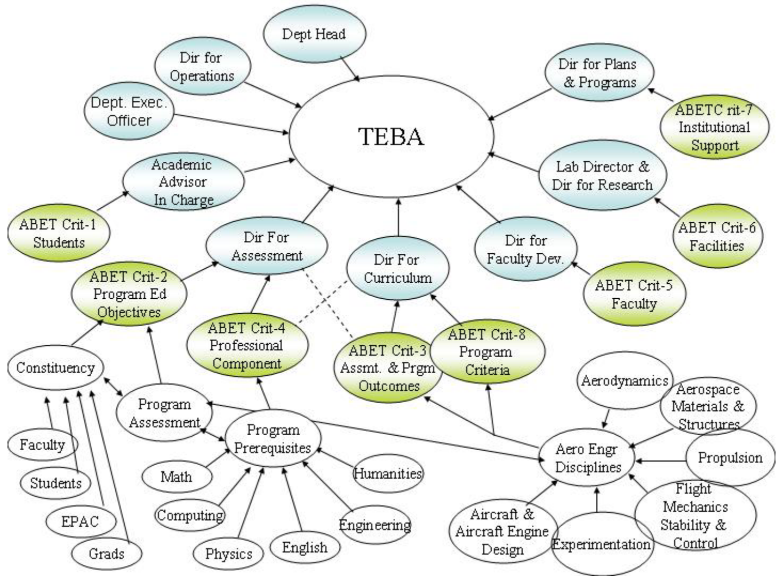


Figure 14 DFAN Administrative Structure for Program Assessment

The administrative structure of TEBA is illustrated in the global concept map of Figure 14. The light blue nodes one level out from the central node (TEBA) define the membership. The green nodes two levels out identify ABET EC-2000 Criteria connected to a particular TEBA member. The clear outer level nodes identify details associated with (connected to) the Criteria, and thus, the responsible TEBA member. DFAN views ABET EC2000 Criterion 3 and 8 as being connected because both criteria pertain explicitly to the DFAN program, thus they overlap in Figure 14. Since Criterion 2 and 3 are also strongly related, dotted lines show connection in this map. Ensuring compliance with ABET EC2000 Criterion 1 is the responsibility of the respective class advisors, and since the DFAN program always applies to three classes currently, the central point of contact on TEBA for Criterion 1 is the Department Academic Advisor in Charge (AIC); class advisors are led by the AIC.

3.7 Program Changes and Improvements

While the USAFA program is being revised with changes to be implemented in August 2002, the aeronautical engineering program is stable and will be modified only slightly by the USAFA program changes. Appendix I. Table A.1a shows the course and credit hour details affecting the Aeronautical engineering program. In terms of credit hours, the program is being reduced from 149.5 to 142.5 credit hours, the reduction coming primarily from the level of core course credit hours. With the number of general education courses in the academic core is being reduced, the opportunity now exists for cadets to have more electives in their respective programs. For engineering majors, this is achieved primarily by removing senior engineering core design course (Engr 410) and the six credit hour foreign language requirement. More explanation on these changes is presented in Section B., Chapter 8. Overall, DFAN views the USAFA program changes as beneficial to the Aeronautical engineering program.

3.7.1 Process to Change Course Educational Outcomes – Changes to statements describing course educational outcomes occur within the applicable discipline, and are approved by the respective Discipline Director. Course Directors prepare Course Policy Letters (CPL: see Appendix I., Table D.20) that present course goal and educational outcomes for the respective courses. Development and refinement of these statements has occurred over several years (started in 1997), so major changes are not anticipated at this time. In effect, changes to a course to include use of different textbooks, revision of course syllabi, changes to laboratory activity have to be approved by the appropriate discipline director prior to final approval by the department head. Changes to program thread activity (communication, design, modern tools) must be approved by TEBA prior to final approval by the Department Head.

3.8 Summary

DFAN believes the aeronautical engineering program is well defined and provides cadets the knowledge, skills, and abilities needed to meet the POG's. The evidence obtained on attainment of PCO's is being used to make improvements to the program. Specifically:

1. Assessment data on weaknesses in communication skills development has led to development and application of the Program Communications Thread.

2. Assessment data from Cadets on workload levels are being reviewed. Considerations for reducing workload levels are being discussed, but in light of the pending USAF program revision and its impact on the Aeronautical engineering program, actions regarding reductions in the workload level will not be made for at least one additional academic year.

3. Institutional assessment data indicate that DFAN can improve in the areas of advising and mentoring. Moreover, Grad survey data, Senior Survey data and Aero Council survey data all show that DFAN needs to improve on engaging cadets in their knowledge of, and understanding of both POG's and PCO's. DFAN intends to have the faculty advisors, as well as all faculty members engage cadets at appropriate times, in and out of class, in discussion on the meaning of both the POG's and PCO's.

Figure 15 NASA X-35 Research Team

Chapter 4. Professional Component

4.0 ABET Criterion 4

The professional component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The engineering faculty must assure that the program curriculum devotes adequate attention and time to each component, consistent with the objectives of the program and institution. Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political. The professional component must include:

(a) one year [32 cr. hrs.] *of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline*

DFAN Program: As shown in Appendix I., Table A.1, Basic Level Curriculum, cadets specializing in the aeronautical engineering program complete six courses in mathematics (19.5 cr. hrs.), and five courses in basic sciences (15 cr. hrs.) for a total of 34.5 credit hours in mathematics and basic sciences. For the revised curriculum shown in Appendix I., Table A.1a, cadets will take six courses in mathematics (18 cr. hrs), 4 courses in basic sciences (12 cr. hrs), and one mathematics or basic sciences elective, for a total of 33 cr. hrs. The 1.5 credit hour reduction results from reducing the 4.5 cr. hrs for Math 141 to 3.0 cr. hrs. Laboratory work is accomplished in both Physics courses (Phy 110 and Phy 215) as in-class laboratory and computer exercises. Both chemistry courses (Chem 141 and Chem 142) and the biology course (Biology 215) have laboratory compliments to the lecture sessions.

(b) one and one-half years of engineering topics consisting of engineering sciences and engineering design appropriate to the cadet's field of study

DFAN Program: As shown in Appendix I., Table A.1, Basic Level Curriculum, cadets specializing in the aeronautical engineering program complete 21 engineering courses, 20 three cr. hr courses, and one 2.5 cr. hr course, for a total of 62.5 cr. hrs. Fifteen of these courses are devoted exclusively to aeronautical engineering topics, and six are courses in other engineering subjects. Details on the aeronautical engineering curriculum are presented in paragraph 4.1 below, and in Chapter 8. Course descriptions for the aeronautical engineering courses are presented in Appendix I, Table E.1, and also in the USAFA Curriculum Handbook.

Program Threads are a new component of the aeronautical engineering curriculum, and are the result of assessment data previously discussed in Chapters 2 and 3. Details for the Program threads to be implemented in August 2002 are presented in paragraph 4.2.

Design has always been an important component in the aeronautical engineering curriculum, and now it will be one of the primary Program Threads (paragraph 4.2). In effect, the elements of engineering design that currently occur in the six courses preceding the senior design sequence will be coordinated to give cadets growth experiences in design as they progress through the program. Because the cadet design experience culminates in designing, building, and flying a prototype or subscale concept demonstrator for a real customer, this process inherently includes experience and learning relative to economic, environmental, manufacturability, sustainability, ethics, and safety issues. Ethical, social, and politic issues are also always discussed, and often they are experienced in the capstone design course, Aero Engr 482 or Aero Engr 483.

(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives

DFAN Program: As shown in Appendix I., Table A.1, Basic Level Curriculum, cadets specializing in the aeronautical engineering program complete 17 courses (52.5 cr. hrs.) in the general education category. These courses are part of the USAFA Academic Core.

The USAFA Academic Core consists of courses offered by the four major academic divisions: Basic Sciences, Engineering, Humanities, and Social Sciences. The objective of the Academic Core is to provide the foundation knowledge and skills needed by all cadets to become effective Air Force Officers (see Appendix I., Table D.6, DF Educational Outcomes). The Academic Core also helps cadets choose an area of academic specialization. In the Basic Science Division, cadets take core courses in chemistry, physics, biology, mathematics, and computer science. In the Humanities Division, core courses pertain to English, history, foreign language, and philosophy (ethics). In the Social Science Division, cadets take courses in economics, law, political science, management, and behavioral science. From the Engineering Division, cadets take seven courses providing foundations in astronautics, aeronautics, mechanics, electrical engineering, civil engineering, and system design. In the revised curriculum, there is no foreign language requirement for cadets specializing in an engineering program.

By Congressional law, academic programs at USAFA are four years (eight semesters), excluding cadets who incur unusual circumstances. As illustrated in Figure 15, semesters 1-4 are devoted primarily to the educational foundations desired in all cadets as entry-level Air Force officers. For cadets specializing in the aeronautical engineering program, semesters 1-4 are devoted primarily to completing the Academic cores courses that are program prerequisites (Figure 17). The latter 4 semesters are devoted to the 300 - 400 level upper-division courses with the major design experience occurring in the 7th and 8th semesters.

Figure 16 Four Year Aeronautical Engineering Program at USAFA

Paragraph 4.1 illustrates the structure of the aeronautical engineering curriculum and shows how courses in this curriculum satisfy the PCO's, the Institutional (DF) Education Outcomes, and the ABET Criterion 3 a-k Outcomes. The three new Program Threads are presented in paragraph 4.2. Technical Core course prerequisites are identified in paragraph 4.3 along with an explanation of the Gateway examination, a process used to assess and evaluate the preparedness of cadets starting the 5th semester. The major capstone engineering design experience is discussed in paragraph 4.4, followed by cadet design achievements, and a summary.

4. 1 Curriculum Structure

Figure 16, is a flow chart showing the courses that comprise the aeronautical engineering curriculum. This flow chart has a key. The courses identified by the black outlined rectangular boxes are program-requirements, and those in ovals identify the technical core course requirements. Dotted lined enclosures indicate electives. Dotted branches signify co-requisites.

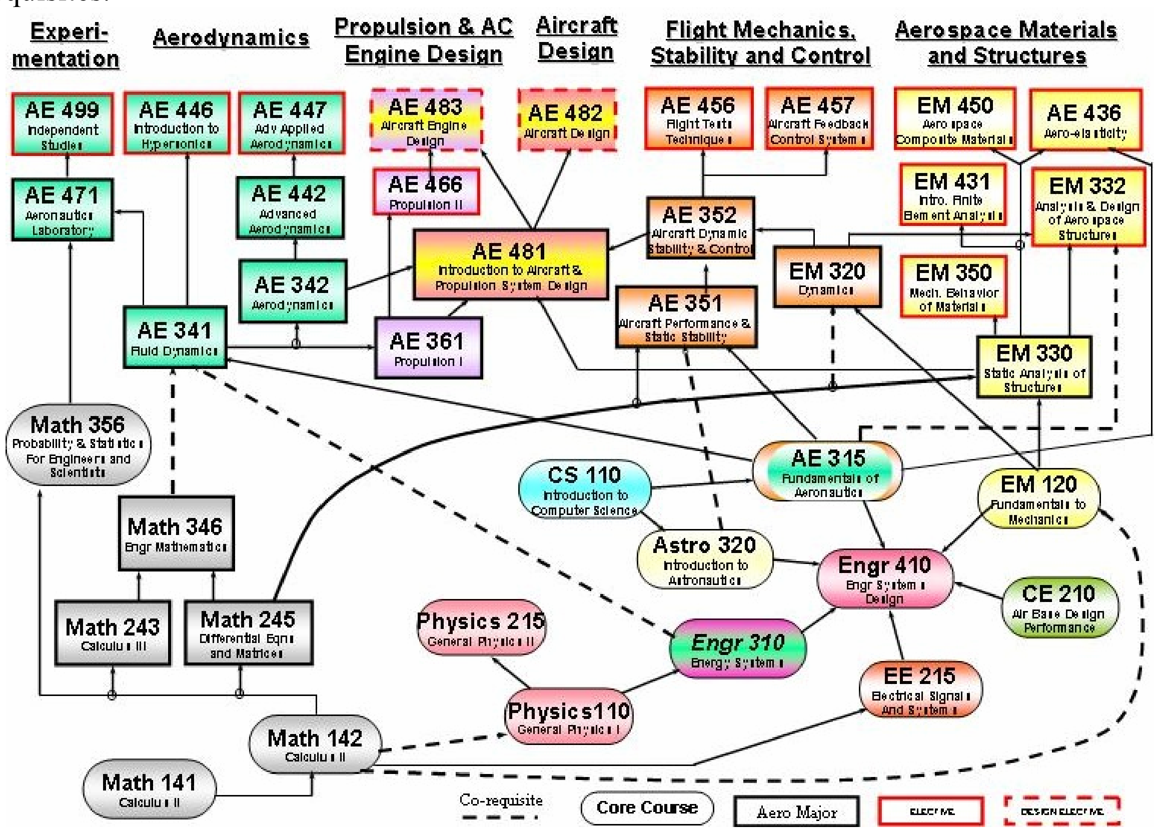


Figure 17 Aeronautical Engineering Curriculum

As shown in Figure 16, the aeronautical engineering curriculum is comprised of six disciplines defined by the headers at the top of the flow chart. The courses contained in each discipline ensure that the graduates have knowledge and skills in aerodynamics, aerospace materials and structures, propulsion, flight mechanics, aircraft stability and control, and design. Details of these disciplines are presented in Section B., Chapter 8., and course description for each course are presented in Appendix I., Table E.1., and in the USAFA Curriculum Handbook.

Table 4 in Chapter 2 shows the correspondence between the aeronautical engineering courses and the POG's. Below, Table 17 shows the correspondence to the PCO's, Table 18 shows the correspondence to the ABET Program Criteria for aeronautical engineering programs, Table 19 shows the correspondence to the ABET Criterion 3 a-k Outcomes, and Table 20 shows the correspondence to the Institutional (DF) Educational Outcomes. In sum, the DFAN curriculum maps well to all sets of outcomes and criteria.

Table 17 DFAN Course Correspondence to DFAN PCO's

	DFAN Program Curricular Outcomes (PCO's)					
Courses	Knowledge (3.1.1)	Experiments (3.1.2)	Design (3.1.3)	Communication (3.1.4)	Teamwork (3.1.5	Independent Learner (3.1.6)
Engr 310	X	X	X	X	X	X
AE 315	X	X	X	X	X	X
EM 330	X	X	X	X		
Mat' & Stru Ele	X	X	X	X		
AE 341	X			X		
AE 342	X			X		
AE 442	X			X		
AE351	X		X	X		
AE 352	X			X		
AE 361	X			X		
AE 471	X	X	X	X	X	X
AE 481	X		X	X	X	X
AE 482	X	X	X	X	X	X
AE 483	X	X	X	X	X	X

Table 18 DFAN Course Correspondence to ABET Program Criteria for Aeronautical Engineering

	ABET EC 2000 Program Criteria for Aeronautical Engineering					
Course	Aerodynamic s	Aerospace Materials * Structures	Propulsion	Flight Mechanics, Stability & Control	Experiments	Engineering Design
Engr310			X		X	1
AE 315	X				X	1
EM 330		X				2
Mat'l/Stru elective		X				1
AE 341	X					
AE 342	X					1
AE 442	X					
AE 351				X		1
AE 352				X		1
AE 361			X			1
AE 471					X	1
AE 481	X	X	X	X		3
AE 482	X	X	X	X	X	3
AE 483	X	X	X		X	3

Table 19 DFAN Course Correspondence to ABET EC 2000 Criterion 3 a-k Outcomes

	ABET EC 2000 Criterion 3 a-k Outcomes										
Course	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k) X
Engr 310	X		X	X	X	X	X	X		X	X
AE 315	X	X	X		X	X	X	X		X	X
EM 330	X	X	X		X		X				X
Mat'l & Stru Ele	X	X	X		X		X				X
AE 341	X				X		X			X	X
AE 342	X				X		X			X	X
AE442	X				X		X				X
AE 351	X		X		X		X			X	X
AE 352	X				X		X				X
AE 361	X				X		X			X	X
AE 471	X	X			X	X	X			X	X
AE 481	X		X	X	X	X	X	X	X	X	X
AE 482	X	X	X	X	X	X	X	X	X	X	X
AE 483	X	X	X	X	X	X	X	X		X	X

Table 20 DFAN Course Correspondence to Institutional (DF) Educational Outcomes

	Institutional (DF) Educational Outcomes						
Courses	Integrated knowledge	Intellectual Curiosity	Communication	Problem Solver	Teamwork	Independent Learner	Military Professional
Engr 310	X		X		X		X
AE 315	X	X	X		X	X	X
EM 330	X		X				X
Mat'l & Stru Ele	X	X	X			X	X
AE 341	X		X				X
AE 342	X	X	X				X
AE 442	X		X				X
AE 351	X		X				X
AE 352	X		X				X
AE 361	X	X	X	X			X
AE 471	X	X	X	X	X	X	X
AE 481	X	X	X	X	X	X	X
AE 482	X	X	X	X	X	X	X
AE 483	X	X	X	X	X	X	X

4.2 DFAN Program Threads: An Initiative

Recently, DFAN created a program to administer separate Academic Threads that provide knowledge and skills across the curriculum for three program elements: communication skills, design-skills, and modern engineering tools. These program elements are called Academic Threads because the knowledge and skills of each element are woven through the curriculum in way that reinforces past developments while incrementally introducing new ones.

DFAN believes that creating these academic threads offers the opportunity to resolve the cadet weaknesses as identified in assessment data, as well as an opportunity to avoid confusion to the cadets for these particular skills developments. The concept entails a unified approach across the program so cadets see consistencies in formats, computational tools, and grading criteria.

The Academic Threads are a relatively new pedagogical activity of the aeronautical engineering program. The three threads currently in development were chosen because of their fundamental importance to both the aeronautical engineering profession and Air Force Officer careers. Moreover, the Aeronautics Department views the Academic Thread approach as a more coherent and effective approach to implementing specific aspects of the aeronautical engineering program. In past years, skills and tools were passed from one course to another via course prerequisites and linkages (CD-Debrief: Appendix I., Table D13 a-g) with less regard as to how the individual experiences fit into an overall educational development of the cadets. Academic Threads formalize the process and provide a clear definition for the program location where each cadet is exposed to each skill and how skill development progresses from that point.

4.2.1. Communications Thread - The educational objective of the Communications Thread is: Graduates will use professional writing and speaking skills necessary to communicate effectively.

The Aeronautics Department understands that the process of developing effective communicators involves consistent and continuous development across the curriculum. When implemented in the fall 2002 semester, the process begins with different courses introducing separate elements of technical professional communication.

In practice, cadets will produce and maintain a portfolio of their own separate communication products as they progress through the curriculum. Then in the laboratory experimentation course (Aero Engr 471), and again in the senior design course (Aero Engr 481) and the major design courses (Aero Engr 482, Aero Engr 483), the cadets will use their portfolios to create and present complete technical reports, and technical oral presentations.

The Communication Thread matrix in Appendix I., Table E.2 shows the implementation plan. Each component of a technical report, for example, is identified in the left column, and the DFAN courses are listed across the top row. The chart is color coded: Red signifies where a communications component is introduced to the cadets in a particular course. Blue signifies where a communications component is repeated. Green identifies the final "teaching" experience. Yellow shows the location for component integration into a complete technical document or presentation.

4.2.2 Design Thread - The educational objective of the Design Thread is: Graduates will use the engineering design process to solve problems and, as applicable, to produce engineering designs.

Design inherently involves framing and resolving ill-defined problems, problems that have no single "correct" answer, but require resolution from several considerations. Much of the present-day cadets' educational background upon entering the Aeronautical Engineering program is structured such that these cadets are accustomed to finding the single correct answer to each problem. The design thread begins the intellectual transformation in the cadets' development of becoming an effective problem solver using the engineering design process.

In practice, the Design Thread entails motivational design experiences in different courses, the complexity of which increases with each new exposure to the process. Cadets learn as they are challenged repeatedly to apply theory to practical solutions. Starting in August 2002, these experiences begin in a new freshman core course, Engr 100, Introduction to Engineering. Every freshman cadet will take Engr 100, half the class in the fall semester, the second half in the spring semester. Engr 100 will introduce the engineering design process and give cadets opportunities to develop their analysis skills as they develop designs for a variety of problems, one being the construction of a small rocket-boosted glider aircraft. For cadets in the aeronautical engineering program, Engr 100 is the start upon which other courses in the curriculum will build and broaden design skills. Appendix I., Table E.3 shows the Design Thread matrix in a format similar to that used for the Communications Thread matrix. The culmination of the design skills developments is the two course senior design sequence, Aero Engr 481 and either of Aero Engr 482 or Aero Engr 483.

4.2.3 Modern Tools Thread - The educational objective of the Modern Tools Thread is: Graduates will use modern tools routinely in their work. Of the many tools available, DFAN focuses on three: (1) Spreadsheets (Excel). (2) Structured programming (MATLAB). (3) Applications packages. Specialized programming occurs for cadets choosing to emphasize computational fluid dynamics applications. For all others, learning to use the modern tools stated above is believed by DFAN to be satisfactory preparation for practice in the Air Force. Appendix I., Table E.4 presents the Modern Tools matrix that shows where each fundamental tool is introduced and developed in the curriculum. The same color code as used for the other threads is also applicable for the Modern Tools Thread.

4.3 Technical Core Course Prerequisites

The Academic Core provides cadets specializing in the aeronautical engineering program, the core knowledge program provides courses in calculus, statistics, computer science, physics, electrical engineering, civil engineering, chemistry, mechanics, aeronautics, energy systems, astronautics, and engineering systems design. Descriptions for the core courses providing technical prerequisite knowledge and skills for the Aeronautical Engineering program, as illustrated in Figure 17, are presented in Appendix I., Table F.1, and in the USAFA Curriculum Handbook. The courses denoted with "Aero Engr Major" arrows define prerequisite knowledge that each cadet entering the aeronautical engineering program is expected to have. The Gateway examination assesses this expectation.

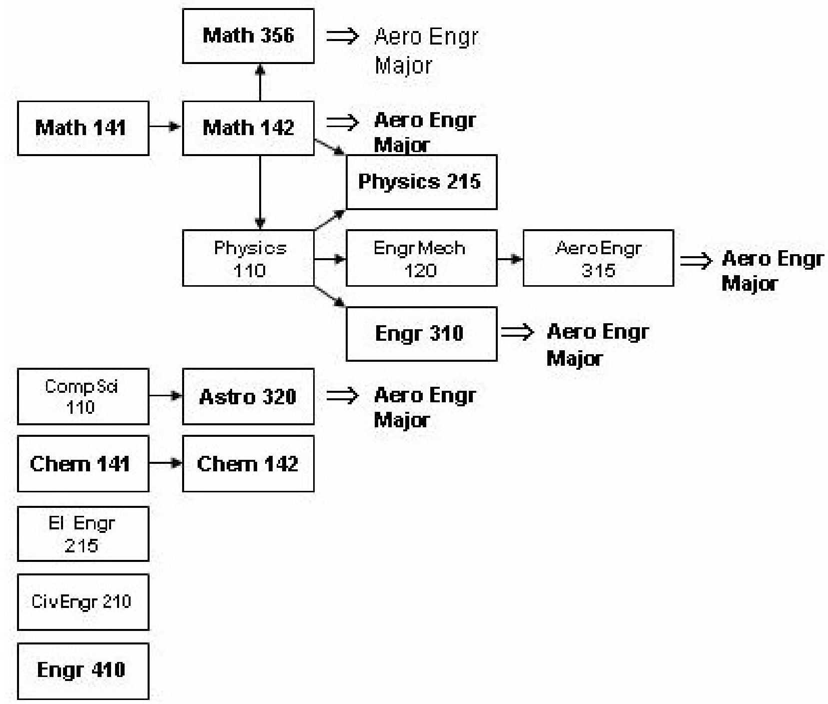


Figure 18 Technical Core Course Prerequisites for Aeronautical Engineering

With the exception of chemistry, electrical engineering, civil engineering, the second physics course, and Engineering Systems Design, the other technical courses in the Academic Core are required prerequisites for the Aeronautical Engineering program.

4.3.1 Gateway Examination - The Gateway Examination (GE) focuses on the fundamental concepts from courses covering calculus, statics, thermodynamics, and aeronautics. From these courses, specific topics that subsequent aeronautical engineering courses build upon were selected for testing in the GE. These topics include solving ordinary differential equations, 1^{st} and 2^{nd} Laws of Thermodynamics, and fundamentals principles in propulsion, aerodynamics, flight mechanics and structural mechanics. The GE is administered to the junior ranked cadets during the annual DFAN Dash-1, one – two days prior to the start of their 5th semester. The GE is now web-based so cadets get immediate feedback on their academic strengths and weaknesses according to their answers. A minimum score of 70% is passing. Cadets with scores below 70 % are enrolled in a remediation program tailored to strengthening the weaknesses identified by the GE. The cadet's academic advisor is involved in the process to ensure that the remediation is completed so that such cadets will be better prepared for the curriculum.

The GE was administered for the first time in the fall of 2000 as a written in-class examination and then again in 2001 as a web-based exercise. The cadet comments regarding the web-based version have been positive. They liked knowing the knowledge and skills they are expected to have upon entering the program as well as knowing particular strengths and areas they needed to improve. They also liked the immediate feedback they received upon completing the GE. Many cadets were excited to learn that they could retake the GE at their convenience from their dorm rooms, and thereby further evaluate their progress towards understanding key foundational engineering concepts.

The GE is administered at the end of the summer session at USAFA. Many cadets felt that they had forgotten key concepts and that they were not in a proper mindset to take an examination before classes begin. Also, some cadets felt that a poor performance on the GE had little bearing on their future performance in the Aeronautical Engineering program. To help mitigate these attitudes, bonus points to be applied in AE 341 and AE 351, two courses in the 5th semester, were awarded on the basis of subjectively determined "cadet-effort," not on performance. Even though the number of bonus points was small, the concept of earning an award seems to have motivated most cadets to do their best on the GE.

DFAN will continue to improve the GE. Used in conjunction with other cadet evaluations data such as the APS (Chapter 1, paragraph 1.4.1), DFAN class advisors have improved opportunities to help cadets succeed in the aeronautical engineering program. Furthermore, data from the GE will be used to help identify weaknesses in the curriculum of pre-requisite courses for the aeronautical engineering program. These data will be used to begin discussions with those departments administering the pre-requisite courses.

4.4 Major Design Experience

The aeronautical engineering program offers two tracks for the major engineering capstone design experience: (1) Aircraft Design, Aero Engr 482. (2) Aircraft Engine Design, Aero Engr 483. For the most part, cadets prepare for either track by completing the courses in the Design Thread, and Aero Engr 481, Introduction to Aircraft and Propulsion systems design. Cadets desiring the Aircraft Engine Design track must also complete Aero Engr 466, Propulsion II. Although these capstone design tracks are different, they are linked in the curriculum. The engine design course and one of the sections of the aircraft design course work on the same mission requirements to develop an integrated engine/airframe solution.

DFAN's strong ties with government agencies and industry is strength of the design experience in the aeronautical engineering. Organizations such as the Air Vehicles Directorate of the Air Force Research Laboratory, the Unmanned Air Vehicle (UAV) Battlelab, Boeing, and Honeywell Engines are actively involved in the problem definition phase, and often in the evaluation of the cadets' final designs. The guidance and feedback from practicing engineers enhances the educational experience for the cadets and the faculty because it transforms an academic exercise into a realistic design experience.

4.4.1 Preparations: The Design Thread - In Aero Engr 315, cadets learn the steps in the design method and the types of activities that occur in each of the design phases. They learn basic aerodynamic, performance, and stability and control analysis methods and apply them in two aircraft design projects. The first project is a simple subsonic strike fighter paper design, with the emphasis on performance prediction that meets design requirements. The second project involves designing, building, and flying a balsa wood glider. This project emphasizes stability and trim requirements for a successful aircraft design. Structural layout and manufacturability issues also permeate the design-build-fly project. These concepts are reinforced in the flight mechanics, stability and control course sequence, Aero Engr 351, Aircraft Performance and Static Stability, and Aero Engr 352, Aircraft Dynamic Stability and Control.

In Aero Engr 361, cadets learn several skills essential to aircraft engine design. Foremost among these is mission fuel burn analysis and basic preliminary engine cycle analysis to include on and off design analyses. Cadets also learn some essential skills for designing inlets and other engine integration requirements.

Aero Engr 481, Introduction to Aircraft and Propulsion Systems Design, is perhaps the cornerstone course on engineering design in the curriculum. Here, all the components of engineering design taught and practiced in "thread-Courses," plus the knowledge learned in all 300 level courses, and many of the 400-level courses culminate in Aero Engr 481. While Aero Engr 481 is the course that starts the process of "tying it all together," the course also introduces many important aspects not developed before. The many tasks involved in conceptual aircraft design include addressing customer requirements and constraints, customer focus (determining what the customer really wants and needs), defining and doing background research on the design problem, creating design concepts and modeling them on paper and computers, aerodynamic analysis, constraint analysis, mission fuel burn analysis, sizing, cost analysis, optimization, trade studies and sensitivity analysis, decision matrices and performance reporting. These items are all part of the Aero Engr 481 introductory "total" design experience. Cadets learn to perform these various analyses on paper as well as in computer spreadsheets and other specialized programs. They create a viable aircraft design and present it in a series of reports and briefings that culminate in a final design review that is evaluated by faculty and other experts from industry and government agencies.

4.4.2 The Aircraft Design Track - In Aero Engr 482, cadets are challenged to design, build and fly a prototype of an aircraft to meet the needs of an actual customer. In some cases the required aircraft is a supersonic military fighter or bomber. The cadets working on this design typically work in concert with cadets in Aero Engr 483, the engine design course, to develop an integrated airframe/propulsion conceptual design. The Aero Engr 482 cadets then are required to build and fly only a subscale concept demonstrator of their design, which is suitable for demonstrating acceptable low-speed aerodynamics and handling qualities.

In other sections of Aero Engr 482, cadets develop working full-scale prototypes of small unmanned aerial vehicles (UAV's) for a variety of military and non-military government agencies. These prototypes are typically used as demonstrators of capabilities, but in some cases may be selected for further development and operational use. In all cases, actually building and flying an aircraft they have designed and interacting with and getting feedback from real customers give cadets practical design experience directly applicable to their engineering careers. The process also immerses cadets in considerations for costs, manufacturability, health and safety, and politics, all of which are part of corporate design experiences.

4.4.3 The Aircraft Engine Design Track - As mentioned above, cadets choosing the Aircraft Engine Design track must complete Aero Engr 466 prior to starting Aero Engr 483; usually the cadets take Aero Engr 466 and Aero Engr 481 concurrently in the fall semester. These requirements prepare the cadets with the foundational tools needed to complete a paper design of a low bypass ratio, afterburning, turbofan engine and all its major components.
Experimental studies provide cadets understanding on engine performance issues. In ENGR 310, cadets collect temperature, pressure, and thrust data from the Continental J-69 turbojet engine, and use these data to calculate the compressor pressure ratio, compressor and turbine efficiencies, fuel flow rate, and thrust based on the 1st and 2nd Laws of Thermodynamics and momentum equation. In Aero Engr 361, cadets examine the effects of off-design performance of the Garrett F109, a medium bypass ratio turbofan engine. They use measured pressures and temperatures near the fan face to construct a fan operating line. Fuel flow rate and thrust measurements enable them to construct a throttle hook which describes the engine's performance at a reduced throttle setting. These two plots help the cadets to solidify the thermodynamics concepts of engine cycle analysis. In addition to the laboratory exercises, scaled drawings of Pratt and Whitney's F100 and F119 engines and engine cut-aways of Pratt and Whitney's F100 turbofan, General Electric's J85 turbojet, Continental's J-69 turbojet, Williams' F122 turbofan, and Garrett's F109 turbofan engines are used in all of the engine track courses to point out the different aspects of engine and engine component design. These tools provide a starting point for component designs that will take place in the capstone engine design course.

The cadets in the capstone engine design course are teamed with a concurrent capstone aircraft design section (Aero Engr 482). The two classes work together to ensure the selected engine meets range, thrust, and airframe integration requirements. At the end of the semester, the cadets and faculty involved in the engine design course travel to Honeywell engines in Phoenix, AZ, to give a 2-4 hour presentation of their engine design to a team of Honeywell's engine component designers. The remainder of the two day trip is spent listening to Honeywell design engineers and touring the manufacturing, assembly, and test areas of their plant.

4.5 Cadet Recognitions & Achievements in Design

Table 21 identifies cadet design projects that have been evaluated and rated by representatives from industry and government agencies as being special and among the best seen in undergraduate cadet work. In addition, comparisons of cadet designs with actual aircraft designed by professional engineers reveal remarkable similarities and confirm that cadets are making similar design decisions and achieving results almost identical to those of engineering professionals.

Table 21 Special Cadet Achievements for Aeronautical Engineering Design

Year	Agency	Description
1998	AF Research Labs, Air Vehicles Directorate	**UCAV Design -** the spring of 1998, the Air Force Research Laboratory Air Vehicles Directorate gave USAFA cadets a request for proposals (RFP) for an uninhabited combat aerial vehicle (UCAV) designed to deliver two large satellite-guided bombs over a mission radius similar to that of modern manned strike fighters. At the time, no one at USAFA knew that the mission and performance requirements given to us by AFRL were very similar to those used in developing the X-45 UCAV now in production. As they developed this design and sized it, cadets made many of the same design decisions as those designers of the X-45, including sizing of the wings, fuselage, and engine, placing the bombs in a large lifting-body fuselage in bays on either side of the engine inlet and bay, and eliminating vertical and horizontal tail control surfaces. The resulting cadet design was strikingly similar in size and configuration to X-45, although we only discovered this more than a year later when the X-45 was revealed to the public.
1999	Battle Labs	**UAV Predator Design -** In the spring of 1999, the UAV Battle Lab asked USAFA cadets to develop design modifications for the RQ-1A Predator reconnaissance UAV that would double or triple its maximum speed and altitude capabilities. The resulting cadet designs included turboprop and turbofan-powered aircraft with the desired performance, but which also incorporated several advanced technologies for specialized airfoils, de-icing systems, and drag-reduction strategies. When cadets briefed these results to the Predator program manager and his staff, many nodded their heads but said little else. In 2002, the turboprop Predator B was made public, revealing that the general Atomics engineers had made many of the same design changes as the cadets had suggested. Other design changes suggested by the cadets are now being considered by the Predator program office.
2000	Battle Labs	**Battle Field Application Design -** In the spring of 2000, the UAV Battle Lab gave USAFA cadets an RFP for a small UAV that could be carried in a soldier's back pack and deployed quickly and silently to provide infrared real-time airborne video of the area surrounding the soldier. The resulting cadet design was very close in size, weight, and configuration to the Dragon Eye UAV now being developed for the Marine Corps to provide the same capabilities. That UAV developed by professional engineers was revealed to the public later in 2000, after the cadets had developed their design. Once again, industry design work duplicated what the cadets had accomplished; validating the design tools and methods they had been taught.
2000	Draper Labs, MIT	**WASP Design –** Confidence by some civilian agencies in the design analysis methodologies taught at USAFA are so great that in 2000, Draper Labs at MIT asked some cadets and one instructor at USAFA to perform a design analysis of the Wide-Area Surveillance Projectile (WASP) gun-delivered surveillance UAV. The resulting study validated the majority of design decisions made by the WASP design team and identified some areas for possible improvement. This work so impressed the WASP team that one of the cadets was selected for a Draper Fellowship to allow them to work after graduation at Draper on development of other small UAV's.
2001	45th Space Wing, Patrick AFB, FL	**Range Safety UAV Design -** In the spring of 2001, the 45th Space Wing at Patrick AFB in Florida asked USAFA cadets to develop a small UAV for range safety and resources monitoring duties on the Cape Canaveral missile range complex. A flying prototype was developed that year and demonstrated at the runway used by the Space Shuttle for landing near the Kennedy Space Center. Several design changes were mandated, and an improved version of the aircraft is being developed in 2002 and fitted with an autopilot provided by the customer. If successful, this UAV may be the first cadet aircraft design to go into limited production.

4.6 Summary

The breadth and depth of the academic education cadets receive at USAFA is renowned thought the Air Force, and the nation in general. The USAFA core is well designed and does provide the general education cadets need to compliment their studies and pursuits in aeronautical engineering.

DFAN believes that the engineering design experiences in the curriculum are the major program strength. The capabilities of the DFAN faculty who lead the design courses combined with the strong associations DFAN has with the engineering community at large collectively produce an outstanding senior design program. Testimony from many external agencies attests to this opinion.

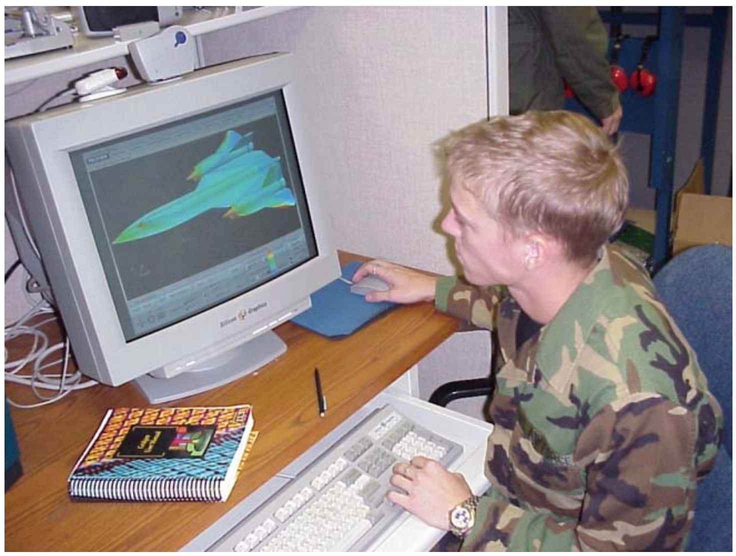


Figure 19 Cadet Steve Young, Class of 2002: CFD Investigation on SR 71 Aircraft

Chapter 5. Faculty

5.0 ABET Criterion 5.

The faculty is the heart of any educational program. The faculty must be of sufficient number; and must have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of cadet-faculty interaction, cadet advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of Cadets. The faculty must have sufficient qualifications and must ensure the proper guidance of the program and its evaluation and development. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and registration as Professional Engineers.

DFAN Program: DFAN is fortunate to have an outstanding faculty and equally outstanding compliment of support personnel. Currently, Department staffing is satisfactory.

Compared to a typical faculty composition at a civilian university, the DFAN faculty, like other USAFA departments, is unique for several reasons. First, the mixture of military and civilian people provides strengths that would not exist otherwise. The military faculty members are vital role-models essential for the professional development of cadets, whereas the civilian faculty expose the cadets to learning how the Air Force maintains professional effectiveness in mixed military-civilian organizations. Second, the military faculty often provides Air Force operational understanding on the technological applications of the "theory," whereas the civilian faculty provides depth on academic inquiry and understanding. Third, a portion of the military faculty is transient, the annual turn-over rate being 10 – 15 % in DFAN, so the Department faculty is consistently energized with new faculty talent. The civilian faculty is essential stability and provides continuity in the disciplines of the curriculum.

DFAN views the military faculty turn-over as a program strength, one that helps the Department attain the objectives pertinent to cadets developing into highly effective entry level Air Force officers. Many of the military officers joining the DFAN faculty are graduates of the Academy, often graduates of the aeronautical engineering program who are returning to USAFA as AF captains with 4 or more years of field experience. The association and operational experiences these young faculty members bring to the program are valued elements in the overall high performance and effectiveness of the Department, evidence of which is seen in the results of annual Institutional Surveys (paragraph 3.5.5).

DFAN recognizes that new faculty members need training as they "take-on" the responsibility of becoming a professional educator at USAFA. In conjunction with institutional programs, DFAN maintains an effective faculty training program (paragraph 5.2). DFAN is pleased that it has a documented history of acquiring outstanding officers from the operational units, many of whom have been sponsored by DFAN to earn PhD degrees at numerous universities. Table 23 shows a short list of most recent DFAN sponsored military faculty PhD's.

Department Manning issues are discussed in paragraph 5.1, Faculty Visitors are discussed in paragraph 5.2, Faculty training is explained in paragraph 5.3, and faculty professional development is discussed in paragraph 5.4.

5.1 Manning

5.1.1 Faculty - The DFAN faculty is comprised of 19 military faculty, 5 fulltime civilian faculty, 1 part-time civilian professor, 1 distinguished visiting professor, and 1 adjunct military instructor. Appendix I., Tables A.3 and A.4 identify the faculty members and present details on qualifications and workload distributions. In Table 22, DFAN faculty members are grouped according to expertise with respect to the DFAN academic disciplines. Each discipline is led by a discipline director, a faculty member with seniority and professional continuity in the discipline. Several faculty members have expertise pertaining to more than one discipline, and they are listed accordingly.

Table 22 DFAN Faculty Composition by Discipline

Aerodynamics Bertin – Discipline Director, PhD Blake – PhD Forsythe – PhD Jefferies - PhD Pluntze – PhD Morand – MS Boede – MS Rose – MS	**Experimental Investigations** Byerley – Discipline Director, PhD Albertson - PhD Blake – PhD Cummings - PhD Forsythe – PhD Morton- PhD Scully – PhD
Propulsion Boyer – Discipline Director, PhD Barlow – PhD Byerley - PhD Nowlin – MS Krueger – MS Sever – MS	**Aircraft Design and Aircraft Engine Design** Brandt – Discipline Director, PhD Mitchell - PhD Morton – PhD Cummings – PhD
Flight Mechanics, Stability and Control Yechout – Discipline Director, PhD Bossert – PhD Kraus – MS McDaniel – MS Sansone - MS Wolf – MS	**Aerospace Materials and Structures** Morton – Discipline Director, PhD Brandt – PhD
Thermal-Fluid Sciences Havener - Discipline Director, PhD Barlow – PhD, Boyer – PhD, Jefferies – PhD, Thompson – MS	

Table 23 DFAN Sponsored Faculty PhD's

Name	Years	University	Field
Barlow	1991-1994	Arizona State University	Propulsion & Heat Transfer
Haven	1994 - 1996	Univ of Washington	Propulsion
Bossert	1994 – 1996	Univ of Washington	Aircraft Flight Mechanics
Pluntze	1995 - 1997	Univ of Washington	Aerodynamics
Wells	2000 - 2002	Univ of CA-Davis	Aircraft Flight Mechanics
Tucker	2001 – 2002	AFIT	Propulsion
Wisniewski	2001 – 2003	Univ of New Mexico	Thermodynamics

5.1.2 Faculty Manning Model - The faculty manning model is based on a three-year "moving average" with a one year lag factor. For example, data for the academic years 1997-1998, 1998-1999, and 1999 – 2000 are used to define the Department's faculty needs for the 2001-2002 academic year; academic year 2000 – 2001 is the one year lag factor in this example. The factors included for each year in the model are, the number of cadets per class in the program, the number of cadets in the cores courses taught by the Department, number of pilot-officers in the program(for every 4 pilots, the Department gets one additional faculty slot because the pilot officers will spend approximately 25 % of their time working in the Academy's flying program), a 10% research factor (10 fulltime faculty = 1 additional faculty slot), and a 4% administrative factor (25 faculty members = 1 additional faculty slot). Based on these factors, DFAN was 100% manned last year.

In academic year 2002 – 2003, the Department will be short 3 professors due to an Air Force wide shortage of engineering officers. Adjunct civilian hires are being pursued as a short term solution to this manning shortage. DFAN expresses this condition as a Concern in Chapter 7, paragraph 7.2.2.

5.1.3 Support Personnel - The DFAN support staff consists of 1 dedicated laboratory engineer, 5 facility managers, 2 machinists, 1 financial manager, and 2 administrative assistants. Together they insure that 6 wind tunnels, 4 engine test cells, 4 design classrooms, water tunnel, flight simulators, computational equipment are all in operating order with up-to-date hardware, and data acquisition systems.

DFAN also has 6 full-time civilian researchers who support the faculty by acting as research sponsors for various cadet research projects in both the Aero Engr 471 Aeronautics Laboratory course and Aero Engr 499 Independent Study Course.

5.2 Visitors

DFAN maintains a visiting professor program, a position for a visiting French faculty member from the Ecole de l'air, adjuct and part-time positions, and visiting research positions. DFAN views these visitor-opportunities as vital to the performance and effectiveness of the program. In addition to the teaching assistance provided, visitors bring experience, new ideas on pedagogy, and opportunities for research that would otherwise not happen. Table 24 shows the DFAN's Visiting Professors, Scholars and Researchers for the past six years.

Table 24 DFAN Visiting Professors, Scholars, Researchers: 1996 - 2002

Academic Year	Name	Position	Organization	Specialization
2001 - 2002	Dr Russ Cummings	Visiting Professor	Cal Poly Tech, San Luis Obispo, CA	Aerodynamics Computational Fluid Mechanics
	Lt Col Kelly Cohen, PhD	Visiting Researcher	Isreal	Neural Networks
	Dr Robert Van Dyken	Rotating Researcher	NIA	Aeronautics
2000 – 2001	Dr Eric Jumper	Distinguished Visiting Professor	University of Notre Dame	Propulsion, Aero-Optics
	Lt Col Sukchol Yoon, PhD	Visiting Professor	National University of Seoul, Korea	Mechanics & Structures
	Maj Christophe Morand, MS	Foreign Exchange Professor	Ecole de l'air France	Aeronautics: "provides instruction on aeronautics in French to cadets majoring in French"
1997 - 2000	Dr Yair Guy	Visiting Researcher	Isreal	
	Dr Robert Van Dyken	Visiting Scholar	Naval Surface Weapons Center, China Lake, CA	Aeronautics
	Maj Dominique Colin, MS	Foreign Exchange Professor	Ecole de l'air France	Aeronautics: "provides instruction on aeronautics in French to cadets majoring in French"
1996 – 1997	Dr James Baughn	Visiting Professor	University of California, Davis, CA	Aerodynamics Thermal Sciences
	Lt Col Gilbert Mahe, MS	Foreign Exchanges Professor	Ecole de l'air France	Aeronautics: "provides instruction on aeronautics in French to cadets majoring in French"
	Dr Alois Kreins	Visiting Scholar	DFLR Köln, Germany	Aerodynamics Experimentation

5.2.1 Visiting Professor Program – The visiting professor program is designed to bring in faculty from other universities who can contribute to our curriculum within specific disciplines. For instance, visiting professors have helped to develop Aero Engr 456, DFAN's flight test technique course, and the courses offered in heat transfer, advanced aerodynamics, propulsion, and aircraft design.

5.2.2 Faculty Visitor from Ecole de l'air - Major Christophe Morand is currently the French faculty instructor visiting DFAN. The normal visitation time is 2 years with an optional one year extension. An important contribution provided by French faculty visitors is the opportunity to provide instruction in French to cadets specializing in the French language on the fundamentals of aeronautics. The course is a special version of DFAN's core course, Aero Engr 315. A separate course notebook is maintained for this version of the course, Aero Engr 315Z. Major Morand has built a complete web-based version of this course, all in French.

5.2.3 Visiting Researchers - The visiting researchers, though not formally part of the faculty, contribute immensely to the computational and experimental research areas of the curriculum. The researchers work closely with one to three cadets on "real-world" research projects such as drag reduction on the Air Force's Predator Unmanned Aerial Vehicle (UAV), active flow control of delta wing configurations, boundary layer studies of low pressure turbine airfoils, advanced UAV concepts, etc.

5.2.4 Adjunct Faculty - DFAN currently has four adjunct (part time) faculty. Each person teaches one section of a course containing 10 – 30 cadets. Table 25 shows the contributions of each person over the past academic year.

Table 25 Adjunct Faculty: Academic Year 2001 - 2002

Name	Academic Rank	Primary Affiliation	Degree	Course Taught
Aaron Byerley	Professor	DFAN Director of Research	PhD	Engr 310 Aero Engr 483
Lt Col Chris Seaver	Instructor	34 TRW/SEF	MS	Engr 310
Maj John Bode	Instructor	34 TRG/CG3D	MS	Aero Engr 315
Maj Ben Thielhorn	Instructor	34 TRS/DOOA	MS	Aero Engr 315

5.3 Faculty Training Program

The Air Force Academy realizes the high turn-over rate of faculty requires a well defined training program that transforms new faculty personnel into professional academic instructors with effective classroom teaching skills. DFAN's faculty turn-over rate is nominally three to four military faculty per year, or approximately 15% of the Department faculty. The several instructor training programs listed below help all new faculty develop into quality instructors devoted to teaching; this faculty personnel standard is a national recognized USAFA hallmark. For DFAN, faculty training occurs on two levels: institutional and departmental.

The Air Force Academy places a premium on high quality instruction and has a rigorous faculty training program in place to help ensure development and use of professional, effective classroom teaching skills by all instructors. Moreover, the high turn-over rate of faculty (10-15% annually) necessitates a well defined training program. The

Aeronautics Department supplements this training with internal training approaches that have proven effective within the Department throughout the years. The several instructor training programs presented below – both institutional and departmental – help all faculty (new and experienced) develop and improve in teaching. DFAN believes the emphasis placed on premium teaching, backed by significant training, is a unique element in the program, and certainly one of factors that contribute to the effectiveness and high performance of the Department. Without exception, all DFAN faculty members value the teaching experience and personal growth they obtain while serving in the program.

5.3.1 Institutional Faculty Training

5.3.1.1 CEE Orientation Training - The Center for Educational Excellence (CEE), an agency under the Dean of the Faculty, conducts a 5-day workshop to orient new and returning instructors to the USAFA teaching environment. The workshop is comprised of five 4-hour sessions: (1) Expectations. (2) USAFA Uniqueness. (3) Getting to Know USAFA. (4) The Educator. (5) The Cadet. The workshop acquaints new faculty with some foundational principles in higher education and introduces them to the unique environment and cadet-life at USAFA. New faculty cadet demographics, interrelationship between the USAFA mission elements (academics, military training, athletics, and character development), the institutional educational outcomes, character development outcomes, standards of conduct and military decorum, faculty and cadet support agencies, how to motivate Cadets to learn, and how to effectively teach to an audience possessing different learning styles are topics discussed in the workshop. A workshop folder from a current offering will be available for review during the ABET visit.

5.3.1.2 CEE Instructional Seminars - The Orientation Workshop is followed by a series of one hour seminars conducted by CEE during the academic year. New faculty members are required to attend a minimum of two seminars per semester. All faculty members are encouraged to participate in and support the seminars. Several DFAN faculty members have shared teaching strategies and classroom experience with USAFA faculty by conducting seminars in this series. The seminars conducted for academic year 2001 – 2002 are listed below in Table 25.

5.3.1.3 The *Academy Educator* – Three times a years CEE publishes the *Academy Educator*, a pamphlet on education. Each issue focuses on a particular aspect of undergraduate education with an emphasis on procedures that other USAFA faculty members have found successful in their respective classrooms. The pamphlet also publishes pedagogical information on successes practices in other institutions. These pamphlets are posted electronically on the Academy's intranet as well as widely distributed to faculty in hard copy.

Table 26 CEE Instructional Seminars for 2001 - 2002

Fall Semester 2001	Spring Semester 2002
CAS Codes, Form 10s, MPAs, and Comment Cards: The Job's Not Complete Until the Paperwork is Done!	Welcome by the Dean of the Faculty: a Continuation of Winter Faculty Orientation
Research and Funding Opportunities at USAFA	Teaching Techies: Capstone Design Projects
Writing Better Test Items	Research and Funding Opportunities at USAFA
Preparing a Portfolio for Professional Growth and Promotion	Classroom Assessment Toolbox III
Using Course Portfolios for Continuity and Inquiry-based Teaching	Preparing a Portfolio for Professional Growth and Promotion
How's My Teaching	How's My Teaching?
The Fundamentals of Responsible, Responsive Group Work	Over-teaching II: "What Drives the Over-teaching Machine?"
Where Do I Start?: Ten Tips for Evaluating Writing	What About Service Learning?
Classroom Assessment Toolbox II	Great Teaching Tips II
More on Active Learning: Games and Group work	Who's to Say?': Moral Relativism in the Classroom
Program Assessment Toolbox III	Program Assessment Toolbox III
Great Teaching Seminar: Great Teaching Tips	The Art of Course Directing I The Course Director as Educational Leader, the Basics
	The Art of Course Directing II The Mechanics of Course Directing
	The Art of Course Directing III The Course Director as Mentor

5.3.2 Department Faculty Training – DFAN has three instructor training practices that supplement the Institutional training program: (1) New Instructor Training. (2) DFAN Course Auditing Program. (3) Faculty Mentoring.

5.3.2.1 New Instructor Training - DFAN training for new instructors runs nominally three weeks; part of this time overlaps the CEE Orientation Week. In addition to learning about the DFAN operating procedures, policies, research opportunities, and classroom teaching tips, new instructors spend time preparing for and presenting four 50-minute teaching sessions based on 4 lessons in the course they are assigned to teach their first semester. These practice-teach sessions are critiqued by veteran DFAN instructors. The first two sessions ease the instructor into a classroom setting by having them work through a problem on the board. Veteran faculty-role-play cadets in the classroom by asking questions that are typical of cadet questions, and by behaving in a manner similar to cadets in real class sessions. In this manner, new instructors are effectively exposed to scenarios likely to occur in an actual classroom. In the final two sessions, the instructor prepares full-length lessons. All practice sessions are critiqued by the veteran faculty.

5.3.2.2 DFAN Course Auditing Program - DFAN uses a supervisor audit program to provide feedback to all instructors. Each DFAN supervisor is required to audit their subordinates at least one lesson per semester. This supervisor audit is completed with a feedback interview, typically performed immediately after the classroom audit.

New instructors are audit an experienced instructor teaching the same course, lesson by lesson, assigned to them. In this audit format, new instructors see how the material they will be covering is presented by a more experienced faculty member. Veteran instructors teaching a new subject will also audit a current instructor of that course. The DFAN audit program is very effective and supported by all DFAN faculty. New instructors will often audit more that one instructor over the course of the semester to learn from teaching styles and classroom strategies of their peers.

5.3.2.3 Faculty Mentoring - New instructors typically spend their first year teaching Aero Engr 315, Fundamentals of Aerodynamics, in one semester, and Engr 310 in the other semester. These core courses each have nominally 17 sections per semester with about seven instructors per course, all teaching the same material at approximately the same pace. Their activities are coordinated by a course director. The course director and other faculty teaching the same course spend considerable time with new faculty so they become comfortable with the material before they teach it. Likewise, new instructors spend many hours preparing their lessons, some even practice teach in an empty classroom prior to presenting the material in their real classroom. New instructors are also assigned to a discipline where the respective Discipline Director prepares them to teach an upper division course in the discipline. This progression from teaching introductory courses to teaching upper division courses takes about two years.

5.4 Professional Development

Department faculty professional development takes many forms: participation in technical and educational conferences, participation in short courses and home study courses, working on-site with government and international research laboratories, participation on professional society technical committees, etc. Many times, funds for these activities are provided by sponsoring agencies. Additionally, DFAN allocates sufficient funds to enable one professional development activity per faculty member every year. The instructional seminars listed in Table 26 are also available to all faculty throughout each semester.

All 19 academic departments are located in Fairchild Hall (some nearby in temporary locations while the building is being renovated), so opportunity to develop collegial associations with faculty and cadets in other discipline is very high. Often, DFAN faculty teach courses in other departments, and often faculty members audit courses outside the aeronautical engineering program thereby further advancing personal knowledge and teaching skills.

5.4.1 Professional Society Involvement - All department faculty members are encouraged to participate in professional societies relating to their particular engineering discipline or education in general. Table 27 shows membership as well as leadership positions of the faculty in various professional societies.

Table 27 DFAN Faculty Leadership in Professional Societies

Professional Society	Number of Faculty Participating
AIAA membership	15: 2 Fellow, 2 Associate Fellow
AIAA leadership	3
AIAA Technical Committees	5
ASME membership	2
ASEE membership	2
SAE	1

5.5 DFAN Faculty Service

The Department of Aeronautics provides a service to DoD, NASA, and Air Force Academy organizations in a number of ways: teaching short courses, conducting research, and working with Academy cadets outside the classroom.

5.5.1 Air Force or Government Agency Interactions - Twice a year, faculty teach one-week courses in Subsonic Aerodynamics, Supersonic Aerodynamics, Propulsion, and Modeling and Simulation at the Air Force Test Pilot School at Edwards AFB, CA. Approximately every two years the Department holds a week-long Propulsion Workshop on-site at the Academy. On the order of 40 people from the Air Force and Navy attend the workshop. Throughout the year the Department is involved in research activity sponsored by AFOSR (Air Force Office of Scientific Research), Special Operations Command, Air Force Battlelabs. Additional details on DFAN faculty research are presented in Appendix I.,G. Recently DFAN started offering a workshop on fundamentals of air breathing propulsion to personnel at the Air Force Air Logistics Center at Tinker Air Force Base; DFAN intends to continue this support.

5.5.2 Service to USAFA – DFAN faculty support academic activities outside the Department as well as the other mission elements (military training and athletics) at the Academy through their participation as an Associate Air Officer Commanding for a 100-member cadet squadron, a Squadron Professional Ethics Advisor, an Officer Representative for an athletic team or club activity, a tutor on cadet trips, freshman academic advisors, etc. Table 28 shows the number of DFAN faculty involved in activities outside the department.

Table 28 DFAN Faculty Support to other USAFA Mission Elements

Activity	Number of DFAN Faculty
Associate Air Officer Commanding	8
Squadron Professional Ethics Advisor	5
Freshman Academic Advisors	8
Tutors	2
Athletic Team or Club Representatives	5
Honor Mentors	3
Military Commander Mentors	1

5.6 Faculty Advising

DFAN believe the faculty advising procedures in the Department are satisfactory. These procedures are discussed in detail in Chapter 1. Cadets generally believe the faculty advising of academic matters is generally good, but faculty advising of matters of career opportunities could be strengthened (Senior Survey and Grad Survey data, Chapter 3). DFAN will initiate faculty improvements in cadet-advising, and in fact, some have already been planned for the fall 2002 semester.

5.7 Summary

DFAN is fortunate to be staffed with outstanding faculty members devoted to educating cadets. Combined, the DFAN faculty represent all disciplines in the program with level of expertise know nationally. DFAN aggressively recruits new faculty annually to ensure that the competencies of departing faculty members are maintained by the competencies of new faculty. DFAN is pleased to have approximately 25 % of the faculty positions be occupied by civilians providing depth and continuity to the Department's scholarly abilities. Presently, DFAN's manning is satisfactory for meeting all Department Objectives (Chapter 2, paragraph 2.5), but the concern of manning mentioned above and presented in Chapter 7, paragraph 7.2.2, is a real issue yet to be resolved.

Figure 20 DFAN Cadets Win AIAA Region V Cadet Paper Competition, 2001

Chapter 6. Facilities

6.0 ABET Criterion 6.

Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-cadet interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for cadets to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of the cadets and faculty and the educational objectives of the institution.

DFAN Response

All academic programs at USAFA are supported with a variety of classroom types, lectinars, auditoriums, and laboratories. Additionally, DFAN maintains and uses special classrooms to provide instruction for the aerodynamic, fluid dynamic, propulsion, flight mechanics, and aircraft design courses. DFAN operates a machine shop devoted to making models and test apparatus used to support cadet independent research studies, as well as to maintain all test facilities in the Aeronautics Laboratory. The Academy maintains an extensive computer network providing intranet and internet service to the all personnel. Some details relevant to cadet usage are highlighted in paragraph 6.5.

Figure 21 USAFA Aeronautics Laboratory

The primary purpose of the Aeronautics Laboratory is to support the USAFA aeronautical engineering program. Paragraph 6.2 explains how the facilities in the Aeronautics Laboratory are used to attain the DFAN PCO's in specific courses.

Regarding DFAN research, two of the four Department Objectives are: 1. Conduct relevant high quality research. 2. Support agencies external to USAFA (Section B. Chapter 2. paragraph 2.4). Thus, in addition to maintaining facilities to support attaining PCO's, DFAN also operates a variety of research facilities that are used regularly by faculty and cadets to perform investigations on several contemporary Air Force mission related projects.
The facilities in the Aeronautics Laboratory have recently been presented in two technical papers, copies of which are included in Appendix I., G. These are:

1. BYERLEY, A., T. Scully, and J. Bertin. "An Undergraduate-Centered Research Program in Aeronautical Engineering." 40th Aerospace Sciences Meeting and Exhibit, AIAA 2002 -1047, January 2002.

2. HAVEN, B.A., A.R. Byerley, D.N. Barlow "An Undergraduate Gas Turbine Engine Program Enhanced by Design and Research Threads." To be presented at the 2002 International Gas Turbine Institute Congress, Amsterdam, Netherlands, June 2002.

6.1 Classrooms

USAFA classrooms are equipped with both overhead-projection systems and blackboards (or whiteboards). Class instruction can be enhanced with multimedia presentations to include photographs and video clips, television broadcasts or movies. In the Aeronautics Laboratory, the aircraft design and aircraft engine design classroom (Figure 22a) has desktop computers allowing cadets to use design analysis and presentation software while in class. The computers are connected to the internet and to network printers. The design classroom also has a library of reference books on the engineering design process, and a broad range of scale model aircraft suspended from the ceiling provide cadets the opportunity to compare and contrast design features of existing aircraft with decisions they make for their project designs.

Figure 22a Aero Engr Design Classroom

Figure 22b Cadet Shop for Project Design

Figure 22b shows a portion of the cadet shop that is used by cadets to fabricate prototypes of their design projects. The shop is moderately equipped with power and hand tools. Intricate and precision parts are made by DFAN staff in the DFAN Machine Shop (Figure 33a).

Figure 23a shows the laboratory room where cadets in Aero Engr 471 learn to use thermocouples, pressure transducers, strain gages, and other bench-top type instrumentation.

Figure 23a Aero Engr 471 Instrumentation Classroom

Figure 23b Lectinar Classroom (seats 75 cadets)

Figure 23b shows one of the Lectinar rooms used for relatively large class sessions. The Lectinars are supported completely by the USAFAnet, and are equipped with one gun digital projectors. Lectinars are also used for cadet club functions, special assemblies, faculty seminars, and USAFA short courses.

6.2 Laboratory Facilities Supporting the DFAN Program

Fundamentally, the entire Aeronautics Laboratory is maintained by USAFA to support all cadet educational activity. In the recent decade however, the development of externally funded research has grown, and some of the test apparatus is now used for research projects (cadets are strongly involved in the research projects) in addition to supporting classroom instruction. Table 29 lists the DFAN facilities directly supporting course outcomes, which

Table 29 Laboratory Facilities Supporting DFAN Program

Discipline	Facilities	DFAN Courses	PCO's
Aerodynamics	1. Low Speed Wind Tunnel 2. CFD Computer Facility	Aero Engr 315 Aero Engr 341 Aero Engr 342 Aero Engr 442 Aero Engr 447	PCO-1 PCO-2
Flight Mechanics, Stability and Control	1. Flight Simulator	Aero Engr 351 Aero Engr 352 Aero Engr 456 Aero Engr 457	PCO-1
Propulsion	1. Continental J-69 Turbojet Engine Facility 2. Garret F109 Turbofan Engine facility 3. Small Scale Rocket Test Cell	Aero Engr 310 Aero Engr 361	PCO-1
Experimental Investigations	1. Subsonic Wind Tunnel 2. Instrumentation Lab 3. All Facilities: Project Dependent	Aero 471 Aero Engr 499	PCO-1 PCO-2 PCO-4
Aircraft & Aircraft Engine Design	Design Classroom Cadet Design Project Shop	Aero Engr 481 Aero Engr 482/483	All 6 DFAN-PCO's

in turn support the PCO's. Table 30 shows the facilities that are currently being used for faculty-cadet research investigations.

Regarding the PCO's, the facilities primarily support attainment of fundamental knowledge, experimental investigations, design, teamwork, and independent learning. DFAN's investigative specializations have historically been aerodynamic testing and propulsion testing. Recently, DFAN faculty members developed the ability to perform CFD investigations, which now compliment the other studies performed in the Laboratory. Note that the design classroom and the cadet design project shop support all 6 DFAN PCO's.

Table 30 USAFA Aeronautics Laboratory Facilities

Facility	Type	Test Section	Maximum Speed	Figure	Research
Subsonic Wind Tunnel	Closed-loop	1m x 1m	Mach 0.63	24a	NASA X38, UAV, C-130 Gunship
Trisonic Wind Tunnel	Blow-down	0.3m x 0.3m	Mach 4.38	24b	Aerodynamic maneuvering missile shapes, CFD Comparisons
3 ft Low Speed Wind Tunnels (2)	Open-loop	1m x 1m	Mach 0.09	25a	Unsteady Aero, BL Flow Control
Cascade Wind Tunnel	Closed-loop	turbine blades	Mach 0.20	25b	Turbine Blade Cooling, BL Separation
Water Tunnel	Closed-loop	.3m x .4m	0.5 m/sec	26a	CFD Comparisons
Small Low Speed Wind Tunnels (3)	Open-loop	0.3m x 0.3m	Mach 0.12	27	Unsteady Aero, BL flow control
Propulsion Engine Test Cells	F109	Turbofan Engine		30b	Air Bearings, High Cycle Fatigue
CFD Complex	Beowulf Linux Parallel Computer			28a, 28b	Aircraft Flow Field Simulations

6.2.1 Aerodynamic Discipline - The Trisonic Wind Tunnel (Figure 24a) supports Aero Engr 471 by introducing cadets to flow visualizations of compressible aerodynamics. This facility

Figure 24a Trisoninc Wind Tunnel

Figure 24b Subsonic Wind Tunnel

also supports many cadet projects for Aero Engr 471 as well as many cadet Aero Engr 499 Independent Research Investigations. Specific Mach numbers are established in this facility using interchangeable, fixed 2D nozzle blocks.

The 3 x 3 foot subsonic wind tunnel (Figure 24a) support course work for Aero Engr 471 where cadets learn to use strain gages and a force balance to measure aerodynamic lift, drag, and pitching moments, as well as to gather data for measurement uncertainty analysis.

The 3 foot low speed wind tunnel (Figure 25a) primarily supports aerodynamic research on active boundary layer flow control. Cadets are involved in this work through the Aero Engr 499 Independent Research Investigations. Past investigations explored the effects of mass injection techniques. Current studies pertain to flutter mechanism, and to plasma flow control concepts. The cascade facility (Figure 25b) also involves cadets through the Aero Engr 499 course. Studies primarily pertain to the turbine and compressor blade research for both boundary layer flow control, and for effective cooling processes for turbine blades.

Figure 25a 3x 3 ft Low Speed Wind Tunnel

Figure 25b Cascade Tunnel (Turning Vane Studies)

The water tunnel (Figure 26a) provides colorful flow visualizations of fundamental flow structures such as vortices, and separations. Dye injections allow for colors to be used to distinguish particular structures, one example is the vortex street shown in Figure 26b. The

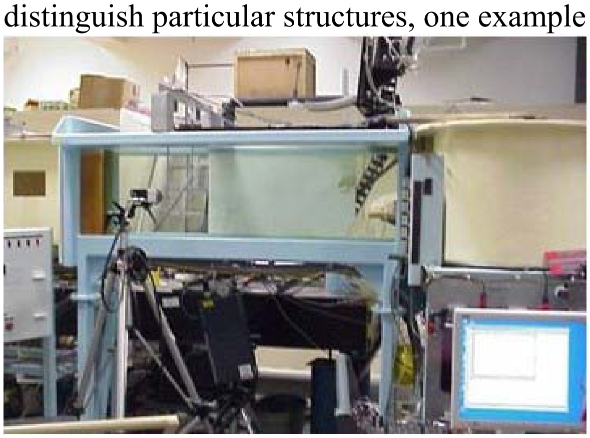


Figure 26a Water Tunnel

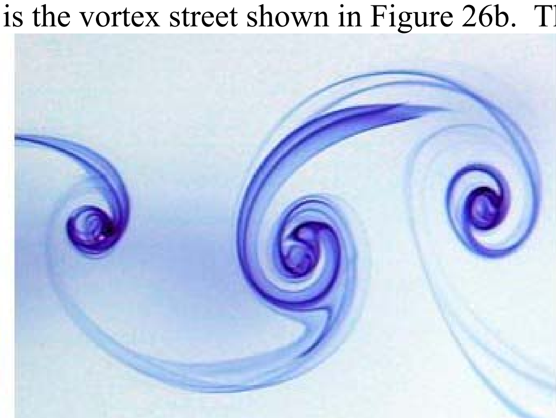


Figure 26b Water Tunnel Dye Injection Visualization: Kármán Streets, Cylinder in Cross Flow

water tunnel supports Aero Engr 315 and Aero Engr 471 by showing cadets how such structures can be observed, as well as the real structures themselves. The water tunnel flow visualizations are also used for qualitative analysis and CFD comparisons.

The Small Low Speed Tunnels (Figure 27) support Aero Engr 315, Fundamentals of Aeronautics, where cadets learn to make pressure measurements, and use such data along with the Bernoulli Equation to compute flow field velocity, as well as lift and drag calculations. Approximately 1000 cadets take Aero Engr 315 each year. The Small Low Speed Wind Tunnels also support Aero Engr 471 and Aero Engr 499 cadet projects.

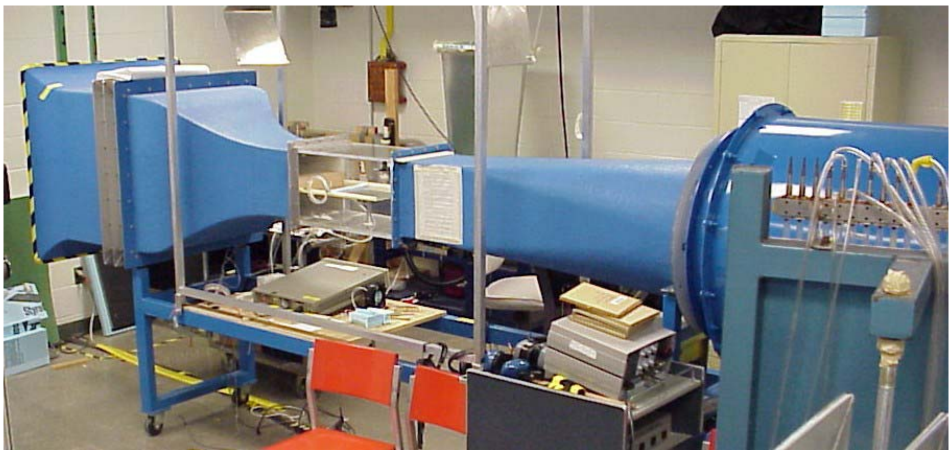


Figure 27 Small Low Speed Wind Tunnel (3)

6.2.1.1 Facilities Supporting Computational Investigations - Experimental and computation investigations offer complimentary educational benefit to teaching aerodynamics to cadets; the benefits are of value to research investigations performed by DFAN. The computational facilities include a Beowulf Linux Parallel Computer that uses a Linux Red Hat 6.0 operating system (Figure 28a), and several dedicated work stations (Figure 28b).

Figure 28a CFD Equipment
Beowulf Linux Parallel Computer

Figure 28b CFD Equipment
Dedicated Terminals

The current configuration is a 32 node machine with 64 parallel processors each operating at 1 GHz. The system has 32 Gb of RAM and 160 Gb of hard disk space. $Cobalt_{60}$, an unstructured Navier-Stokes code, and Fluent™, a commercial code, are two CFD software packages currently being used on this system. As of now, the CFD facilities support all courses in the Aerodynamics discipline, plus Aero Engr 499. The current 64 processors will soon be updated to 128 parallel processors.

6.2.2 Flight Mechanics Discipline – Figure 29 shows two flight simulators, which cadets use all the flight mechanics courses (Aero Engr 351, Aero Engr 352, Aero Engr 456, and Aero Engr 457). The simulator shown in the left picture is part of the dedicated Flight Mechanics classroom. The desktop computers are connected to the USAFAnet and the Internet. The simulator shown in the right side photograph is in a separate room in the laboratory. Cadets use these simulators to study how stability and control factors affect the performance of aircraft in flight. The simulators are programmed with multiple Air Force fighter and transport aircraft.

Figure 29 Flight Simulator Systems

In addition, cadets also use the simulators in Aero Engr 352 to verify design considerations involving aircraft stability derivatives. Once the cadets establish stability derivatives for a particular aircraft, they use the flight simulators to determine whether or not the derivatives are acceptable. This aspect provides cadets a nearly hands-on evaluation and learning experience.

6.2.3 Propulsion Discipline - Quite possibly, the propulsion engine test complex in the Aeronautics Laboratory is "one-of-a-kind" in the nation for undergraduate programs. The complex has four engine test cells that operate with minimal noise and pollution.

The cells can accommodate engine testing for relatively small turbojet engines producing up to 8,000 pounds maximum, which includes a safety margin. Currently, these cells provide cadets real engine test experience for the TJ-69 turbojet (Figure 30a) in the core thermodynamics course, Engr 310 (about 800 cadets per year). The F109 medium bypass turbofan engine (Figure 30b), and an Allison T63 Turboshaft engine (Figure 30c) are used to support cadet studies in Aero Engr 361 Propulsion I, Aero Engr 466 Propulsion II, and Aero Engr 499.

Figure 30a TJ-69 Turbojet Engine

Figure 30b F109 Turbofan Engine

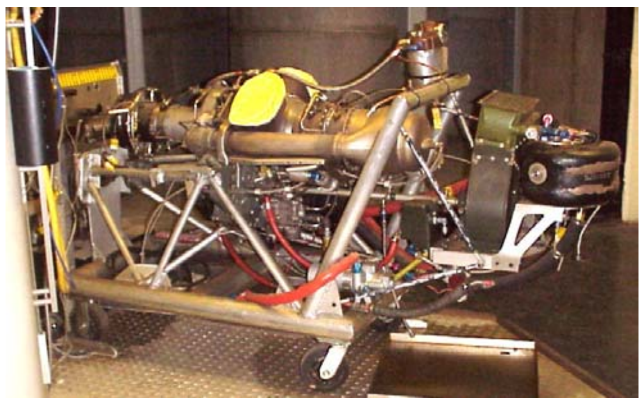


Figure 30c T63 Allison Turbo-shaft Engine

Complimenting these engine test facilities is a museum of jet propulsion engine displays, 1950 vintage turbojets through a present-day high thrust (35,000 pounds-force) low bypass ratio turbofan engine. Figure 31a shows the "cut-away" Pratt & Whitney F100 turbofan engine used in the Air Force F-15 and F-16 aircraft, and Figure 31b shows the General Electric J-85 Turbojet used to power the T-38, the Air Force's primary jet trainer aircraft. A state-of-the-art low bypass turbofan engine that is earmarked for use in Joint Strike Fighter is also on display. Both of these engine displays are full-scale. Other engine cut-away displays include the Garrett F 109 engine and the Williams F 122 used in cruise missles.

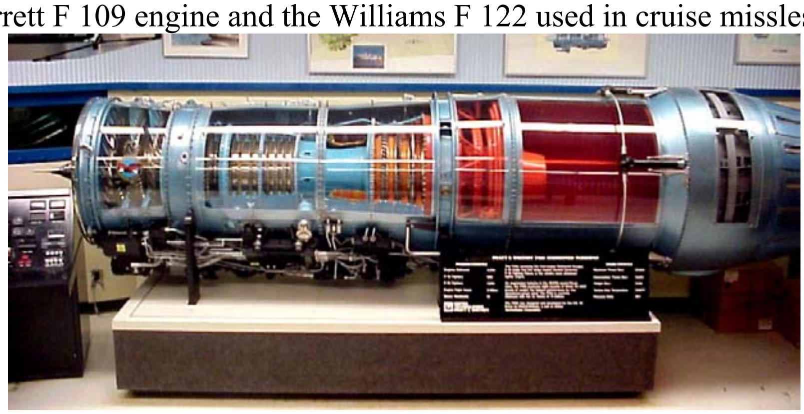


**Figure 31a Pratt & Whitney
F100 Low By-Pass Turbofan Exhibit**

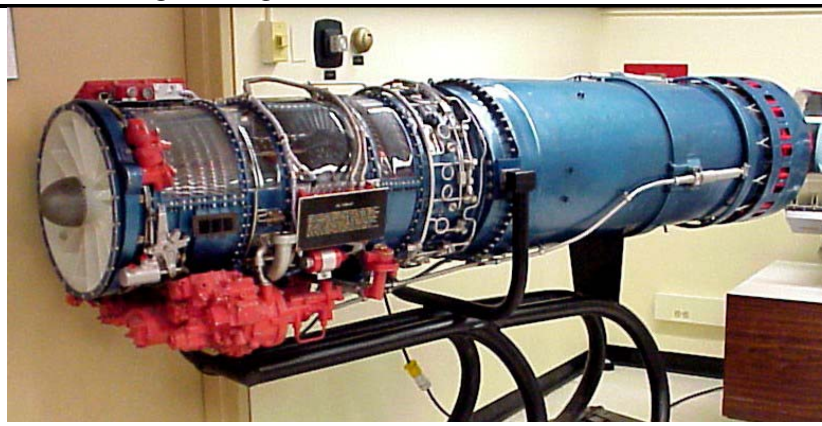


**Figure 31b General Electric TJ 85
Turbojet Engine**

6.3 Instrumentation

The DFAN test facilities are equipped with sensors and instrumentation that cadets and faculty use to measure forces and moments, temperature, pressure, velocity, and flow rates. The forces and moments are measured with a series of internal force balances. Velocities are measured using pitot-static pressure, hot-wire anemometry (HWA), particle image velocimetry (PIV), and laser Doppler velocimetry (LDV). Flow visualization includes dye-injection (in the water tunnel), Schlieren photography, and laser thermal tufts which is a technique developed and patented at USAFA. Figure 31a shows one of the PIV laser systems, and Figure 31b shows one of the force balance systems used in the subsonic wind tunnels

Figure 32a PIV Laser System

**Figure 32b Force Balance for 3 x 3 ft
Subsonic Wind Tunnel**

6.4 DFAN Machine Shop

DFAN has a fully equipped machine shop (Figure 33a) operated by two experienced machinists. In addition to the milling machines, lathes, drill presses, power saws, and hand tools, the shop has a computer numerically controlled (CNC) milling machine capable of manufacturing objects with complex curvatures that are defined in CAD files. A Genisys 3D Printer (Figure 33b) also supports the rapid production of design prototypes.

Figure 33a DFAN Machine Shop

Figure 33b Genisys 3D Printer

6.5 USAFA Computer Infrastructure

Beginning in 1998, the Academy started developing a computer infrastructure that would adequately provide computer support to all USAFA personnel. Key in the development plan was the need for cadets and faculty to have network connected computers to aid the academic development of the cadets. Once in place, the system is upgraded annually.

USAFAnet provides numerous capabilities. Network users have access to the Internet, electronic mail, bulletin boards, retrieval systems, laser printers, and disk drives for sharing or exchanging files. Gateways also connect USAFAnet to other military and government installations, colleges, and universities, the Defense Data Network, and the Internet. Since its initial installation USAFAnet has been expanded to all offices on the Academy (over 8,000 users) and has the flexibility to meet the Academy's data communication needs for the next 15 years.

The Academy equips and maintains microcomputer laboratories for cadet use, both for in-class instruction and for special exercises outside class. Figures 34a and 34b show two such laboratories. The laboratories continue to be upgraded with modern workstations to meet the ever-increasing demands of the academic disciplines. Specialized interactive videodisk laboratories provide state-of-the-art instruction in foreign language and other disciplines.

Figure 34a Network Computer Laboratory (NCL)

Figure 34b Multi-Media Laboratory (MML)

Starting in 1999 notebook computers have been used by many faculty members to facilitate taking presentations into the classroom and working from home. Also, over 250 of the 300 classrooms are equipped with over-head one-gun projectors for displaying high-quality video images of computer output, VCR, or TV signals in the class. In 2001 the Academy switched from issuing desktop computers to high-end notebook computers for all entering cadets. The mobility of notebooks allows cadets more flexibility in their study environment, since they can take them to the library, classrooms, or on trips. It also allows computerized instruction during class without having to move to computer labs. Wireless access points are being installed in the cadet library and throughout the Fairchild Hall, the principle academic building, and the Class of 2006 will be the first class to receive wireless network cards.

6.6 Modern Engineering Tools

Use of modern engineering tools is a Program Thread in the DFAN Aeronautical Engineering Program (Section B. Chapter 3, paragraph 4.2.3). In addition to learning the use of computer software packages, cadets also learn to use modern experimental diagnostics in their laboratory course work in Aero Engr 471, and the senior design courses. Software that cadets use as part of their course work includes s compliment of Microsoft products (Word, Excel, PowerPoint, FrontPage), and Matlab.

6.7 Summary

DFAN believes that the USAFA lecture classrooms and the special classrooms in the Aeronautics Laboratory dedicated to DFAN program disciplines provide cadets proper learning environments for their study of aeronautical engineering. The numerous computing facilities combined with classroom access to USAFAnet and the Internet allow cadets ample opportunity to access information with relative ease. The classrooms in the Aeronautics Laboratory dedicated to flight mechanics, and to engineering design provide cadets access to modern equipment that truly enhances their intellectual development in aeronautical engineering.

DFAN believes the Aeronautics Laboratory provides cadets unique opportunities to enhance and broaden their classroom knowledge though the process of inquiry and observation of real aerodynamic phenomena. The breadth and quality of the facilities allow cadets to study behavior spanning a range of aerodynamic interests. These facilities enhance cadet comprehension of fundamental principles, and also allow those who participate in research to use modern good equipment.

As an aside to this chapter on facilities, DFAN believes that personnel who work and operate the facilities in the Aeronautics Laboratory are a vital resource contributing to each cadet's educational growth through experimentation.

Chapter 7. Institutional Support and Financial Resources

7.0 ABET Criterion 7

Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, maintain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

DFAN Program: The United States Air Force Academy is a military service academy supported directly by the Department of the Air Force under the US Government's Department of Defense.

Funding for government agencies is categorized as *appropriated funds*, or as *non-appropriated funds*. Appropriated funds, approved by the US Congress, pay for all basic operational expenditures. Salaries, costs for faculty and certain cadet development activities, and operational expenses to include all USAFA facilities, facility operations, maintenance and upgrades comprise the budget for appropriated funds. Facilities include classrooms, laboratories, computing equipment to include mainframe and desktop computers and a variety of site-licensed software, library, office space and furniture, telephone and internet support, and all utilities. DFAN's annual operating expenditure is nearly level at $ 90K (Appendix I., Table A.5).

Non-appropriated funds consist of money received from external sources for services provided above and beyond basic requirements. DFAN non-appropriated funding comes primarily from DFAN research activity, and from grants or special awards. Research funds primarily support the research work, and only a small portion is used to augment appropriated funds supporting facility or equipment upgrades. However, much of the DFAN research contributes to the curriculum (e.g. AE 471, AE 499, AE 482/483) and as such, this money provides opportunity for both faculty and cadet professional development. Gift funds contribute to cadet and faculty development by supporting field trips to government laboratories, aircraft engine companies, and aircraft companies. Gift funds also are used to support cadet participation at AIAA Student conferences. DFAN's research level for the past year is about $ 800K; this sum does not include salaries for fulltime DFAN faculty and staff.

7.1 DFAN's Budget Determination Process

Annual budget allocations for appropriated funds begin approximately six months prior to the start of each fiscal year. The fiscal year is 1 Oct – 30 Sep. DFAN prepares and submits a Financial Plan to the budget committee in the office of the Dean of the Faculty for desired travel and miscellaneous requirements. The DFAN travel budget is based on a policy to provide support for one professional development trip per faculty member per year. The miscellaneous requirements include maintenance, supplies, and the special support contracts needed to operate the Department, course and laboratory facilities. The budget committee evaluates the budget requests for all departments to determine the annual budget plan for the Academics Mission element. In addition to these operating costs, DFAN submits requests for equipment expenditures exceeding $100K as unfunded budget requirements. When identified as a need for program support, DFAN submits requests for high-cost facility upgrades through the Program Objective Memorandum process, the standard Department of Defense process for long-term budget requests.

7.2 Adequacy of Support Necessary to Achieve Program Outcomes

The current budget is satisfactory for maintaining and conducting the program in Aeronautical Engineering. Materials needed to conduct the classes and laboratories that support the aeronautical engineering program are adequate.

Institutional support is also adequate. Currently, Fairchild Hall, the central academic building, is being renovated to include office and classroom upgrades. When completed, the renovation will provide better academic environments thereby improving opportunity for attainment of program educational outcomes.

7.2.1 Support from DFAN Research - In the absence of a graduate engineering program, the Aeronautics Department nonetheless maintains a strong research program, overhead funds from which help support professional development for faculty and cadets. These overhead funds also help support laboratory facility and equipment upgrades. The Aeronautics Department's reputation for producing high quality, relatively inexpensive and timely research is strong. Research is a Department Objective (Section B., paragraph 2.5.5). Because of this reputation and the numerous contracts in the sponsoring organizations, DFAN anticipates its reputation for relevant and excellent research to continue, and thus, the overhead funds derived from the research projects will contribute to support the overall academic program.

7.2.2 DFAN Concern – First mentioned in Chapter 5, paragraph 5.6, DFAN sees a concern that could impact maintaining an adequate faculty, which in turn, impacts the program. Overall, a shortage exists in the Air Force for military engineering-officers. Approximately ¾ of the current DFAN faculty are military officer-engineers. DFAN's concern pertains to the availability of military officer-engineers in the coming years because a reduction in qualified military faculty would have a negative impact on the quality of the Aeronautical Engineering program. While filling military faculty billets with civilian faculty is possible, DFAN desires to maintain predominantly military officer-engineering faculty to serve as military role models and military career counselors for the cadets specializing in aeronautical engineering. DFAN also desires to maintain the quality of its program due in part to the favorable 20 to 1 student – faculty ratio, nominally, and also the quality of its faculty research contributions to both the cadets and the Air Force.

7.3 Adequacy of Faculty Professional Development

Opportunities for DFAN faculty professional development are plentiful and include both traditional and non-traditional means. Traditional means include activities like conducting research, either in the Aeronautics Laboratory or at an on-site sponsoring agency's location, attending and presenting papers at technical and educational conferences, participating in short courses and home study courses, publishing journal articles, participating on professional society technical committees. Additionally, many non-traditional (Academy specific) opportunities are available – these are described in the paragraphs that follow.

Faculty members are encouraged to participate in AIAA, ASME and ASEE conferences, technical committees, and to hold leadership positions in these societies. Department members are currently involved in multiple technical committees and both regional and national leadership positions**.** Table 27 in Chapter 5 shows the number of DFAN faculty who volunteer time participating in leadership positions in professional societies.

DFAN faculty also participate as consultants in a variety of industry and government design studies, some members serve on national panels, and several of the senior members serve as reviewers of new text books, authors of texts books, and reviewers to technical journals.

Another resource available for faculty members is the Center for Educational Excellence (CEE). This organization provides seminars for improved teaching techniques several times a semester. In addition, they provide guidance whenever desired on ways to improve the classroom and learning experience. Table 26 in Chapter 5 shows the instructional seminars conducted by CEE this past year.

The Air Force Academy also provides some unique professional development opportunities not available at most universities. Faculty members are allowed to serve as academic advisors to cadet squadrons, as well as professional ethics advisors.

The military faculty members are also allowed to serve as Associate Air Officers Commanding for cadet squadrons, which provide leadership opportunities. The leadership positions in the department are primarily held by the military faculty.

7.4 Non-Faculty Support Personnel

As presented in Chapter 5 (paragraph 5.1.3), DFAN maintains the following support personnel positions maintained by DFAN: 2 administrative assistants, 1 financial manager, 5 laboratory facility managers, 1 supply technician, 2 machinists, and 1 support services technician.

7.4.1 Maintaining Support Personnel - Support personnel in the department are primarily government civilians and enlisted personnel who operate the Aeronautics Laboratory under the direction of the Aeronautics Laboratory Director. DFAN support personnel are indispensable to the Department's mission and objectives. DFAN's modus operandi for the facilities has proven to not only keep the facilities in a state of readiness, but it has also contributed directly to maintaining high levels of performance and correspondingly high morale. Each wind tunnel system has a laboratory technician who is the facility manager for that tunnel. As such, the technician shares in the planning and execution of all tests conducted in that facility. Facility managers work directly with, and provide guidance to, cadets during research in that respective tunnel. DFAN's management practice is to create and maintain a work environment in which every employee, especially the support personnel, are empowered to have responsibility over the tasks and equipment under their direction.

Evidence gathered from annual Department Climate Surveys show that overall, DFAN support personnel are satisfied with their respective jobs, environment, and supervision, and the morale is consistently high. Regarding replacements, DFAN follows established government rules for hiring. Hiring is based on searching for highly qualified people who have established records of initiative, ethics, and being team-players.

7.5 Facility Maintenance and Upgrades

DFAN maintains a long term plan to upgrade and add to the Aeronautics Laboratory. Funding for this plan is yet to be approved. The upgrade defines improvements for office space that will allow the entire Department faculty to be centrally located in the Aeronautics Laboratory building. Presently, the DFAN faculty is located two buildings, Fairchild Hall (the main academic building) and the Aeronautics Laboratory building. Additionally, approximately $ 38 million dollars are being sought for construction of a new wind tunnel facility that would enhance the Department's teaching and research opportunities, such as the aerodynamics of unmanned vehicles.

The Department's facility maintenance and upgrades plan will be available for review during the ABET visit.

7.6 Services and Institutional Support

Numerous institutional support services are provided by two commands: USAFA Headquarters and the Air Force 10th Air Base Wing. Also, the building facilities manager under the office Dean of Faculty provides support for administration, facility maintenance, and personnel management. The Civil Engineering squadron operates a help desk to provide support on issues concerning power outages and heating/cooling irregularities.

Of the many institutional support services provided at USAFA, some of the primary ones are:

7.6.1 Communications & Computer Support The 10th Communications Squadron (10th ABW/SC) provides communications, computing, network, and information resources for the entire Academy. Under the office of the Dean of the Faculty, the Director of Academic Computing (DFET) is responsible for choosing, securing rights to, and installing the computers and software each cadet purchases.

7.6.2 Legal Support Office of the Staff Judge Advocate (10th ABW/JA) provides legal counsel and defense attorneys for military members at USAFA, including cadets. Attorneys from this office also prosecute criminal cases.

7.6.3 Lodging and Meals The 10th Services Squadron (10th ABW/SV) provides meals (via the cadet dining hall); morale, welfare, and recreation equipment; temporary lodging; laundry services; etc. for cadets and other USAFA personnel.

7.6.4 Medical Support The 10th Medical Group (10th ABW/SG) includes the USAFA hospital, Cadet Clinic, and Dental Clinic. Medical and dental care, flight physicals and qualification exams, surgery, vaccinations, and other medical services are provided for cadets and other USAFA personnel by this organization.

7.6.5 Physical Plant Support The 10th Civil Engineering Squadron (10th ABW/CE) is responsible for the physical plant for all USAFA facilities, including dormitories, academic buildings, the library, the field house and gymnasium, clubs, visiting officers quarters and base residences. Under the office of the Dean of the Faculty, the facilities manager has responsibility for the academic building, and acts as liaison to 10th ABW/CE.

7.6.6 Security The 10th Security Forces Squadron (10th ABW/SF) provides law enforcement and security services to the USAF Academy.

7.6.7 Spiritual Support The Base Chapel System provides for the spiritual needs of cadets and other USAFA personnel.

7.6.8 USAFA Library - The library located between the academic and military training buildings is a valued resource to cadets and faculty alike. The library is supported by internet and intranet resources. The library maintains archives of information on military and government documents.

7.7 Summary

DFAN believes the Institutional support provided by the Air Force is satisfactory. The facilities and annual resources allow DFAN to accomplish the PCO's with a sustained record of excellence. The personnel assigned to DFAN are outstanding. DFAN's concern regarding maintaining adequate faculty staffing is noted in paragraph 7.2.2 above.

Figure 35a Mitchell Hall
Cadet Dining Facility

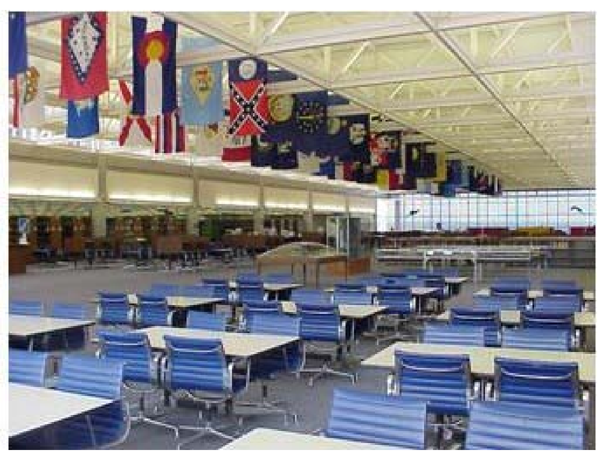


Figure 35b USAFA Library
Main Lobby

Chapter 8. Program Criteria

8.0 ABET Criterion 8.

Each program must satisfy applicable Program Criteria. Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications…..Program Criteria for Aerospace and similarly named engineering programs: Aeronautical Engineering

1. Curriculum. Aeronautical engineering programs must demonstrate that graduates have knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control…..Programs must also demonstrate that graduates have design competence which includes integration of aeronautical or astronautical topics.

2. Faculty. Program faculty must have responsibility and sufficient authority to define, revise, implement, and achieve program objectives. The program must demonstrate that faculty teaching upper division courses have an understanding of current professional practice in the aerospace industry.

DFAN Program: The aeronautical engineering curriculum at USAFA presents cadets a comprehensive treatment in aerodynamics, (includes foundations in fluid mechanics), computational fluid dynamics, aerospace structures and materials, air-breathing propulsion (includes foundations in thermodynamics and gas dynamics), flight mechanics, stability and control, experimental methods, and aircraft or aircraft engine design. Paragraph 8.1 below explains the details of each discipline in the curriculum. Figure 17 in Chapter 4 is the curriculum flow chart showing the sequence of courses. Additional information on the basic level curriculum is presented in Appendix I, Tables A.1 and A.2. Course descriptions are presented in Appendix I E.1, aeronautical engineering curriculum, and in the USAFA Curriculum Handbook.

The revised aeronautical engineering curriculum is described in paragraph 8.8 below. Details directly affecting the curriculum are illustrated in the revised flow curriculum flow chart shown in Figure 40, and additional information is presented in Appendix I, Tables A.2a.

Once established in 1973, the aeronautical engineering curriculum has undergone only minor changes, two being a strengthening of the two course senior-level design sequence, and the discontinuance of a heat transfer course. Recently, the entire USAFA program has undergone revision, some of which affects the aeronautical engineering curriculum. The major changes are: (1) addition of Aero Engr 241, Aero-Thermodynamics course, a new course that presents the 1st and 2nd Laws of Thermodynamics along with an introduction to gas dynamics. Aero Eng 241 replaces the core engineering thermodynamics course, Engr 310, effective August 2002. (2) Addition of computational fluid dynamics in the Aero Engr 342. (3) Elimination of the core engineering systems design course, Engr 410. (4) Inclusion of Engr 100, a new freshman course designed to introduce all cadets to engineering, (5) elimination of the six hr foreign language requirement for cadets specializing in a technical discipline.

DFAN considers the faculty to be its program strength. Faculty issues to include staffing, qualifications, professional development are discussed in Section B., Chapter 5.0. Specific information on each faculty member is presented in Appendix I. Section C. Faculty Vitae.

8.1 DFAN Curricular Disciplines

To help delineate the DFAN curriculum with respect to the ABET Program Criteria for aeronautical engineering programs, DFAN has structured the program into six curricular disciplines: (1) Aerodynamics. (2) Flight Mechanics, Stability and Control. (3) Propulsion. (4) Aerospace Materials and Structures. (5) Experimental Investigations. (6) Design. Design includes two tracks, aircraft design and aircraft engine design. As describe in Section B., Chapter 3, each discipline is led by a discipline director who is responsible for the educational outcomes, the content, and the assessment and evaluation of student performance for that particular discipline. Each discipline director maintains a discipline continuity notebook, which will be available for review during the ABET visit.

Table 31 DFAN Curricular Disciplines

Discipline	Paragraph	Discipline Director email
Aerodynamics	8.2	(Dr) john.bertin@usafa.edu
Flight Mechanics, Stability and Control	8.3	(Dr) thomas.yechout@usafa.edu
Propulsion	8.4	(Maj, PhD) keith.boyer@usafa.edu
Aerospace Materials and Structures	8.5	(Maj, PhD) scott.morton@usafa.edu
Experimental Investigations	8.6	(Dr) aron.byerley@usafa.edu
Aircraft Design Aircraft Engine Design	8.7	(Dr) steven.brandt@usafa.edu

Figure 35 illustrates the administration process for the DFAN curriculum. At the course level, course directors are responsible for the course(s) under their respective charge. Course directors report to the applicable discipline director who has responsibility for the academic structure of the discipline. At the next level, the discipline directors are responsible to the DFAN Curriculum Director, the member of TEBA who is responsible for ensuring that the DFAN Curriculum is compliant with the DFAN-PCO's, the Institutional (DF) Educational Outcomes, and the ABET EC2000 Criterion 3, a-k outcomes, and the Criterion 8 Program Criteria for aeronautical engineering. Lastly, TEBA advises the Department Head semi-annually on the status of the DFAN program.

For convenience, descriptions for each course in the DFAN curriculum are present in Appendix I., Table E.1, as well as in the USAFA Curriculum Handbook. The following sections highlight the six curricular disciplines.

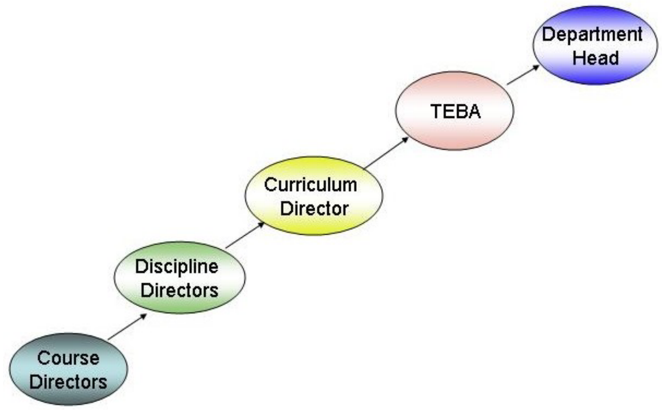


Figure 36 DFAN Curriculum Administration Process

8.2 Aerodynamics Discipline

The Aerodynamics Discipline consists of four required courses and two electives. The required courses are:

AeroEngr 315, Fundamentals of Aeronautics;
AeroEngr 341, Aeronautical Fluid Mechanics;
AeroEngr 342, Aerodynamics; and
AeroEngr 442, Advanced Aerodynamics.

The two elective courses are:

AeroEngr 446, Introduction to Hypersonics; and
AeroEngr 447, Computational Fluid Dynamics (revised curriculum name).

8.2.1 Discipline Curricular Outcomes – The educational objective of the Aerodynamics Discipline is:

Cadets will understand basic fluid mechanics and its applications to aerodynamics.

To attain this objective, cadets will demonstrate the following discipline curricular outcomes:

1. an ability to explain the development of the basic equations of fluid mechanics and their application to aerodynamics.
2. an ability to make complementary use of analytical/numerical/experimental techniques to solve undergraduate-level aerodynamics problems.
3. an ability to communicate effectively using oral, written, and graphical formats.
4. an ability to perform effective literature and internet research and demonstrate the ability to engage in lifelong learning.
5. an ability to work effectively as a member of a team.

Table 32 shows how the required courses in the Aerodynamics Discipline contribute to attainment of the discipline curricular outcomes, and the ABET EC 2000 Criterion 3 a-k Outcomes.

Table 32 Aerodynamics Discipline: Curricular Outcomes

Outcomes	Required Courses				Electives		ABET EC 2000 Criterion 3 a-k
	AE 315	AE 341	AE 342	AE 442	AE 446	AE 447	
1. an ability to explain the development of the basic equations of fluid mechanics and their application to aerodynamics	X	**X**	**X**	**X**	**X**	**X**	a,b,e,g,i,k
2. an ability to make complementary use of analytical/numerical/experimental techniques to solve aero problems	**X**	**X**	**X**	**X**		**X**	a,b,e,g,i,k
3. an ability to communicate effectively using oral, written, and graphical formats		**X**	**X**	**X**	**X**	**X**	b,e,g,ik
4. an ability to perform effective literature and internet research, and indicate the ability to engage in lifelong learning		**X**			**X**	**X**	e,i,j,k
5. an ability to work effectively as a member of a team		**X**		**X**	**X**	**X**	a,b,e,f,g,k

8.2.2 Assessment Synopsis – Student success in the Aerodynamics Discipline is measured using a variety of assessment tools which target explicit criteria within each outcome. These criteria are detailed in the "State of the Discipline" briefing presented in the Aerodynamics Discipline notebook.

8.2.3 Significant Student Achievements in Aerodynamics -

An Experimental Investigation on Separation Over Turbine Blades at Low Reynolds Numbers - C1C Nathan Loucks – 2nd Place, AIAA Student Paper Competition, Region V, April 2002.

8.2.4 Discipline Director Summary – (note: writing is italicized because it needs verification by discipline director) Evidence gathered from course work, comprehensive examinations, and instructor observations indicates that all educational outcomes of the Aerodynamics Discipline are being attained by the cadets.

The number and depth of coverage of topics in the Aerodynamics Discipline have been subjects of continued discussion amongst the faculty. The predominant concern is focused on keeping the presentation of knowledge at a manageable level while concurrently adding opportunities for new knowledge and skill, CFD being a case in point. For several years, DFAN understood the need to have coverage of CFD in the curriculum, but until the recent USAFA curriculum revision became a reality, CFD was slipped-in whenever possible, or treated as an elective subject. Now however, opportunity to have a course dedicated to CFD in the curriculum exists, as explained below.

(1) Including introductory gas dynamics in the new thermodynamics course, Aero Engr 241, will free up the 9-10 lessons in AE 341 formerly presenting this material.

(2) Subject material (potential flow, stream functions, boundary layer solutions, d'Alembert's paradox, Cl_{max}) in Aero Engr 342 will moved into the vacated 10-lesson space of Aero Engr 341.

(3) Aero Engr 342 will be redeveloped into a computational aerodynamics course. The proposed new Aero Engr 342 course description is: "Theory and application of computational tools used to predict fluid flows around basic and complex geometries. Grid generation, CFD solvers, post-processing use of modern tools. Computational methods for stability, accuracy, shock capturing, turbulence modeling, and parallel computing. Insights on fluid flow phenomena developed from analysis of CFD simulations for vortices, shock induced boundary layer separation, boundary layers, and shockwaves."

(4) Aero Engr 442 Applied Aerodynamics is revised to combine subject material presently covered in AeroEngr 342 (low-speed aerodynamics) and Aero Engr 342 and Aero Engr 442 (high-speed aerodynamics) courses.

This plan is currently under development in DFAN.

Figure 37 DFAN Aerodynamics Discipline

8.3 Flight Mechanics, Stability and Control Discipline

The Flight Mechanics, Stability and Control Discipline consists of two required courses and two electives. The required courses are:

AeroEngr 351, Aircraft Performance & Static Stability, and
AeroEngr 352, Aircraft Dynamic Stability & Control.

The two elective courses are:

AeroEngr 456, Flight Test Techniques, and
AeroEngr 457, Aircraft Feedback Control Systems.

8.3.1 Discipline Curricular Outcomes – The educational objective of the Flight Mechanics, Stability and Control Discipline is:

Cadets will understand the fundamentals of aircraft mechanics.

To attain this objective, cadets will demonstrate the following discipline curricular outcomes:

1. an ability to explain the fundamentals of aircraft performance, stability, control, and flight test.
2. an ability to analyze and design simple aircraft and feedback control systems to meet performance and handling qualities requirements.
3. an ability to apply a variety of analysis tools including structured programming.

Table 33 below shows how the required courses in the Flight Mechanics, stability and Control Disciple contribute to the attainment of the discipline curricular outcomes, and the ABET EC 2000 Criterion 3 a-k Outcomes.

Table 33 Flight Mechanics, Stability and Control Discipline: Curricular Outcomes

Outcomes	Required Course		Electives		ABET EC 2000 Criterion 3 a-k
	AE 351	AE 351	AE 457	AE 456	
1. an ability to knowledgeably explain aircraft performance, stability, control and flight test techniques.	X	X	X	X	a,e,k
2. an ability to analyze and design simple aircraft and feedback control systems and to meet performance and handling qualities requirements.	X	X	X		a,b,c,d,e,g,k
3. an ability to apply a variety of analysis tools including structured programming.	X	X	X	X	a,b,c,d,e,g,k

8.3.2 Assessment Synopsis – Student success in the Flight Mechanics, Stability and Control Discipline is measured using a variety of assessment tools which target explicit criteria within each outcome. These criteria are detailed in the "State of the Discipline" briefing within the Flight Mechanics, Stability and Control Discipline notebook.

One of the primary tools is the end of program Comprehensive Exam. The exam asks 23 questions addressing Outcome #1 while graduate surveys and the end of program surveys focus on Outcomes #2 and #3. The results of the Class of 2001 Comprehensive Exam show that students met the outcome by scoring, on average, a 70% on all examination questions. The survey results for the class of 2002 were not available at the time this document was written.

Other assessment data reflect outstanding individual performance in this discipline. Student research projects focusing on Performance, Stability and Control issues are consistently recognized at the Regional AIAA Student Paper Competitions (paragraph 8.4.3 below).

8.3.3 Significant Student Achievements in Flight Mechanics – Table 34 shows the cadet projects that have regularly won in external student-peer competitions over the past 5 years. While these accomplishments are the result of particular cadets, the history of this winning record is evidence on the overall high quality of cadet performance in this discipline.

Table 34 Cadet Special Recognitions in Aircraft Flight Mechanics

Academic Year	Event	Placement	Title
2001-2002	AIAA Region V Student Competition	3rd	X-38 Component Build-up and Directional Stability Analysis
2001-2002	AIAA National Student Competition, Reno, NV	1st	X-38 Rudder Configuration and Parafoil Cavity Investigation
2000-2001	AIAA Region V Student Competition	1st	X-38 Rudder Configuration and Parafoil Cavity Investigation
1999-2000	AIAA National Student Competition, Reno, NV	Finalist	A Wind Tunnel Investigation to Reduce the Drag Associated with External Protuberances on the AC-130H Gunship
1998-1999	AIAA Region V Student Competition	1st	A Wind Tunnel Investigation to Reduce the Drag Associated with External Protuberances on the AC-130H Gunship
1998-1999	AIAA National Student Competition, Reno, NV	Finalists	An Experimental Wind Tunnel Investigation to Reduce the Drag on the AC-130U Gunship
1997-1998	AIAA Region V Student Competition	1st	An Experimental Wind Tunnel Investigation to Reduce the Drag on the AC-130U Gunship

Another good measure of cadets' knowledge of flight mechanics fundamentals is how they are able to apply their knowledge of flight mechanics in the engineering workplace. DFAN has a unique opportunity to evaluate this since many of our aeronautical engineering majors are placed with industry, NASA, and Air Force labs and test organizations during the summer immediately following their junior year. Each host is asked to provide feedback on how well they are prepared in the fields of flight mechanics and aerodynamics. Almost without exception, the feedback is glowing and indicates that our students clearly standout in the understanding of fundamentals when compared to students from other universities. As an example of this, Mr. Rick Barton, NASA JSC Aero and Flight Mechanics Branch Chief (281-483-4650), who has supervised our students for several summers, recently commented,

"Your students are consistently head and shoulders above those we have from other universities."

Figure 38 DFAN Flight Mechanics Discipline

8.3.4 Discipline Director Summary – The Flight Mechanics Discipline is believed to be very strong. Unique aspects include:

- An 'in house' authored text (soon to be published by the AIAA Education Series), which is specifically tailored to the Aero Engr 351/352/457 courses and which has been consistently rated by students in the top 5% of all textbooks used at USAFA.

- Integration of the Genesis 3000 flight simulator into the Aero Engr 351/352/456/457/482 courses, which provides students 'hands on' experience to complement understanding of flight mechanics fundamentals.

- Integration of MATLAB programming and control system analysis capabilities into the Aero Engr 351/352/457 courses provides cadets working knowledge of a modern analysis tool.

- Flight experience in Aero Engr 456, which includes four performance and flying qualities flights in the T-41D and one flight in the T-38 which provides students 'real world' experience with flight test fundamentals and exposure to actual Air Force test pilots.

- Field trips in Aero Engr 456 course expose students to the Air Force flight test environment, unique aircraft such as air racers and homebuilt, and uniquely qualified designers and test pilots.

- Outstanding opportunities for flight mechanics research at the undergraduate level based on the excellent wind tunnel, CFD, and simulation capabilities available in the Aeronautics Laboratory, and faculty with research programs sponsored by a variety of DoD and NASA organizations.

8.4 Propulsion Discipline – The Propulsion Discipline consists of one required course and two electives. The required course is:

Aero Engr 361, Propulsion I.

The two elective courses are:

Aero Engr 466, Propulsion II (engine component design)
Aero Engr 483, Aircraft Engine Design.

8.4.1 Discipline Curricular and Outcomes – The educational objective of the Propulsion Discipline is:

<u>Cadets will understand the relationship between engine cycles, or types, and missions for military airbreathing and rocket propulsion systems.</u>

To attain this objective, cadets will demonstrate the following discipline curricular outcomes:

1. an ability to apply principles of Thermodynamics to analyze and describe airbreathing and rocket propulsion systems.
2. an ability to use basic models for compressible gas dynamics and know the trends in total properties for each model.
3. an ability to explain engine cycle theory and use it to analyze gas turbine engines.

Table 35 below shows how the required course in the Propulsion Discipline contributes to the attainment of the discipline curricular outcomes, and to the ABET EC2000 Criterion 3 a-k Outcomes.

Table 35 Propulsion Discipline: Curricular Outcomes

Outcomes	Required Course	Electives		ABET EC 2000 Criterion 3 a-k Outcomes
	AE 361	AE 466	AE 483	
1. an ability to apply principles of Thermodynamics to analyze and describe airbreathing and rocket propulsion systems.	X	X	X	a,b,e,g,j,k
2. an ability to use basic models for compressible gas dynamics and know the trends in total properties for each model.	X	X	X	a,e,k
3. an ability to explain engine cycle theory and use it to analyze gas turbine engines.	X		X	a,b,c,e,g,j,k

8.4.2 Assessment Synopsis – Success in the Propulsion Discipline is measured using a variety of assessment tools that target explicit criteria within each outcome. These criteria are detailed in the "State of the Discipline" briefing within the Propulsion Discipline notebook.

One of the tools is the end of program Comprehensive Exam. The exam asks nine questions addressing Outcome #1, one question addressing Outcome #2, and three questions addressing Outcome #3. Another tool involves qualitative and quantitative feedback from the engine selection portion of the Aircraft Design course (Aero Engr 481) as well as feedback from industry propulsion engineers gained during the Engine Design Course (Aero Engr 483).

In the areas assessed using the comprehensive exam, the results of the Class of 2001 show the students have met the outcome by scoring, on average, a 70% on 7 of the 9 exam questions.

We feel the best overall assessment of Aero Engr 361 comes from feedback from the Aircraft and Engine Design Course (Aero Engr 481) since all the students who take Aero Engr 361 will take Aero Engr 481 the following semester. Informal instructor feedback indicates the students have all the skills necessary to explore a wide range of engine cycles, plot and analyze performance trends, and make a cycle selection that satisfies the aircraft mission requirements. The engine cycle selection exercise is conducted during task #3 of the overall design effort. The average score on this part of the effort was 93%.

External assessment is obtained through the Engine Design course, Aero Engr 483. Each spring semester, the students who are in the third course of a three course propulsion sequence brief their engine cycle and engine component preliminary design to the engineering staff at Honeywell Engines in Phoenix, AZ. During this third course, the students build on the Aero Engr 361 and Aero Engr 481 experiences to select an engine cycle. They use the basic models for compressible gas dynamics from Aero Engr 361 and the component design tools gained in Aero Engr 466 (Propulsion II) to perform a preliminary design of all the main engine components.

8.4.3 Significant Student Recognition and Accomplishment– Below are representative comments on feedback from the Honeywell engineers when cadets in Aero Engr 483 briefed the staff on their 2002 design work:

"Excellent presentation by both teams! Good demonstration of understanding the RFP and the general design issues. Also showed good team work and communication with each other on technical issues. Also seemed to understand the importance of communication with the customer. Impressive work!"

"I can't believe these guys are doing this level of work as undergraduates. We were able to discuss their engine design decisions as if they were our peers".

Another example of cadet distinctive work is that done by C1C (former) Roland Rosario. Following a 6-week CSRP in June 2001 at Arnold Engineering Development Center (AEDC), Arnold AFB, TN, Dr Frank Steinle, the sponsor, proposed the work be continued, and presented at an AIAA session. Roland demonstrated the feasibility of using neural net and fuzzy logic technology for real-time optimization and control of variable vanes in a large transonic, 16-foot test section wind tunnel compressor. AEDC wants to incorporate these technologies immediately. Per Dr Steinle: "…Roland was introduced to Neural Net technology and because he was familiar with MATLAB and is one sharp cadet, he was off and running. He did a great job…" For his part, Roland was a finalist for the prestigious Dean of Faculty Moore Award for cadet outstanding summer research. Further, he was lead author and presenter of an AIAA paper (see below) in a regular technical congress section (non-student section). The second paper listed below has been accepted for presentation at the Jan 2003 AIAA Reno conference.

8.4.4 Discipline Director Summary - Based on internal and external assessment of the tools and skills the students gained in Aero Engr 361, student performance, the appropriateness of the assessment and the assessment tools, and attainment of discipline outcomes, the Propulsion Discipline is rated satisfactory.

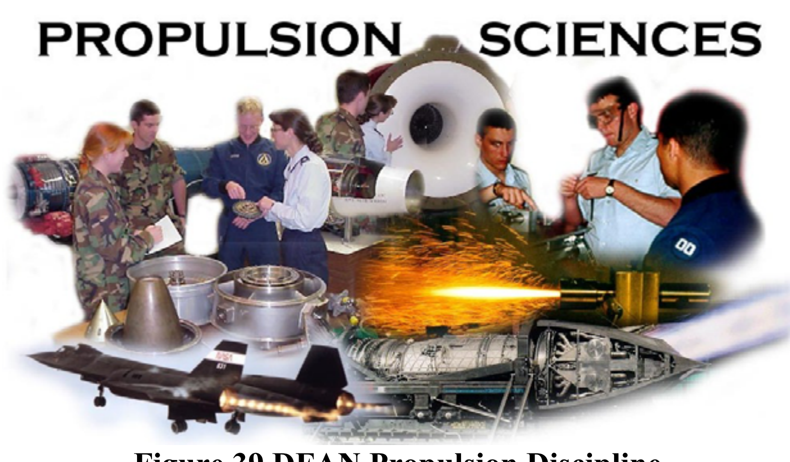


Figure 39 DFAN Propulsion Discipline

8.5 Aerospace Materials and Structures Discipline

The Aerospace Materials and Structures Discipline consists of three required courses and five electives. The required courses are:

Engr Mech 320, Dynamics
Engr Mech 330, Static Analysis of Structures
AeroEngr 481, Introduction to Aircraft and Propulsion System Design.

The five elective courses are:

Engr Mech 332, Aerospace Structures
Engr Mech 350, Mechanical Behavior of Materials
Engr Mech 431, Introduction to Finite Element Analysis
Engr Mech 450, Aerospace Composite Materials
AeroEngr 436, Aeroelasticity

8.5.1 Discipline Curricular and Outcomes – The educational objective of the Aerospace Materials and Structures Discipline is:

Cadets will understand the fundamentals of aerospace structures and material properties and their interactions.

To attain this objective, cadets will demonstrate the following discipline curricular outcomes:

1. an ability to design and perform accurate static and dynamic analysis of a structure to perform a specified function.
2. an ability to accurately analyze absolute and relative motion of particles and rigid bodies and the associated loads.
3. an ability to demonstrate a breadth of fundamental knowledge in aerospace material properties and selection, cause and impact of fatigue, finite element analysis, and structural dynamics, as well as a depth of knowledge in at least one of these topics.
4. an ability to create and interpret a conceptual design for an aircraft structure to include specifying the location and orientation of major structural components and affect of material selection.
5. an ability to collect and correctly analyze experimental data from a representative structural member.

Table 36 below shows how the required courses in the Aerospace Materials and Structures Discipline contribute to the attainment of the discipline curricular outcomes.

8.5.2 Assessment Synopsis – Success in the Aerospace Materials and Structures Discipline is measured using the end of program Comprehensive Exam, Graduate and Supervisor surveys as well as feedback from the Capstone Design courses regarding the students' ability to do the required structural analyses. These assessment tools target explicit criteria within each outcome which are detailed in the "State of the Discipline" briefing within the Aerospace Materials and Structures Discipline notebook.

The Comprehensive exam asks five questions addressing Outcome #1, two questions addressing Outcome #2, four questions addressing Outcome #3, three questions addressing Outcome #4, and two questions addressing Outcome #5.

Table 36 Aerospace Materials and Structures Discipline: Curricular Outcomes

Outcomes	Required Courses			Electives							ABET EC 2000 Criterion 3 a-k Outcomes
	EM 320	EM 330	AE 481	EM 332	EM 350	EM 431	EM 450	EM 436	EM 482	EM 483	
1. an ability to design and perform accurate static and dynamic analysis of a structure to perform a specified function.		X	X	X	X	X	X		X		a,b,e,k
2. an ability to accurately analyze absolute and relative motion of particles and rigid bodies and the associated loads.	X					X					a,e,g,k
3. an ability to demonstrate a breadth of fundamental knowledge in aerospace material properties and selection, cause and impact of fatigue, finite element analysis, and structural dynamics, as well as a depth of knowledge in at least one of these topics.		X	X	X	X	X	X		X	X	a,c,d,e,h,j,k
4. an ability to create and interpret a conceptual design for an aircraft structure to include specifying the location and orientation of major structural components and affect of material selection.			X	X		X	X		X	X	a,c,d,e,g,k
5. an ability to collect and correctly analyze experimental data from a representative structural member.		X		X	X		X				a.b.e.g

8.5.3 Significant Student Achievements in Aerospace Materials and Structures – None that pertain explicitly to cadet work in the discipline of aerospace materials and structures.

8.5.4 Discipline Director Summary -The current strategy for this discipline of teaching core educational outcomes in Engr Mech 320, Engr Mech 330, and Aero 481 with an in depth experience in an elective Aerospace Materials and Structures topic is working very well. Based on internal and external assessment of the tools and skills the students gained in Engr Mech 320, Engr Mech 330, and Aero 481, student performance, the appropriateness of the assessment and the assessment tools, and attainment of discipline outcomes, the Aerospace Materials and Structures Discipline is rated satisfactory

8.6 Experimental Investigations Discipline

The Experimental Investigations Discipline is consists of one required course and one elective. The required course is:

AeroEngr 471, Aeronautical Laboratory.

The elective course is:

AeroEngr 499, Independent Study

The DFAN curriculum has incorporated Computational Fluid Dynamics into the AE 442 course, a modifications that will result in knowledge and skills develop-overlaps between the Aerodynamics and Experimental/computational Disciplines.

8.6.1 Discipline Curricular and Outcomes – The educational objective of the Experimental Investigations Discipline is:

Cadets will understand the fundamentals of experimental and computational investigations.

To attain this objective, cadets will demonstrate the following discipline curricular outcomes:

1. an ability to explain the role of experimental and computational investigations in gaining insight into the physics of aerodynamic phenomena and in making good engineering decisions based upon that insight.

2. an ability to perform effective library and internet research to obtain the necessary background information for the experimental or computational investigation.

3. an ability to design and conduct experimental and computational investigations using the appropriate methodology to make accurate measurements or predictions of force, velocity, temperature, and pressure.

4. an ability to reduce, analyze, and interpret experimental and computational data.

5. an ability to effectively communicate the experimental and computational approach and results using oral, written, and graphical formats.

Table 37 below shows how the required course in the Experimental Investigations Discipline contributes to the attainment of the discipline curricular outcomes, and to the ABET EC 2000 Criterion 3 a-k Outcomes.

Table 37 Experimental Investigations Discipline: Curricular Outcomes

Outcomes	Required Course	Electives	ABET EC 2000 Criterion 3 a-k Outcomes
	AE 471	AE 499	
1. an ability to explain the role of experimental and computational investigations in gaining insight into the physics of aerodynamic phenomena and in making good engineering decisions based upon that insight.	**X**		a,e,f,h,i,j
2. an ability to perform effective library and internet research to obtain the necessary background information for the experimental or computational investigation.	**X**	**X**	d,e,f,g,h,i,j,k
3. an ability to design and conduct experimental and computational investigations using the appropriate methodology to make accurate measurements or predictions of force, velocity, temperature, and pressure.	**X**	**X**	a,b,c,d,e,f,i,k
4. an ability to reduce, analyze, and interpret experimental and computational data.	**X**	**X**	a,b,d,e,f,i,k
5. an ability to effectively communicate the experimental and computational approach and results using oral, written, and graphical formats.	**X**	**X**	d,e,f,g,k

8.6.2 Assessment Synopsis – Assessment involves used of several instruments: faculty observations on cadet performance to include evaluation of oral and written project reports, comprehensive examination questions, evaluations from external sources to include the Air Force Office of Scientific Research, Air Force Research Laboratories, and NASA, plus all agencies supporting the DFAN CSRP cadets. Additionally, DFAN accepts the historical record of cadet success in AIAA and other student paper competitions as assessment evidence on the quality of work accomplished by cadets in the Experimental Discipline.

8.6.3 Significant Student Achievements in Experimental Investigations - Cadet accomplishments in experimental work are documented in Table 3, Chapter 2, page 12. A notebook of cadet-kudos documenting evidence of performance for cadet work in research and experimentation will be available for review during the ABET visit.

8.6.4 Discipline Director Summary – The evidence collected to date indicates that the educational outcomes of the Experimental Investigations Discipline are being attained by the cadets. DFAN will continue to develop research opportunities to support cadet participation and growth in this discipline. DFAN believes that it's good standing in the technical community at large (DoD, NASA) makes the opportunity for continued external research support very realistic, so DFAN believes it will be able to sustain programs supporting cadet research opportunities.

8.7 Design Discipline

The Design Discipline currently consists of one required course and one of two design elective courses. The required course is:

AeroEngr 481, Introduction to Aircraft and Propulsion System Design.

The elective courses are:
AeroEngr 482, Aircraft Design
AeroEngr 483, Aircraft Engine Design

8.7.1 Discipline Curricular and Outcomes - The educational objective the Design Discipline is:

Cadets will understand the fundamentals of aircraft design.

To attain this objective, cadets will demonstrate attainment of the following discipline curricular outcomes:

1. an ability to develop and evaluate engineering designs that meet customer needs.
2. an ability to communicate effectively using oral, written, and graphical formats.
3. an ability to work effectively as a member of a multidisciplinary team.
4. an ability to perform effective literature and internet research and demonstrate the ability to engage in lifelong learning.
5. an ability to make morally responsible judgments about legal, environmental, and ethical implications of engineering, management, and business decisions.

Since the discipline consists of a one required course followed by one required design elective course, outcomes emphasizing design are satisfied in Aero Engr 481, and reinforced in the follow-on design elective course.

The groundwork for this capstone aircraft design experience is established in the engineering core, which consists of required courses taken by every USAFA cadet, regardless of major, in mechanical engineering, electrical engineering, civil engineering, astronautical engineering, and aeronautical engineering. In addition to these 5 core courses, all USAFA cadets also take one general engineering design course, where the basic engineering method is taught. All of these engineering core courses have strong design components, with at least one design project in each course.

Cadets specializing in Aeronautical Engineering obtain additional design experience in Aero Engr 351, where they design, build, and fly a balsawood glider, and in Aero Engr 352, where they design and optimize an aircraft feedback control system. In Aero Engr 471, the laboratory course, they must design and conduct an experimental investigation of a specified research problem. This gives them additional experience with creative problem solving, including all the basic steps in the design process. Students also learn analysis and optimization methods in their other major's courses which they will apply to their design project in Aero Engr 481.

Table 38 below shows how the required course in the Design Discipline, plus the required design elective course contribute to attainment of the discipline curricular outcomes, and ABET EC 2000 Criterion 3 a-k Outcomes.

Table 38 Aircraft Design, Aircraft Engine Design Discipline: Curricular Outcomes

Outcomes	**Required Course**	**Electives**	**ABET EC 2000 Criterion 3 a-k Outcomes**
	AE 481	AE 482 or AE 483	
1. an ability to develop and evaluate engineering designs that meet customer needs	X		a,c,e,k
2. an ability to communicate effectively using oral, written, and graphical formats	X	X	g
3. an ability to work effectively as a member of a multidisciplinary team.	X	X	d
4. an ability to perform effective literature and internet research and demonstrate the ability to engage in lifelong learning	X	X	i
5. an ability to make morally responsible judgments about legal, environmental, and ethical implications of engineering, management, and business decisions.	X	X	f,h,i

8.7.2 Assessment Synopsis – The design discipline director, course directors, and instructors use several instruments to assess the effectiveness of the design sequence in achieving the discipline outcomes. Most important of these are the cut sheets used to grade cadet briefings and written reports. Each cut sheet lists all of the course outcomes and criteria covered by a given briefing or report, and all instructors evaluate each team product. The average scores on each criterion given to each cadet team by all the evaluators give a good indication of the success of the course in helping cadet meet the criteria of each outcome. If problems are discovered, these are reported in the course debriefs given at the end of each semester. Corrective action and the success of that action in improving cadet performance are also tracked and reported in the course debriefs.

Representatives from industry and government agencies also visit USAFA and evaluate cadet design projects. These practicing engineers give cadets and faculty feedback on the validity and quality of cadet design work, and on ways that the cadet design experience can be made more realistic and useful. This feedback is also reported as the other primary assessment tool in the course debriefs. Copies of the course debriefs are maintained in the course director and discipline director continuity books.

Recent assessment of the design course sequence has identified problems with completeness of cadet reports, noting that it was common for cadets to do required analysis correctly but then fail to include it in the report. A detailed grading cut sheet was made available to cadets when a given task was assigned, and this virtually eliminated the completeness problem.

A second problem with the design sequence involved assessing ethics. Engineering ethics is taught in these courses primarily through examples and built-in ethical dilemmas which occur as cadets accomplish the design tasks. Assessing these activities is challenging, because the level of ethical standards that a cadet has internalized is often difficult to determine. Beginning with the fall of 2001, cadets were given a case study and required to write an essay on how they would respond to the ethical dilemma it described. The results were very encouraging. Cadets consistently identified the ethical dilemma and in most cases decided to handle it by not compromising their own standards. Those who did not decide to take such a hard line stand found ways to satisfy their superior's demands without harming the customer and in the long run persuading their supervisor to change what they planned to do.

A third problem appears from time to time. It results from cadets tending to treat analysis software given to them as a "black box" without really understanding what it does or when its results may be questionable. The software was created to speed up the analysis process and allow cadets to complete several cycles of the design loop and optimize their designs. This allows them to create believable, useful design concepts that compare favorably with those created by professional engineers. In order to prevent cadets from the "black box" approach, they are now required to create sample calculations of every type of analysis the software performs. An experiment will be conducted in the fall of 2002 which will require cadets to actually code a spreadsheet that accomplishes all the analysis done by the software. If successful, and if it doesn't add too much to cadet workload, this spreadsheet will replace the sample calculations.

Except for the few small problems just mentioned, assessment of the design sequence indicates it is achieving the course and discipline outcomes. In particular, representatives from industry and government agencies have praised cadet design work for its high quality and usefulness.

8.7.3 Significant Student Achievements in Design – Cadet design projects are evaluated by representatives from industry and government agencies. These representatives have identified several recent cadet aircraft design projects as representing the best examples they have seen in academia. In addition, comparisons of cadet designs with actual aircraft designed by professional engineers reveal remarkable similarities and confirm that cadets are making similar design decisions and achieving results almost identical to those by professionals. Several recent examples were especially impressive in this regard.

In the spring of 1998, the Air Force Research Laboratory Air Vehicles Directorate gave USAFA cadets a request for proposals (RFP) for an uninhabited combat aerial vehicle (UCAV) designed to deliver two large satellite-guided bombs over a mission radius similar to that of modern manned strike fighters. At the time, no one at USAFA knew that the mission and performance requirements given to us by AFRL were very similar to those used in developing the Boeing X-45 UCAV now in production. As they developed this design and sized it, cadets made many of the same design decisions as those designers of the X-45, including sizing of the wings, fuselage, and engine, placing the bombs in a large lifting-body fuselage in bays on either side of the engine inlet and bay, and eliminating vertical and horizontal tail control surfaces. The resulting cadet design was strikingly similar in size and configuration to X-45, although we only discovered this more than a year later when the X-45 was revealed to the public.

In the spring of 1999, the UAV Battle Lab asked USAFA cadets to develop design modifications for the RQ-1A Predator reconnaissance UAV that would double or triple its maximum speed and altitude capabilities. The resulting cadet designs included turboprop and turbofan-powered aircraft with the desired performance, but which also incorporated several advanced technologies for specialized airfoils, de-icing systems, and drag-reduction strategies. When cadets briefed these results to the Predator program manager and his staff, many nodded their heads but said little else. In 2002, the turboprop Predator B was made public, revealing that the General Atomics engineers had made many of the same design changes as the cadets had suggested. Other design changes suggested by the cadets are now being considered by the Predator program office.

In the spring of 2000, the UAV Battle Lab gave USAFA cadets an RFP for a small UAV that could be carried in a soldier's back pack and deployed quickly and silently to provide infrared real-time airborne video of the area surrounding the soldier. The resulting cadet design was very close in size, weight, and configuration to the Eagle Eye UAV now being developed for the Marine Corps to provide the same capabilities. That UAV developed by professional engineers was revealed to the public later in 2000, after the cadets had developed their design. Once again, industry design work duplicated what the cadets did, validating the design tools and methods they had been taught.

Confidence by some civilian agencies in the design analysis methodologies taught at USAFA are so great that in 2000, Draper Labs at MIT asked some cadets and one instructor at USAFA to perform a design analysis of the Wide-Area Surveillance Projectile (WASP) gun-delivered surveillance UAV. The resulting study validated the majority of design decisions made by the WASP design team and identified some areas for possible improvement. This work so impressed the WASP team that one of the cadets was selected for a Draper Fellowship to allow them to work after graduation at Draper on development of other small UAVs.

In the spring of 2001, the 45th Space Wing at Patrick AFB in Florida asked USAFA cadets to develop a small UAV for range safety and resources monitoring duties on the Cape Canaveral missile range complex. A flying prototype was developed that year and demonstrated flying from the runway used by the Space Shuttle for landing near the Kennedy Space Center. Several design changes were mandated, and an improved version of the aircraft is being developed in 2002 and fitted with an autopilot provided by the customer. If successful, this UAV may be the first cadet aircraft design to go into limited production.

Figure 40 DFAN Aircraft and Aircraft Engine Design Discipline

In the spring of 2002, The Air Force Research Laboratory Air Vehicles (AFRL/VA) Directorate asked USAFA to investigate the feasibility of designing a solar-powered version of the "Sensorcraft" class of long-endurance reconnaissance UAVs. Cadets developed an analysis methodology for sizing solar-powered aircraft and applied it to the very demanding Sensorcraft mission. They briefed their results including trade studies to the AFRL/VA representatives and also gave them a copy of the spreadsheet they developed to implement their analysis and sizing methodology. The AFRL/VA engineers were extremely impressed with the cadets' work, and were especially pleased to have the spreadsheet which they plan to use to analyze other solar-powered aircraft.

8.7.4 Discipline Director Summary - The design course sequence is achieving its discipline outcomes, and in the process is arming cadets with the skills they need to function effectively as Air Force officers. While some effort is still needed to ensure cadets truly understand the analysis methods they are using, and further work is required in ethics instruction and assessment, the sequence is effectively preparing cadets to function as contract monitors, project officers, and design engineers as well as effective team members in a variety of problem-solving contexts. When practicing engineers comment that they are able to speak to cadets "like they are our peers" and when they say cadet work is, "the best they have ever seen," this is strong evidence of the success of the courses at achieving their outcomes.

8.8 Revised Aeronautical Engineering Curriculum

Revisions to the Academy's overall program have been developed to be implemented with the Class of 2006. The revisions take effect with the start of the Fall semester in August, 2002. The changes impacting the Aeronautical Engineering program are viewed by DFAN

as being helpful and will allow cadets more time to devote to Aero Engr courses. Figure 41 is a revised flow chart of the curriculum. The primary changes are:
(1) Reducing the first course in calculus (Math 141) by 1.5 credit hours.
(2) Replacing the core thermodynamics course (Engr 310) with new course, Aero Engr 241, Aero- Thermodynamics. This course will include introductory treatment for 1-D compressible gas dynamics along with introductory fundamentals of thermodynamics.
(3) Elimination of the core engineering design course, Engr 410.
(4) Elimination of a 6 cr. hr foreign language requirement.

Change (1) creates a 1.5 cr. hr reduction in the total program, while also allowing cadets to choose and mathematics course or a basic science course as an elective that better meets personal interests. Change (2) will provide coverage of thermodynamics in a manner better suited to the Aerodynamics and Propulsion Disciplines in the program. The vacancy created by transferring coverage of gas dynamics to Aero Engr 241 (formerly, this material was included in Aero Engr 361, Propulsion I, and Aero Engr 442, Advanced Aerodynamics) provided an opportunity to devote coverage to topics here-to-fore difficult to include in the program. For instance, the cascading effect for Aerodynamics (paragraph 8.2.2 above) now allows for a full course treatment on CFD.

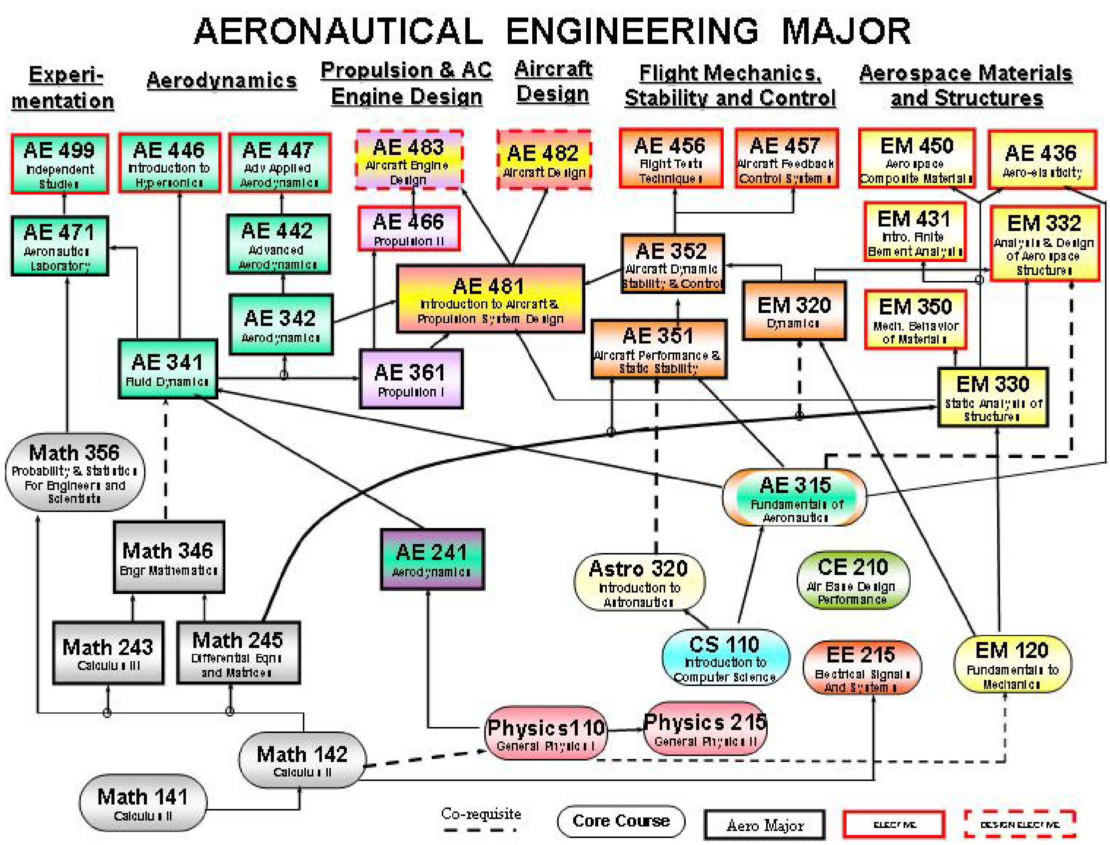


Figure 41 Revised DFAN Curriculum Flow Chart

8.9 Summary

DFAN believes that the performance data obtained thus far from both internal and external assessment measures show that the Aeronautical Engineering curriculum is properly designed to:

(1) Allow cadets opportunity to attain all program curricular outcomes.

(2) Fulfill all ABET EC 2000 criteria as specified in Criterion 8.

DFAN believes its faculty is empowered to, and does provide curricular changes according to procedures established in the Department to maintain program relevance.

DFAN believes that the faculty members are well prepared to provide instruction in the program disciplines. The faculty maintains proficiency as competent professional educators through participation in educational design seminars, participation in the professional community, and contemporary research and design projects.

Glossary

Term or Acronym	Description
AFIT	Air Force Institute of Technology, WPAFB, OH
AIAA	American Institute of Aeronautics and Astronautics
AIC	Advisor in Charge
APS	Academic Program Schedule
ASC	Aeronautical System Center,, WPAFB, OH
Classes	Class correspondence according to: First Class = Senior rank, Second Class = Junior rank, Third Class = Sophomore rank, Fourth Class = Freshman rank
Class of xx	Denotes year of graduation, e.g., Class of 2003 graduates in May 2003
Comprehensive Examination (CE)	DFAN Program Assessment Instrument
Core	The academic courses in Basic Sciences, Engineering, Humanities, and Social Sciences required of all cadets irrespective of major. Core currently consists of 31 courses: see USAFA Curriculum Handbook
Course Director (CD)	Faculty member in charge of a course within a discipline in the aeronautical engineering program.
CD-Debrief	Course review presented by the course director
CSRP	Cadet Summer Research Program
DASH-1	DFAN Annual Kick-off Seminar
DFR	Registrar, Dean of Faculty
Discipline	Knowledge and skills pertinent to a particular category. The aeronautical engineering program is defined by 6 disciplines: (1) Aerodynamics. (2) Aerospace Materials and Structures. (3) Propulsion. (4) Flight Mechanics, Stability and Control. (5) Experimental and Computational Investigations. (6) Aircraft and Aircraft Engine Design.
Discipline Director	Faculty member in charge of a discipline in the aeronautical engineering program.
DF	Dean of Faculty
DFAN	Department of Aeronautics (Dean of Faculty, Aeronautics)
EPAC	Engineering Program Advisory Council, part of the external advisory team.
Gateway Examination (GE)	DFAN Assessment Instrument: Program Prerequisite Knowledge

GPA	Grade Point Average (academic courses only)
Major	Academic discipline specialty of focused study
Majors Night	Job-Fair type function allowing undeclared cadets to preview academic specialties at USAFA
MPA	Military Performance Average
NCA	North Central Association: Provides accreditation for USAFA as an institution of higher education
Overload	Term in which a cadet takes more than 6 courses
OTS	Commissioning source: Officer Training School, Lackland AFB, TX
PCO	Program Curricular Outcome (equivalent to ABET Program Educational Outcome). Statement that defines knowledge, skill, ability at the time of graduation.
POC	Point of Contact
POG	Program Operational Goal (equivalent to ABET Program Objective). Statement that defines observable ability of alumni approximately 2-3 years beyond graduation.
PP	Permanent Professor: Department Heads
RFP	Request for proposals: part of government procurement process: introduced and used in DFAN design courses
ROTC	Commissioning source: program at civilian universities
STO	Sequential Tour Officer: Military faculty serving on extended assignment
Surveys	1. GS=Graduate Survey: Administered by Beh. Sci. Dept. to graduates: annual 2. CS=Climate Survey: Administered by Beh. Sci. Dept. to faculty: annual 3. EOCC=End of Course Critiques: Administered in all courses: Student Critique
TEBA	Senior-level DFAN committee responsible for ABET compliance and Program Review
UAV	Unmanned Arial Vehicle
UPT	Undergraduate Pilot Training
USAFA	United States Air Force Academy

Additional Program Data

Table D.1

The Aeronautical Engineering Major @ USAFA Pamphlet

The Aeronautical Engineering Major @ the United States Air Force Academy

August 2001

THE AERONAUTICAL ENGINEERING MAJOR

Successful completion of the Aeronautical Engineering Major leads to the degree of Bachelor of Science in Aeronautical Engineering. This degree is accredited by the Engineering Accreditation Commission of the Accreditation Board of Engineering and Technology. The aeronautical engineering profession involves the design, development, testing, manufacturing and maintenance of all atmospheric flight systems. Air Force aeronautical engineers are strongly involved in the national commitment of maintaining global air superiority through the deployment of state-of-the-art aircraft for the US Air Force. The Aeronautics Department at USAFA contributes actively to this commitment by preparing cadets for service to the Air Force as skilled entry level aeronautical engineers with competencies in six diciplines:

1. Aerodynamics
2. Aircraft and Aircraft Engine Design
3. Aerospace Materials and Structures
4. Propulsion
5. Aircraft Flight Mechanics
6. Experimental and Computational Investigations

Aerodynamics

The purpose of the Aerodynamics Discipline is to teach cadets how and why airplanes fly. With the foundations of flight and aerodynamics initially studied in the core engineering course, ***AeroEngr 315, Fundamentals of Aeronautics***, cadets acquire more in-depth knowledge on the principles of aerodynamics, fluid mechanics and gas dynamics with regard to flow physics of solid objects in flight. As airplanes fly faster, the flow physics affecting aerodynamic performance become more complex. Understanding these effects, and being able to use theory and mathematics to design airplanes correctly requires cadets to first learn the fundamentals and then build upon this understanding by applying the fundamentals to the aerodynamics of winged aircraft. Three courses in this discipline establish the foundations in aerodynamics that cadets use in the senior-year design courses, ***AeroEngr 481 & 482,*** to design, build and test specific aircraft.

Required Courses:

AeroEngr 341. Aeronautical Fluid Mechanics
AeroEngr 342. Aerodynamics.
AeroEngr 442. Advanced Aerodynamics

Electives:

AeroEngr 446. Introduction to Hypersonics

AeroEngr 447. Advanced Applied Aerodynamics

Aircraft and Aircraft Engine Design

The objective of the aircraft and aircraft engine design discipline is to teach cadets how to use their knowledge of aerodynamic principles to design and build an aircraft system, or to design an aircraft engine system or component, to meet specific customer needs. A two-course sequence is used to accomplish this objective. In the lead course,

AeroEngr 481, cadets learn the fundamentals of engineering design. Then, depending on preference, cadets continue their design experience by working on a real aircraft design (***AeroEngr 482***), or a real aircraft engine design (***AeroEngr 483***). In both courses, cadets have strong interaction with and very often present the results of their design project to industry engineers.

Required Courses:
AeroEngr 481, Introduction to Aircraft and Propulsion System Design plus one design elective
Design Electives:
AeroEngr 482. Aircraft Design
AeroEngr483. Aircraft Engine Design.

Aerospace Materials and Structures

STRUCTURES

The primary purpose of the Aerospace Structures and Materials Discipline is to give cadets basic knowledge and understanding of how aerospace structures are designed and built. Aircraft have very special but fundamentally simple requirements: they must be strong, failsafe and lightweight. Engineers designing or working on modern day aircraft systems must know how to make safe, lightweight structures. This means they must understand how to use composite materials and sturdy construction design strategies. Building on the foundations developed in ***EngrMech 120***, cadets learn the physical fundamentals affecting the design of basic aerospace structures. Emphasis is placed on learning to predict how beams bend, twist or buckle, and fail, and then using such knowledge to design lightweight safe structures. Following the required course, ***EngrMech 330,*** cadets select from the elective shown below to learn more about aircraft structures, or more about modern materials, or more about modeling and design using finite element analysis. **Materials** (requirement*:* ***EngrMech 330, Static Analysis of Structures***, and one Structures and Materials elective).

Required Courses:

EngrMech 330. *Static Analysis of Structures* plus one elective from the list below

Electives:

EngrMech 332. Aerospace Structures.
EngrMech 350. Mechanical Behavior of Materials.
EngrMech 431. Introduction to Finite Element Analysis.
EngrMech 450. Aerospace Composite Materials.
AeroEngr 436. Aeroelasticity.

Propulsion

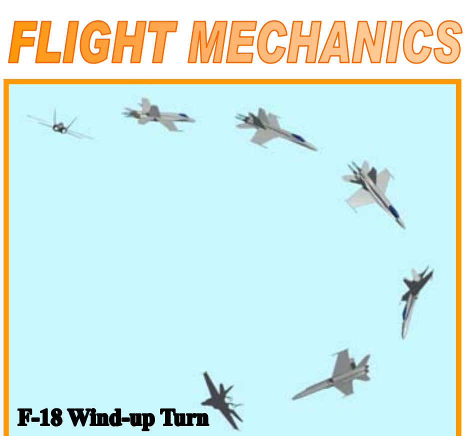
The primary purpose of the propulsion discipline is to provide fundamental knowledge and understanding of air-breathing propulsion systems. The required introductory course teaches the principles of propulsion to include a description and study of turbine engine components. Following this, cadets learn about many modern-day engines such as turbofans, turboprops, ramjets and scramjets. Cadets also learn about rocket systems and rocket nozzles. Since the gas flow through these systems is often very fast, cadets learn the fundamentals of compressible gas dynamics: shock waves, heat transfer, and friction effects in fast moving gas streams. Emphasis is placed on teaching these fundamentals using many real-world applications especially with regard to systems currently being used in Air Force airplanes.

Required:

AeroEngr 361, Propulsion I.

Electives

AeroEngr 466. Propulsion II.
AeroEngr 483. Aircraft Engine Design (capstone design course).
AeroEngr 495. Special Topics.
AeroEngr 499. Independent Study.



Aircraft Flight Mechanics, Stability and Control

The objective of the aircraft flight mechanics, stability and control discipline is to teach cadets the fundamentals of aircraft performance, stability, and control. Aircraft in flight experience many different forces. In addition to understanding how aircraft behave in takeoff, landing, maneuvering, and cruise modes, cadets learn how design insights are used to achieve controlled flights for conventional and high performance aircraft. Learning how aircraft are controlled in flight is an important aspect of this discipline. All aircraft have a variety of specially designed control surfaces, and a variety of sensors that tell how the aircraft is behaving. Together, these devices control the flight of the aircraft. To design these devices correctly, engineers first need to understand the forces acting on and influencing the motion of the aircraft, and the processes used to sense aircraft responses as intelligible signals that can be fed to a control system to improve the flight of the aircraft. A three-course sequence teaches these fundamentals

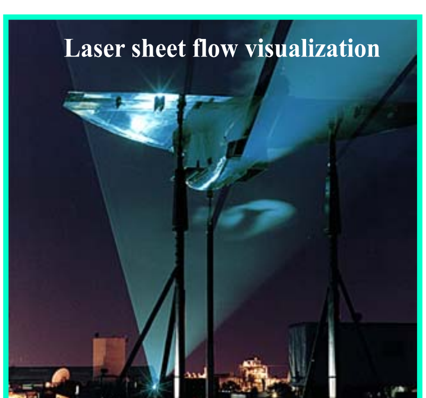
Required:
EngrMech 320. Dynamics.
AeroEngr 351. Aircraft Performance and Static Stability.
AeroEngr 352. Aircraft Dynamics Stability and Control.

Electives:
AeroEngr 456. (plus lab) Flight Test Techniques. (department permission required)
AeroEngr 457. Aircraft Feedback Control Systems.

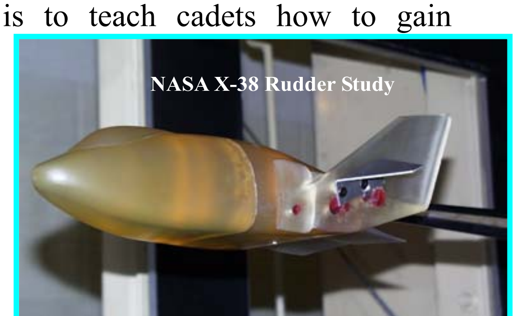
AeroEngr 456, Flight Test Techniques, is a unique offering at USAFA. Based around four flights in a Cessna T-41D aircraft at USAFA, cadets learn to develop, execute, and present the results from performance and flying qualities of this aircraft. In the final project, cadets conduct a flight test evaluation of the Northrop T-38A supersonic advanced trainer aircraft at the Air Force Flight Test Center, Edwards Air Force Base, CA.

Experimental and Computational Investigations

AERODYNAMICS

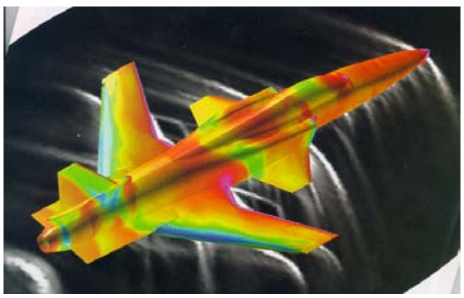


The primary purpose of the experimental and computational investigations discipline is to teach cadets how to gain understanding of aerodynamic phenomena through the use of experimental and



EXPERIMENTATION

computational methods. In one required course**,** cadets learn how to plan and conduct wind tunnel experiments in which the lift and drag forces acting on aircraft models are measured. They also learn to analyze and interpret these measurements so that good decisions can be made about the design of new aircraft. Throughout the curriculum, cadets learn how to use computer models to understand the physics associated with air flowing over aircraft wings and bodies. This understanding promotes the development and evaluation of new ideas about how to make aircraft fly faster, higher, further and with greater maneuverability. In ***AeroEngr 442, Advanced Aerodynamics,*** cadets learn the fundamentals of computational fluid dynamics (CFD), and how to use existing CFD codes to obtain information on an actual problem. Electives involving research are available.



Required:
AeroEngr 471. Aeronautical Laboratory.

Electives:
AeroEngr 495. Special Studies.
AeroEngr 499. Independent Study. (cadet research)

AERONAUTICS MAJOR COURSE REQUIREMENTS: 158 Semester Hours

A. 94 Semester hours of academic core courses to include the following core alternates:

Astro 320 Intro to Astronautics for the Engineer and Scientist (replaces Astro 410)
Math 356 Probability and Statistics for Engineers and Scientists (replaces Math 300)

B. 15 Semester hours of other core courses:

9 Semester hours of Commandant's academic core courses (Military Strategic Studies)
6 Semester hours of Director of Athletics core courses (Physical Education)

C. 48 Semester hours of major's courses:

1. Math 243 Calculus III
2. Math 245 Differential Equations and Matrices
3. Math 346 Engineering Math
4. EngrMech 320 Dynamics
5. EngrMech 330 Static Analysis of Structures

6. AeroEngr 341 Aeronautical Fluid Mechanics
7. AeroEngr 342 Aerodynamics
8. AeroEngr 351 Aircraft Performance and Static Stability
9. AeroEngr 352 Aircraft Dynamic Stability and Control
10. AeroEngr 361 Propulsion I
11. AeroEngr 442 Advanced Aerodynamics
12. AeroEngr 471 Aeronautics Laboratory
13. AeroEngr 481 Introduction to Aircraft and Propulsion System Design
14. Design Elective
    a. AeroEngr 482 Aircraft Design or
    b. AeroEngr 483 Aircraft Engine Design
15. AeroEngr Elective (See information below)
16. Structures and Materials Elective (see information above)

AeroEngr Elective:

You will choose your elective(s) based on a chosen "specialty" from the six disciplines discussed above. The AeroEngr Elective must be either one of the Structures and Materials Electives or one of the following:

a. EngrMech 432 Finite Element Analysis (prereq: EngrMech 431)
b. MechEngr 441 Heat Transfer
c. AeroEngr 446 Introduction to Hypersonics
d. AeroEngr 447 Advanced Applied Aerodynamics
e. AeroEngr 456 Flight Test Techniques (department permission required)
f. AeroEngr 457 Aircraft Feedback Control Systems
g. AeroEngr 466 Propulsion II
h. MechEngr 467 Energy Conversion
i. AeroEngr 482 Aircraft Design (if not used as design option)
j. AeroEngr 483 Aircraft Engine Design (if not used as design option)
k. AeroEngr 495 Special Topics (3 sem hrs only, Dept permission required)
l. AeroEngr 499 Independent Study (3 Sem hrs only, Dept permission req.)
m. Other Engineering or Basic Science courses with department permission.

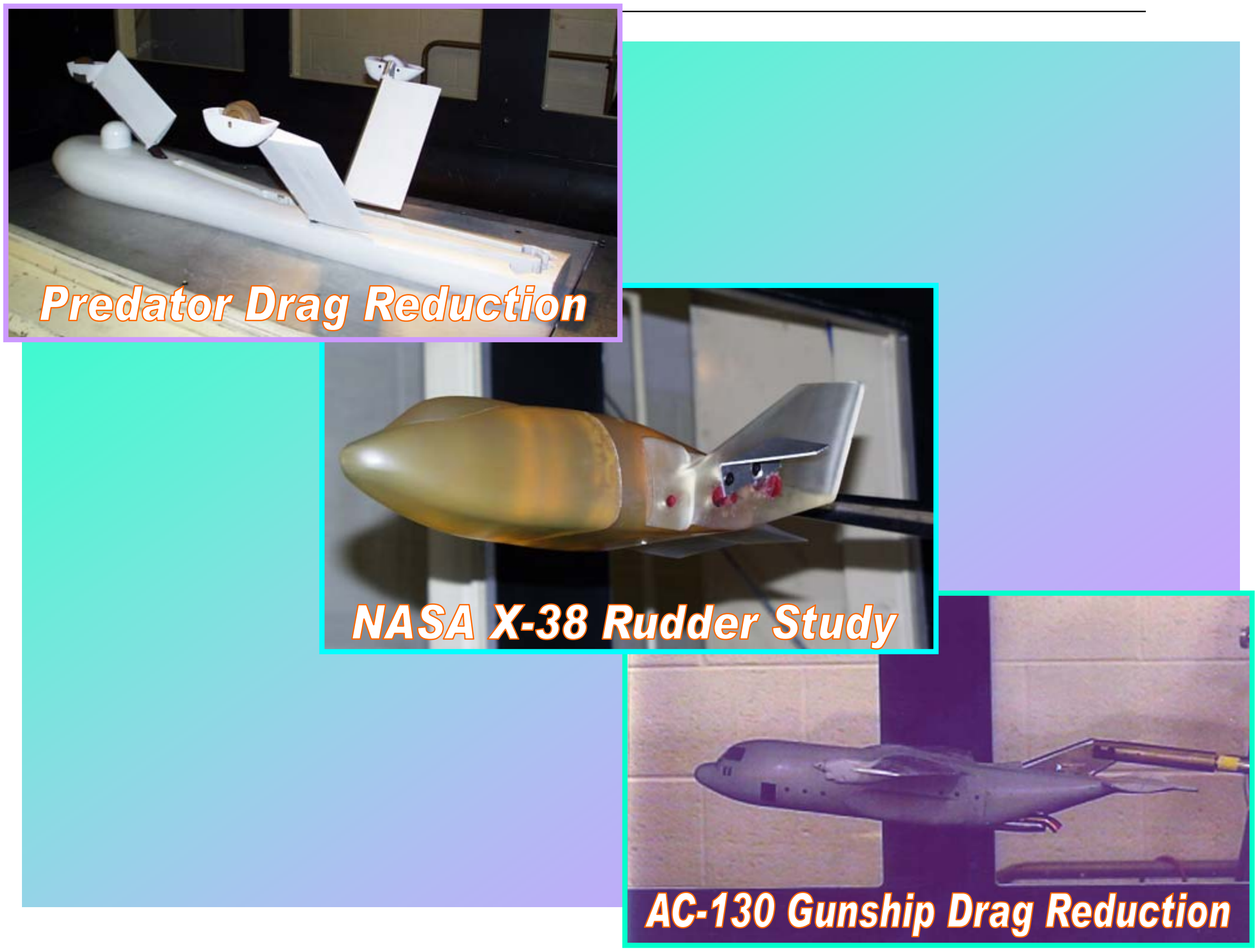
Check your APS and the Curriculum Handbook for the proper sequence of technical core and prerequisite courses to enable you to take AEROENGR 315 and ENGR 310 in your third class year. (Normal sequence: AEROENGR 315 - FALL; ENGR 310 - SPRING). To get the latest information, please talk to an aero advisor:

Class of 2004 Advisors

Capt Todd Krueger (AIC) 3-8564
Capt David McDaniel 3-8510
Capt Tony Mitchell 3-8495
Capt Scott Nowlin 3-3438
Col Neal Barlow 3-4010

Class of 2005 Advisors

Maj Keith Boyer (AIC) 3-2619
Dr. Steve Brandt 3-2207
Dr. Tom Yechout 3-9089
Capt Bob Kraus 3-4315



AERONAUTICS LABORATORY

Stretching across 55,000 square feet and valued at $120M, the Aeronautics Laboratory is arguably the finest undergraduate research facility in the world. In addition to full classroom support, cadet and faculty teams conduct well over 30 AF, DoD, and NASA sponsored research projects annually, valued in excess of $1.6M.

Major Tunnels	Engine Test Cells	Other Teaching Aids

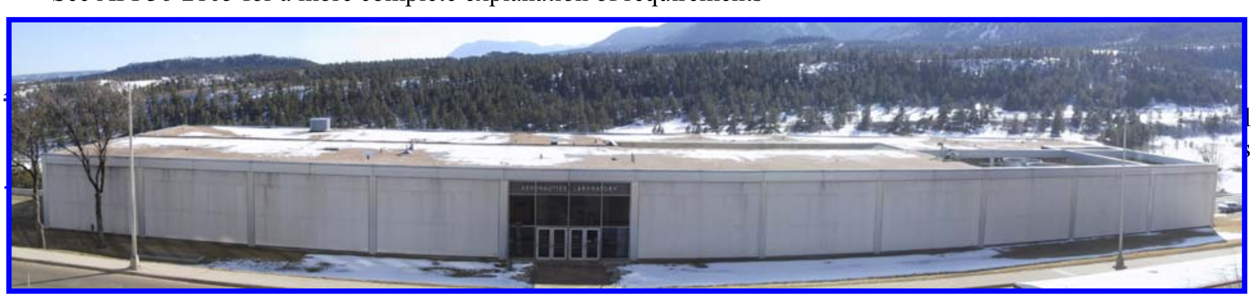
1' x 1' Trisonic 3' x 3' Subsonic 3' x 3' Low Speed 15" x 20" Water 3' x 2' Cascade	F-109 Turbofan J-85 Turbojet J-69 Turbojet Rocket Auto Engine T-63 Turboshaft	Flight Simulator Smoke Tunnel 12" Low Speed Tunnels 1" Supersonic Tunnels Laminar Flow Tables High Perf Computer Center

AIR FORCE OPPORTUNITIES FOR AERONAUTICAL ENGINEERS

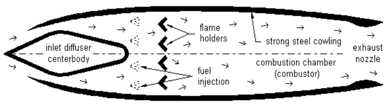
Aeronautical engineers are responsible for the research, design, development and testing of the aerospace vehicles that put the "Air" in Air Force. The Aeronautical Engineering major qualifies you for an aeronautical engineering AFSC (62EXA; Development Engineer, Aeronautical) and many other AFSCs. As an aeronautical engineer you may be involved in "hands on" aeronautical research and development of aircraft, missiles and propulsion systems. At some point in your Air Force career, you can expect to work on programs ranging from basic research through full-scale development of major weapon systems. Your work may involve experimentation, technical analysis of aeronautical systems performance, flight test or program management of aeronautical systems under development. Aeronautical Engineering majors are eligible for graduate programs in Aeronautical Engineering. Officers with Aeronautical Engineering majors are academically qualified for USAF Test Pilot School as a test pilot, test navigator or flight test engineer. Approximately 100 flight test engineer positions are open in the Air Force. These positions are staffed by individuals who regularly fly in flight test or test chase aircraft. Other Air Force Specialty Codes that you will be qualified for include:

AFSC	Duty Title	Minimum Grade Requirement*
11EX	Experimental Test Pilot	2 Lt
12EX	Experimental Test Navigator	2 Lt
21AX	Aircraft Maintenance/Munitions	2 Lt
22SX	Space and Missile Maintenance, Missile	2 Lt
61SXA	Scientist, Analytical	2 Lt
62EXG	Developmental Engineer, Project	2 Lt
62EXF	Developmental Engineer, Flight Test	2 Lt
63SX	Acquisition Manager	2 Lt

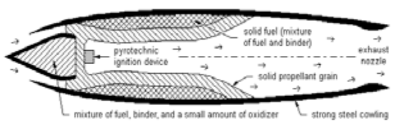
- See AFI 36-2105 for a more complete explanation of requirements



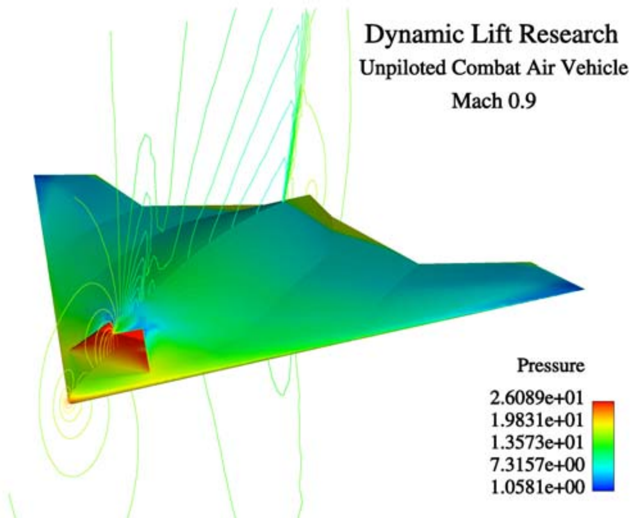
Arnold AFS, Tennessee
Brooks AFB, Texas
Edwards AFB, California
Eglin AFB, Florida
Hill AFB, Utah
Kirtland AFB, New Mexico
Los Angeles AFB, California
Robbins AFB, Georgia
Tinker AFB, Oklahoma
Wright-Patterson AFB, Ohio

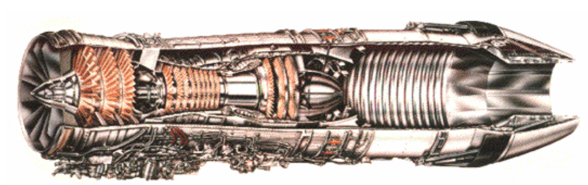


Liquid Propellant Ramjet



Solid Fuel Ramrocket at Launch - Rocket Mode





F110-GE-129 Afterburning Turbofan


AEDC
Arnold Engineering
Development Center
Arnold Air Force Base, TN

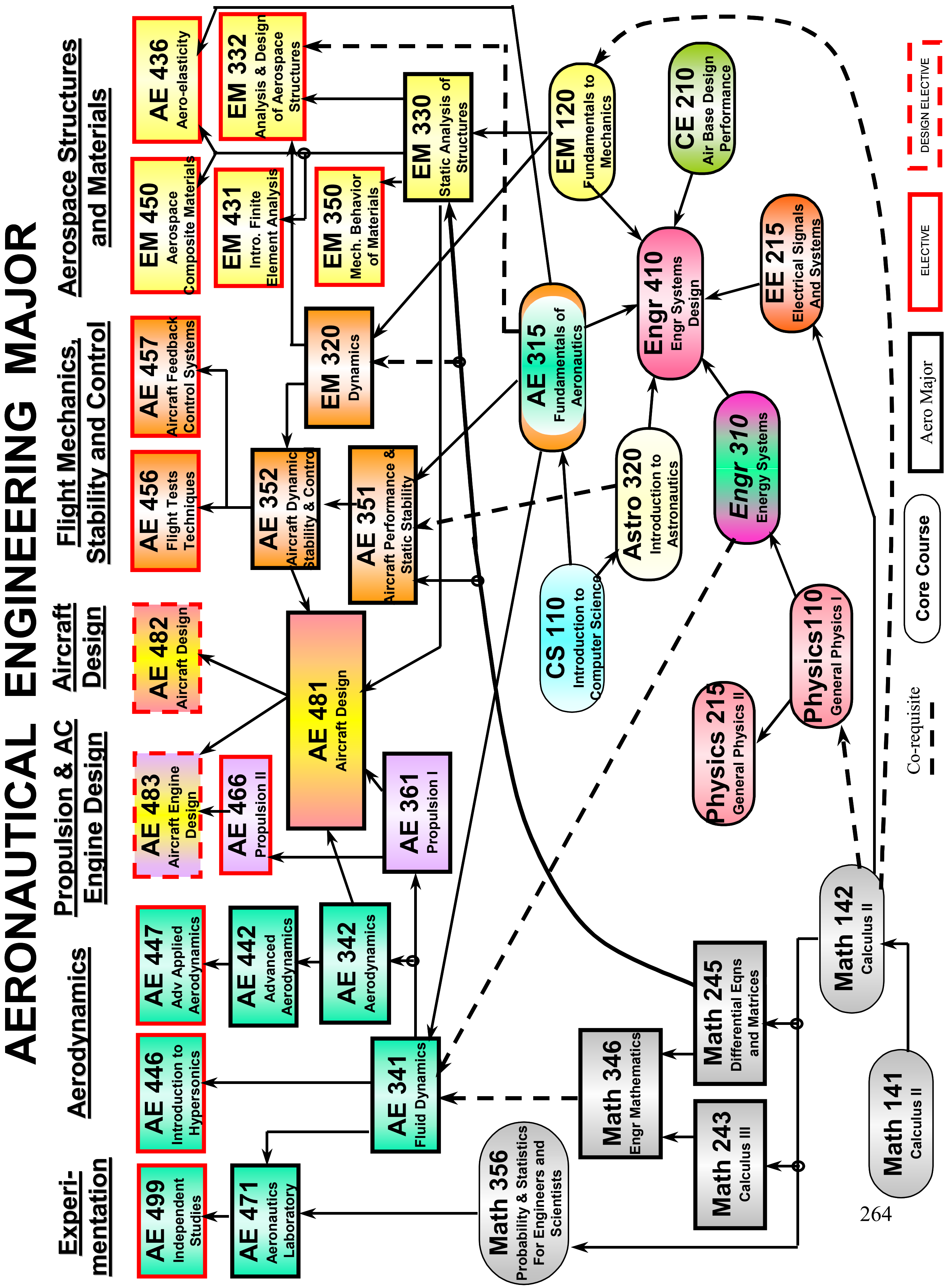

AERONAUTICAL ENGINEERING MAJOR
Experi-mentation
Aerodynamics
Propulsion & AC Engine Design
Aircraft Design
Flight Mechanics, Stability and Control
Aerospace Structures and Materials
AE 499 Independent Studies
AE 471 Aeronautics Laboratory
AE 446 Introduction to Hypersonics
AE 341 Fluid Dynamics
AE 447 Adv Applied Aerodynamics
AE 442 Advanced Aerodynamics
AE 342 Aerodynamics
AE 483 Aircraft Engine Design
AE 466 Propulsion II
AE 361 Propulsion I
AE 482 Aircraft Design
AE 481 Aircraft Design
AE 456 Flight Tests Techniques
AE 352 Aircraft Dynamic Stability & Control
AE 351 Aircraft Performance & Static Stability
AE 457 Aircraft Feedback Control Systems
EM 320 Dynamics
EM 450 Aerospace Composite Materials
EM 431 Intro. Finite Element Analysis
EM 350 Mech. Behavior of Materials
AE 436 Aero-elasticity
EM 332 Analysis & Design of Aerospace Structures
EM 330 Static Analysis of Structures
Math 356 Probability & Statistics For Engineers and Scientists
Math 346 Engr Mathematics
Math 243 Calculus III
Math 245 Differential Eqns and Matrices
Math 141 Calculus II
Math 142 Calculus II
CS 110 Introduction to Computer Science
Astro 320 Introduction to Astronautics
AE 315 Fundamentals of Aeronautics
Physics 215 General Physics II
Physics110 General Physics I
Engr 310 Energy Systems
Engr 410 Engr Systems Design
EM 120 Fundamentals to Mechanics
CE 210 Air Base Design Performance
EE 215 Electrical Signals And Systems
Co-requisite
Core Course
Aero Major
ELECTIVE
DESIGN ELECTIVE

Table D.2
Agenda, Fall Dash-1, August 2001Aeronautical Engineering

DASH 1

Fairchild Hall, H-2
1500 – 1700
6 Aug 2001

Agenda

Section	Description
I (20 min)	**Opening Remarks and Welcome**
II (10 min)	**ABET Overview** 1. ABET & EC-2000 2. Aero Engr Program Outcomes 3. Assessment: 4. Gateway & Comprehensive Exams
III (20 min)	**The USAFA Aero Engr Program** 1. Aerodynamics 2. Aerospace Materials and Structures 3. Propulsion 4. Flight Mechanics, Stability and Control 5. Aircraft and Engine Design 6. Experimentation
IV (5 min)	**Air Force Engineers** 1. Career opportunities/progressions 2. Entry Level jobs
V (5 min)	**Emerging Initiative** Aero Optics & Related Laser-Based Technology
VI (5 min)	**AIAA** 1. The Association The USAFA Student Section
VII (5 min)	**Honor Societies** 1. Tau Beta Pi 2. Sigma Gamma Tau
VIII	**Questions & Answers**
IX	**Ice Cream**
X	**1st Degree Section** 1. Grad School Opportunity (Dr. Lavin) 2. Scholarships (Dr. Lavin) 3. Aero Council (Capt Wolf)

Table D.3 Academy Program Summary: Sample

ACA! C PROGRAM SUMMARY **F l Data - Privacy Act of 1974** **Γ Q2 System**

Snapshot Date: 1. 2002 22:57

SSAN: [illegible]
Name: [illegible] **CUM GPA:** 3.99 **Advisor:** Dr. Havener, George A.
CL YR: 2004 **SQ:** 29 **Core GPA:** 3.99 **Entry Med:** 3 **Aca Comp:** 3850
Major: AERO **Major GPA:** 4 **Curr Med:** 3 **State:** CO **CUM Credit Hours:** 0063.00

Summer 2000

ENGLISH	111	3.0		X
MATH	141	4.5		X
MATH	142	3.0		X
MIL TNG	100	.0		P
PHY ED	100	.0		P
SPANISH	131	3.0		X
SPANISH	132	3.0		X
GPA	MPA	16.5	PEA	

Fall 2000

CHEM	141	3.0	A	A
ECON	221FR	3.0	A	A
ENGRMECH	120FR	3.0	A	A
MATH	243FR	3.0	A	A
PDP	100	.0		
PHY ED	116CD	1.0		A
PHYSICS	110H	3.0	A	A
GPA	MPA	16.0	PEA	
4.00 4.00	3.500 3.500	2.92 2.92		
HONORS DC				

Spring 2001

BIOLOGY	215	3.0	A	A
CHEM	142	3.0	A	A
COMP SCI	110	3.0	A	A
ENGLISH	211FR	3.0	A-	A
HISTORY	101	3.0	A	A
MSS	111H	3.0	A	A
PDP	101	.0		
PHY ED	114H	.5		A-
PHYSICS	215H	3.0	A	A
GPA	MPA	21.5	PEA	
3.99 4.00	2.750 3.125	2.82 2.89		
HONORS D				

Summer 2001

EL ENGR	215	3.0		A
MIL TNG	220AC	.0		P
MIL TNG	260DE	.0		P
MIL TNG	307EF	.0		P
GPA	MPA	3.0	PEA	
4.00 4.00	9.999 3.125	0.00 2.89		

Fall 2001

ARMNSHP	251B	.0		P
BEH SCI	200	4.5	A	A
CIV ENGR	210	2.5	A	A
ENGR	310	3.0	A	A
HISTORY	202	3.0	A	A
MATH	245	3.0	A	A
PDP	200	.0		
PHY ED	340A	.5		B-
POL SCI	211	3.0	A	A
RUSSIAN	131	3.0	A	A
GPA	MPA	22.5	PEA	
3.97 3.99	3.750 3.333	2.60 2.83		
HONORS DC				

Spring 2002

AEROENGR	315	3.0		
ARMNSHP	461	.0		P
ASTRO	320	3.0		
MATH	346	3.0		
MGT	210	3.0		
PDP	201	.0		
PHILOS	310	3.0		
PHY ED	111G	.5		
PHY ED	222H	.5		
POL SCI	312	3.0		
RUSSIAN	132	3.0		
GPA	MPA	22.0	PEA	
0.00 3.99	9.999 9.999	0.00 2.83		

Summer 2002

ARMNSHP	472	.0	P
MIL TNG	301	.0	P
MIL TNG	444	.0	
		.0	

Fall 2002

AEROENGR	341	3.0
AEROENGR	351	3.0
ENGRMECH	320	3.0
MATH	356	3.0
MSS	311	3.0
PDP	300	.0
PHY ED	215C	.5
PHY ED	315D	.5
RUSSIAN	221	3.0
		19.0

Spring 2003

AEROENGR	342	3.0
AEROENGR	352	3.0
AEROENGR	361	3.0
AEROENGR	471	3.0
ENGRMECH	330	3.0
PDP	301	.0
PHY ED	341H	.5
RUSSIAN	222	3.0
		18.5

Fall 2003

AEROENGR	442	3.0
AEROENGR	481	3.0
ENGR	410	3.0
ENGRMECH	450	3.0
MATH	469	3.0
PDP	400	.0
PHY ED	484B	.5
PHY ED	486D	.5
RUSSIAN	223	3.0
		19.0

Spring 2004

AEROENGR	482Z	3.0
ENGLISH	411	3.0
FORARSTU	440	3.0
LAW	310	4.5
MSS	411	3.0
PDP	401	.0
PHY ED	483G	.5
RUSSIAN	321	3.0
		20.0

Validation Credit

ENGLISH	111	2000A
MATH	141	2000A
MATH	142	2000A
SPANISH	131	2000A
SPANISH	132	2000A

Athletic Squads

IWAC	Fall
IRQC	Spring

Military Position

C1 ASSISTANT	Fall
SQ-3DEG-ELB2	Spring

Page 1 of 1 **Personal Data - Privacy Act of 1974**

Table D.4 Aeronautics Department CSRP History

CSRP Project	Sponsoring Agency
Hard Target Defeat Project	AF Research Laboratories, Weapons Test Center, Eglin AFB, FL
Unified Instrumentation Tests	NASA Langley Research Center, VA
Boeing Conceptual Theater Transport	AF Research Laboratories, Wright-Patterson AFB, OH
Fan Section of JSF's Engine	AF Research Laboratories, Wright-Patterson AFB, OH
Strike Eagle Spin Analysis	The Boeing Co, St Louis, MO
Weapons Separation	The Boeing Co, St Louis, MO
X-33 Reentry Trajectory	AF Research Laboratories, Wright-Patterson AFB, OH
Turbine Blade Heat Transfer	AF Research Laboratories, Wright-Patterson AFB, OH
Heat Transfer for Rocket Nozzles	AF Research Laboratories, Rocket Test Center, Edwards AFB, CA
CFD of Spinning Aircraft	Arizona State University, AZ
C-130 with the Back-Door Down	AF Research Laboratories, Wright-Patterson AFB, OH
Turbine Blade Heat Transfer	AF Research Laboratories, Wright-Patterson AFB, OH
X-38 Reentry Heating	NASA Johnson Space center, Houston , TX
Analysis of Organic Compounds	AFRL, Wright-Patterson AFB, OH
Visually Represent Axial Airflow	AF Arnold Engineering Development Center, TN
Aero-thermo Environment for Body-Flap	NASA Johnson Space Center, Houston, TX
Analyze Compressors using Neural Nets	Arnold Engineering and Development Center, TN
Analyze Problem Flow in a Wind Tunnel	Arnold Engineering and Development Center , TN
Interpret Instrumentation Readings	Arnold Engineering and Development Center, TN
Space-Based Laser	AF Research Laboratories, Phillips Laboratories, Kirtland AFB, NM
F-16 Flight-Test Data	Air Force Flight Test School, Edwards AFB, CA
Analyze Flight-Testing the AC-130H Gunship	Air Force Material Command, Air Logistic Center, Warner Robins AFB, GA
Low-Speed Flight Tests of the X-38	NASA Johnson Space Center, Houston, TX

Table D.5 Faculty and Cadet Professional Travel History

Period of Travel (Total Trips)	Number of Trips	Number of Faculty (Number of Cadets)	General Category of Travel
2001 – 2002 (86)	(10)	(12)	Professional Society Meeting & Conferences
	(49)	(15)	Workshops, Continuing Education, Planning meetings
	(12)	(15) (80)	Joint Faculty-Cadet Trip: Student Conferences, and Contractor Project Meetings
	(15)	(10)	Military Specific Meetings
2000 – 2001 (57)	14	11	Professional Society Meeting & Conferences
	19	11	Workshops, Continuing Education, Planning meetings
	11	9 (20 cadets w/repeats)	Joint Faculty-Cadet Trip: Student Conferences, and Contractor Project Meetings
	13	8	Military Specific Meetings
1999 – 2000 (49)	3	17	Professional Society Meeting & Conferences
	14	15	Workshops, Continuing Education, Planning meetings
	9	19 (100 w/ repeats)	Joint Faculty-Cadet Trip: Student Conferences, and Contractor Project Meetings
	13	11	Military Specific Meetings
1998 – 1999 (81)	7	15	Professional Society Meeting & Conferences
	(49)	(19)	Workshops, Continuing Education, Planning meetings
	(10)	(10) (50 w/ repeats)	Joint Faculty-Cadet Trip: Student Conferences, and Contractor Project Meetings
	15	10	Military Specific Meetings
1997 – 1998 (78)	8	15	Professional Society Meeting & Conferences
	41	16	Workshops, Continuing Education, Planning meetings
	6	12 (80)	Joint Faculty-Cadet Trip: Student Conferences, and Contractor Project Meetings
	23	12	Military Specific Meetings
1996 – 1997 (63)	14	11	Professional Society Meeting & Conferences
	(26)	(17)	Workshops, Continuing Education, Planning meetings
	(8)	(13) (60 w/repeats)	Joint Faculty-Cadet Trip: Student Conferences Contractor Project Meetings
	15	8	Military Specific Meetings

(XX) Estimates

Table D.6 DF Educational Outcomes

Educational Outcome	Description
Officers who possess breadth of integrated, fundamental knowledge in the basic sciences, engineering, the humanities, and social sciences, and depth of knowledge in an area of concentration of their choice.	Breadth of fundamental knowledge in these four domains is the essential foundation of intellectual competence and adaptability in a complex and changing world. More than knowing mere facts, integrated, fundamental knowledge refers to competence in solving basic problems characteristic of different disciplines and in discerning key interrelationships among disciplines. This knowledge-base must also provide graduates with an awareness of the technological, social, political, and economic complexities that awareness and the abilities described in the remaining outcomes.
Officers who are intellectually curious.	Beyond possessing knowledge and having abilities to put that knowledge to active use, graduates of the Academy must be inclined to do so. We want to develop an attitude of intellectual curiosity in our graduates that predisposes them to lifelong learning.
Officers who can communicate effectively.	Effective communication is the ability to transmit and receive information with a high probability that the intended meaning is passed from sender to receiver. This requires speaking, writing, reading and listening skills ad may involve symbolic forms as well as natural language, the use of various media and information systems, and the ability to communicate with varied audiences in impromptu as well as planned settings.
Officers who can frame and resolve ill-defined problems.	Ill-defined problems are ambiguous, interactive and ever-changing. Framing means constructing a working model, and revising it based on feedback. Resolving means that an ill-defined problem is never solved for good; rather it is solved again and again (re-solved) as the problem is framed again and again; and each successive solution is more refined (resolution).
Officers who can work effectively with others.	Officers work with people varying in rank, position, gender, race, attitudes, abilities, cultural background, etc. And they do so facing diverse tasks and demands. While there is no simple recipe for success, working effectively with others involves the ability to adapt to a wide variety of working relationships and challenges in ways that foster both mutual respect and long-term unit effectives.
Officers who are independent learners.	Learning independently does not imply learning along. Rather, it means a learner who has learned how to learn. Therefore, the learner can make valid judgments about what to learn and how to learn it, and is capable of assessing the results.
Officers who can apply their knowledge and skills to the unique tasks of the military profession.	This outcome sets us apart from other academic institutions. Our graduates must be able and willing to use the basic intellectual foundations provided by their education to master the art of war.

Table D.7 United States Air Force Academy Character Outcomes

Character Outcome
Officers with forthright integrity who voluntarily decide the right thing to do and do it.
Officers who are selfless in service to their country, the Air Force, and their subordinates.
Officers who are committed to excellence n the performance of their personal and professional responsibilities.
Officers with the self-discipline, stamina, and courage to do their duty well under even the most extreme and prolonged conditions of national defense
Officers who respect the dignity of all human beings.
Officers who are decisive, even facing high risk.
Officers who take full responsibility for their decisions.
Officers who understand the significance of spiritual values and beliefs to their own character development and that of the community.

Table D.8 Core Courses on Ethics and Military Professionalism

Course Number	Name	Catalog Description
Beh Sci 200	An introduction to Behavioral Sciences and Leadership.	This course provides an introduction to the scientific study of human behavior at the individual level, addresses fundamental knowledge about living and working in small groups (such as families or military units), and introduces the student to sociology and anthropological perspectives on the structure and function of larger social groups. The course also provides an introduction to the study of leadership with particular emphasis on multiple perspectives for analyzing leadership situations so cadets can better understand and enhance individual and group performance. The course makes extensive use of experiential exercises that reinforce psychological principles and leadership skills that complement basic concepts.
Law 310	Law for Commanders.	An introductory course examining the nature of law, legal reasoning and the legal system. Examination of the constitutional foundations of the legal system, including the military justice system. Extensive analysis of the role of the military in society, including the legal status of command, and the military disciplinary system. Review of substantive areas of the law encountered by military officers in their personal and official capacities, including criminal law, torts, contracts, property, family law, administrative law and the law of armed conflict
Philos 310	Ethics	A critical study of several major moral theories and their application to contemporary moral problems with special emphasis on the moral problems of the profession of arms.
MSS 111	Introduction to Military Strategic Studies	Introduction to Air Force officership, military theory, doctrine, and strategy. Examines the fundamental ideas of the profession of arms and military strategy and their application to warfare. Studies of key leaders and important operations highlight the professional character and theories needed to understand the military strategic process.
MSS 310/311	Foundations of Military and Aerospace Power.	Examines key concepts of military theorists and of air and space theory and doctrine. Case studies and employment exercise illustrate the relationships between doctrine, strategy, force, command relationships, training, and combat operations. Final exam. Prereq: AFO 110; C2C standing or C3C standing with course director approval.
MSS 411	Introduction to Joint and Multinational Operations.	Examines joint U.S. military doctrine and employment concepts. Students relate the basic doctrines of all U.S. services to current crisis situations and employment concepts. Case studies of military operations are used to illustrate course concepts. A crisis exercise is utilized to apply these concepts in a simulated joint conflict.

Table D.9a EPAC Charter: Cover Page

CHARTER

Engineering Program Advisory Council
For
Aeronautical, Astronautical,
Engineering-Mechanics, and Mechanical
Engineering Programs at USAFA

Established
December 1999

United States Air Force Academy
Colorado 80840

Table D.9b EPAC Members

Title	Engineering Specialization
Executive Director	Aircraft Materials Structures
Dean Air Force Institute of Technology	Engineering Education Graduate School
Commander	Aircraft propulsion
Chief Scientist	Aerospace Materials
Chief Scientist	Aircraft Structures
Chief Scientist	Aerodynamics
Group Scientific Officer & Chief Engineer	Propulsion
Manager, Technology Directorate	Aerodynamics Ground Testing
Chief, Engine Propulsion Directorate	Thermal Sciences Propulsion Turbine Aero-Thermal Research
Chief Air Vehicles Design	Aircraft Design
Colonel & Commandant	Aircraft Flight Mechanics
	Aerospace Materials & Structures
Lt Colonel Deputy Chief	Astronautics
Colonel, USAF Vice Director	Astronautics
Technical Advisor	Astronautics
Lt Colonel Director of Operations	Astronautics

Table D.10 POG Assessment Data: Supervisor Evaluation for Cadets in CSRP

Program Educational Outcome	**Supervisors' Comments**
1.Possess breadth of integrated, fundamental knowledge in engineering , basic sciences , social sciences, and humanities; and depth of knowledge in aeronautical engineering.	On the Cadet's first day, Dr. Davis gave Cadets Roberts and Rosario a set of partial notes on compressor aerodynamics and thermodynamics (a technique used by Dr. Davis to teach undergraduates at a local university) and an advanced text book on gas turbine propulsion, **Mechanics and Thermodynamics of Propulsion** by Hill and Peterson.. Their first task was to fill out the partial notes and understand the terminology contained within the chapter 7 of Hill and Peterson. Both cadets took on this task eagerly and completed it to Dr. Davis' satisfaction. This provided them with the specific background necessary to communicate with the technical leaders to accomplish the task in compressor aerodynamics. Both cadets could not have done their respective tasks without an appropriate set of prerequisite classes prior to the summer work experience at AEDC. To understand Chapter 7 of Hill and Peterson, the cadets needed a good understanding of basic thermodynamic concepts such as work, energy, and the application of the 1st law of thermodynamics. In addition, the cadets needed to understand the concepts of gas turbine propulsion to undertake the advanced compressor aerodynamics. Dr. Steinle provided Cadets Rosario and Sobecki with background material to review and gave them a brief overview of the problem. Cadet Rosario was introduced to the topic of Neural Net and Cadet Sobecki was introduced to the concept of digital filtering. Cadets Roberts, Rosario and Sobecki had sufficient background that they were able to rapidly grasp the fundamental issues and become productive. Cadet Sammons' role was heavily "hands-on" in construction of the model. His technical knowledge and background was used in the assembly process that required application of mathematical principles and interpretation of engineering drawings.
2. Communicate effectively.	All three cadets, when in a setting that required verbal communication with the technical leaders, demonstrated excellent ability to communicate their ideas and questions. On several occasions, each cadet got "stuck" because of his limited background in comparison to the complexity of the task. At these points, the cadets took the opportunity to discuss their technical problems with the appropriate leader and got the required guidance. This action is not always easy for many people because they think they should be able to or are expected to solve all problems that come their way. It takes a mature person to begin to understand that there are times when it is necessary to ask others for help. Asking questions is necessary for learning. Cadet Sammons demonstrated effective communication skills by his manner of suggesting improvements to the model construction process and asking questions when the situation warranted. At the end of the seven-week period at AEDC all cadets prepared and gave oral presentations to the Base Commander, other AEDC Air Force personnel and Sverdrup technical leaders about their activities at AEDC. Without exception, all cadets gave professional presentations that were easily understood by all in the audience.

3. ***Work effectively on teams and grow into team leaders.***	Each cadet was assigned a technical leader who provided guidance and technical leadership while the cadets were at AEDC. Even though, the cadets were more in a follower role in this mode, they exhibited the desire to work with other engineers to accomplish the task set forth. In one case, Cadet Roberts was assigned to work with a summer intern from Tennessee Tech to aid in the development of a methodology for portraying compressor blade performance visually. Since many of the aerodynamic concepts were new to both the summer intern and cadet Roberts, teaming of these two individuals worked well. As one would get stuck, the other could fill in with information or determine a means to obtain that information because of their different backgrounds. Later on, even Cadet Rosario worked with Cadet Roberts and the summer intern when his task required compressor aerodynamic calculations and visualization. Cadets Rosario and Sobecki worked directly with Dr. Steinle. Cadet Sammons demonstrated the ability to follow instructions as well as take initiative when required. He was required to work with other individuals ranging from inexperienced temporary summer employees to experienced engineering staff. In all cases he demonstrated the ability to work as a team member, communicate effectively and cooperate with the other team members.
4. **Are independent learners, and as applicable, are successful in graduate school.**	All three cadets had work habits that allowed them to be independent thinkers and learners. Much of the information that they had to digest would be on a graduate level. A higher level of understanding of compressor thermodynamics and energy conversion was required for Cadets Roberts and Rosario to accomplish the tasks. Cadet Rosario had to learn the principles behind Neural Nets and how to create a neural net using MATLAB. Cadet Sobecki was required to become familiar with digital filtering and learn how to use a program to generate a design for a digital filter. If they choose to go to graduate school, all three cadets have shown through their exposure to real problems faced by a professional engineer and their progress in solving those problems that they will do well.
5. **Can apply their knowledge and skills to solve Air Force engineering problems, both well and ill-defined.**	All cadets had to deal with real engineering problems that were beyond their “homework” experience. For Cadet Roberts, his problem was defined “a-little-at-a-time” so that the technical leaders could define the next step as a previous step was being completed. This was done since the exact product desired was not completely known. This scenario is one that is played out everyday in a research environment because the principal investigator is trying to determine what it is that he desires on limited information. In the case of Cadet Rosario, he had a problem that was well beyond his means to complete during the seven weeks available. In fact, the technical leader made comments to the effect that he was working a problem that could easily become a graduate student’s thesis topic. In both cases, the cadets charged on to find a meaningful solution and a way to continue the research effort beyond their seven-week stay at AEDC. Both Roberts and Rosario have agreed to work on their respective efforts during the Fall Semester and publish a paper at the upcoming AIAA Aerospace Sciences Meeting in January 2002. Cadet Sobecki’s problem was focused on analysis of dynamic data and extracting modal features through digital filtering. As a consequence of his contribution, Cadet Sobecki will participate in the preparation of an AIAA paper with Dr. Steinle and will present his digital filtering analysis and results.

	Construction of this model required innovation of new construction techniques. Cadet Sammons made suggestions that improved the process.
6. **Know and practice their ethical, professional, and community responsibilities as embodied in the United States Air Force Core Values.**	While at AEDC, the cadets had the opportunity to participate in the 50th Anniversary of AEDC celebration. Associated with this event, was an Air Show hosted by AEDC and the surrounding communities. As part of the Air Show, Air Force and AEDC booths were set up that were manned in part by the cadets. Not only did they enthusiastically participated in this event, they even requested that they be able to extend their time at AEDC beyond their original termination date to be able to participate in this event as well as continue their technical activities at AEDC. Unfortunately, Cadet Sobecki was not approved for an extension of time because of prior duties. In the future, it would be better for the cadets to have a 7-week tour rather than a 5-week tour since it is expected that they will be given a professional level problem that will be a challenge for them, but within their capability. The extra two weeks provide the maximum benefit and assure sufficient progress. In all of our dealings with these cadets, we as technical leaders found their behavior both ethical and professional and their work of professional quality. We were quite impressed; they are a credit to the Academy and the Air Force. Cadet Sammons demonstrated a highly developed sense of ethics and professionalism that reflect well upon himself and the United States Air Force.

Table D.11
Electronic Graduate Survey: DFAN
POG's

Aeronautics Survey of the Class of 1999

AFPC Approved Survey SCN 02-XXXA

Thanks for agreeing to take this short survey. Your responses are ***anonymous*** and very valuable to us. This survey should take **less than 10 minutes** to complete.

We're trying to assess our Program Operational Goals or "POGs". A POG represents a skill or understanding that a USAFA graduate in Aeronautics should have the first few years after graduation. POGs are high-level goals, and hence there are only six of them!

We want your opinion on (1) whether the POG is a good one and (2) how well you were prepared by your DFAN program relative to that POG (this part is assessed by asking one or more questions that relate to the POG). Most questions are to be answered on a 0-4 "GPA-like" scale:

4 = most, high, always, very well, best, etc.
3 = above avg, usually, well, etc.
2 = neutral, medium, average
1 = below avg, seldom, not well, etc.
0 = least, low, never, poorly, worst, etc.
(Placing your cursor over a black arrow ⟵ shows you this scale.)

Survey Starts Here

I am: ◉ Active Duty USAF ○ Not Active Duty USAF
My duty AFSC is: [ ] (Please type "NA" if not active duty.)

POG 1. Officers who possess breadth of integrated, fundamental knowledge in engineering, the basic sciences, social sciences, and humanities; and depth of knowledge in Aeronautics.

- Demonstrates competence and well-roundedness
- Willing and able to accomplish assigned tasks

How ***important*** is this POG? ☐ ⟵ (0 to 4)

1. How comfortable are you doing and leading your assignments? ☐ ⟵ (0 to 4)

Optional Comments on POG 1:

POG 2. Officers who communicate effectively .

- Ability to address and tailor information to a range of audiences from executive level to technical working-level to non-technical

How ***important*** is this POG? ☐ ⟵ (0 to 4)

2a. How well-organized and written are your documents? ☐ ⟵ (0 to 4)

2b. How well-organized and presented are your briefings? ☐ ⟵ (0 to 4)

Optional Comments on POG 2:

POG 3. Officers who work effectively on teams and grow into team leaders.

- Self-motivated and self-starting
- Can interface with personnel internal and external to the unit
- Accomplishes team goals

How ***important*** is this POG? ☐ ⟵ (0 to 4)

3. How well did your engineering program at USAFA prepare you to effectively work with and lead others? ☐ ⟵ (0 to 4)

Optional Comments on POG 3:

POG 4. Officers who are independent learners committed to life-long learning.

- Pursues self-improvement and brings knowledge to the organization
- Demonstrates initiative to do research and resolve issues with minimal supervision

How ***important*** is this POG? ☐ ⟵ (0 to 4)

4a. Are you enrolled in outside educational pursuits (PME, grad school, etc.)?
☐ Yes ☐ No

4b. Do you assist others with new concepts or tools (trainer, mentor)? ☐ ⟵ (0 to 4)

4c. Do you keep abreast of technical literature? ☐ ⟵ (0 to 4)

4d. Can you generate new or alternate solutions to problems? ☐ ⟵ (0 to 4)

Optional Comments on POG 4:

POG 5. Officers who can apply their knowledge and skills to solve Air Force problems, both well- and ill-defined.

- Can discern root issues and offer creative potential solutions

How ***important*** is this POG? ☐ ⟵ (0 to 4)

5. Did your engineering program at USAFA provide you the skills you need to be an effective problem solver? ☐ ⟵ (0 to 4)

Optional Comments on POG 5:

POG 6. Officers who know and practice their ethical, professional, and community responsibilities as embodied in the United States Air Force Core Values.

- Sets the example of high ethical and moral standards
- Displays qualities of strong citizen-airman

How ***important*** is this POG? ☐ ← (0 to 4)

6a. Have you received one or more disciplinary actions? ○ Yes ○ No

6b. Do you have a strong work ethic (motivated to put in the needed time)? ☐ ← (0 to 4)

6c. Are you an active member of a professional society? ☐ ← (0 to 4)

6d. Are you involved in community service? ☐ ← (0 to 4)

Optional Comments on POG 6:

Survey Ends Here

Please check over your responses, then click below to submit. And THANKS again.

Submit (Note: Please just click once--it may take a few seconds to process.)

Table D.12
Summary Data From 28Feb-1 Mar 2002 EPAC Program Meeting

Item	Current	EPAC Recommendation	DFAN, DFAN DFEM Action
POG-1	Possess breadth of integrated, fundamental knowledge in engineering, basic sciences, social sciences, and humanities; and depth of knowledge in (AE, AstroE EM, ME).	DFAS POG wording should be consistent with POG statements for DFAN and DFEM programs.	Agree: DFAS POG wording changed to be consistent with DFAN and DFEM statements.
POG-2	Communicate Effectively.	Distinguish Objectives for written & oral communication.	No Change: Prefer to have distinctions for specific communications formats be part of the assessment criteria to be evaluated by supervisors and grads.
POG-3	Work Effectively on teams and grow into team leaders.	Change to: Self-starting officers who work effectively with others, work as team members, and who grow into team leaders.	No Change: Prefer to have wording on "self-starting" be part of the assessment criteria to be evaluated by supervisors and grads.
POG-4	Are independent learners, and as applicable, are successful in graduate school.	Independent learners committed to life-long learning, and as applicable, are successful in continuing education and graduate school.	Change POG-4 to read: Are independent learners committed to life-long learning. Being successful in all educational programs during the first 2-3 years following graduation form USAFA is evidence supporting attainment of POG-4.
POG-5	Can apply their knowledge and skills to solve Air Force engineering problems, both well and ill-defined.	Can apply their knowledge and skills to frame and solve engineering and other problems, both well and ill defined.	Change POG-5 to read: Can apply their knowledge and skills to solve Air Force problems, both well and ill-defined.
POG-6	Know and practice their ethical, professional, and community responsibilities as embodied in the United States Air Force Core Values.	No Change.	

Institution: United States Air Force Academy
Program: Aeronautical Engineering June 2002

Item	Current	EPAC Recommendation	USAFA Action
Assessment (surveys)	Separate Department Surveys	Develop **common** survey for use by DFAN, DFAS and DFEM: Supervisors Alumni Make Surveys Electronic	I. Standard surveys for assessing attainment of POGs will be done. The model and process will follow the current DFEM survey and process. DFAN, DFAS and DFEM will administer surveys. II. Establish Survey Administration Process: 1. Jan-Feb: administer survey 2. Mar-Apr: collate responses 3. Apr-May: Analyze data, prepare summary 4. Jun-Jul: Share results with department faculty, and with EPAC. Also prepare actions for implementation. 5. Sep-Oct: Review issues at with EPAC. 6. Oct-Nov: Document findings. II. Construct Web page to support Survey III. Develop Grad Tracking Process
Assessment (base Visits)	One by DFAN, August , 2001	Annual	Continue, but on an as-needed or desired basis.
Broaden EPAC Membership to include all possible 1st yr assignments	AFRL, ASCX, AEDC, TPS, NORAD, Space Command	Include SMC, ESC, Eglin Test Center, Hanson AFB	DFAN will make contact with Armament Lab at Eglin AFB. Others to be determined on an as-needed or desired basis.
GRE	Not used now	Use GRE scores for assessment	Will check with USAFA Registrar to determine feasibility of obtaining and using GRE scores.
Human Factors and systems engr in curriculum	Sporadic, usually done in sr yr design courses	Define the objectives for human factors and systems engineering, then identify how curriculum can support these objectives	DFAN, DFAS and DFEM will undertake a study to determine need for human-factors and system engineering in the respective programs

Table D.13 a-g
CD-Debriefs: Example
Aero Engr 361 Propulsion I

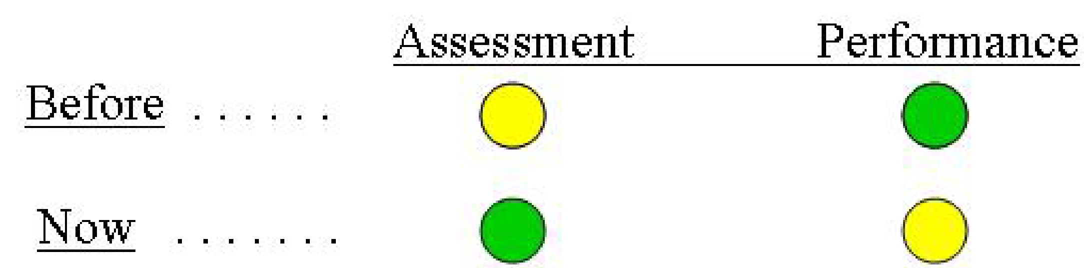
Course Designation: Aero Engr 361
Course Title: Propulsion I

COURSE DE-BRIEF
September 01

Course Director: Colin Tucker, Capt, USAF
Discipline Director: Brenda Haven, Lt Col, USAF, PhD

Term: Spring 2001

Overall Standing:



LINKAGE

Course Description

Introduction to compressible flow, including flows with simple area change, heat addition, friction, and shock waves. Aircraft and rocket engines. Analysis, parametric design and performance of ramjets, turbojets, turbofans, and turboprops. Liquid and solid rocket engines. Introduction to operating principles of major engine components and rocket nozzles.

Labs, Design project.

Prerequisites

- II Aero Engr 341 Aeronautical Fluid Mechanics
  - normal/oblique shocks
- II Engr 310 Energy Systems
  - definitions
  - first law for components
  - isentropic relations

Course Goal:

By course completion you should understand the fundamental principles of aerospace propulsion

Target Courses

- II Introduction to Aircraft and Propulsion System Design [AE 481]
- II Propulsion II [AE 466]
- II Mission and Constraint Analysis (III) [AE482 / 483]

Level I:	Exposure; vocabulary; qualitative and quantitative understanding
Level II:	Ability to apply knowledge to qualitative and quantitative analysis over limited set of problems
Level III:	Ability to apply knowledge to qualitative and quantitative analysis over wide range of problems

Outcomes Mapped to ABET Criterion 3

Educational Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1. Apply principles of Thermodynamics to analyze and describe airbreathing and rocket propulsion systems	X	X			X		X			X	X
2. Use basic models for compressible gas dynamics and know the trends in total properties for each model	X				X						X
3. Explain cycle theory and use it to analyze real gas turbine engines	X	X		X	X		X			X	X

ABET Criterion 3: 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 responsibilities
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 to engineering practice

Outcomes Mapped to DFAN Operational Goals

Educational Outcomes	(1)	(2)	(3)	(4)	(5)	(6)
1. Apply principles of Thermodynamics to analyze and describe airbreathing and rocket propulsion systems	X	X		X		
2. Use basic models for compressible gas dynamics and know the trends in total properties for each model	X			X	X	
3. Explain cycle theory and use it to analyze real gas turbine engines	X	X	X	X	X	X

DFAN Program Operational Goals: Officer who…

1) …possess breadth of integrated, fundamental knowledge in the engineering, basic sciences, social sciences, and humanities; and depth of knowledge in aeronautical engineering.
2) …communicate effectively using oral, written, and graphical formats.
3) …work effectively as a leader or member of a multidisciplinary team.
4) …are independent learners, and as applicable, are successful in graduate school.
5) …can apply their knowledge and skills to solve Air Force engineering problems, both well- and ill-defined.
6) …live by the ethical and professional responsibilities embodied in the United States Air Force Core Values.

Institution: United States Air Force Academy
Program: Aeronautical Engineering June 2002

Aero Engr 361 • Spring 2001

Assessment Instruments and Performance Summary

Outcome & Overall Performance	Specific Criteria	Instruments & Specific Performance
1. Apply principles of Thermodynamics to analyze and describe airbreathing and rocket propulsion systems: [yellow]	a. Address the advantages and disadvantages of turbojet, turbofan, turboprop, and ramjet/scramjet engines	GR2.7 [yellow]
	b. Identify and state the purpose of the components of turbojet, turbofan, turboprop, and ramjet/scramjet engines	GR1.1 [red], GR1.2 [yellow]
	c. Reduce 1st and 2nd Laws of Thermodynamics for engine components: inlet, fan, compressor, combustor, turbine, afterburner, and nozzle	GR1.5 [red], GR1.7 [yellow], GR1.8 [green], F21 [yellow]
	d. Perform a power balance	GR1.11 [red], GR2.1 [green]
	e. Calculate thrust and thrust specific fuel consumption for real and ideal turbojet, turbofan, and ramjet engines	GR1.6 [yellow], F23 [yellow], F24 [yellow]
	f. Explain the trends in total temperature and total pressure through a real turbojet engine and plot these trends on a T-s diagram	GR1.3 [red], GR2.7 [yellow]
	g. Perform an energy balance to obtain fuel flow rate	F22 [red]
	h. Understand the influence of installation losses on thrust and thrust specific fuel consumption	GR1.6 [yellow]
PERFORMANCE KEY: 80%-100% [green] 60%-80% [yellow] < 60% [red]	i. Discuss the advantages and disadvantages of rockets versus airbreathing engines	
	j. Distinguish between rocket types in terms of mission capability, specific impulse, and thrust-to-weight ratio	F2 [yellow]
	k. Calculate rocket thrust, specific thrust, and thrust coefficients	F7 [yellow], F25 [yellow]
	l. Discuss the effect of altitude on rocket nozzle performance	F3 [yellow]

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Assessment Instruments and Performance Summary

Outcome & Overall Performance	Specific Criteria	Instruments & Specific Performance
2. Use basic models for compressible gas dynamics and know the trends in total properties for each model: 🟡	a. Determine changes in total pressure across oblique and normal shock combinations for supersonic inlets	GR1.8🟢, F12🟡, F18🟢
	b. Determine the total pressure ratio and mach number for a constant area heat addition (Raleigh flow)	GR1.10 🔴
	c. Determine the total pressure ratio mach number for simple friction flow (Fanno flow)	
	d. Determine the static temperature, pressure, Mach number, and velocity at the exit of a convergent-divergent nozzle using simple area flows (1-D isentropic and real flows)	GR1.4🔴, GR2.6🔴
	e. Determine area using mass flow parameter and Mach number	GR1.9🟡, GR2.8🟢
	f. Know that total pressure decreases through shock waves, Raleigh flows, and Fanno flows	F5🔴, F6🟢
	g. Know that total temperature is constant through shock waves, Fanno flows, and 1-D isentropic flows	F13 🟡

PERFORMANCE KEY:
80%-100%🟢
60%-80%🟡
< 60%🔴

Aero Engr 361 • Spring 2001

Assessment Instruments and Performance Summary

Outcome & Overall Performance	Criteria	Instruments & Specific Performance
3. Explain cycle theory and use it to analyze real gas turbine engines: 🟡	a. Calculate component isentropic and polytropic efficiencies	GR2.5🟢, GR2.9🟢, F19🟢, F20🔴
	b. Explain the importance of specific thrust as it relates to engine size	
	c. Explain the relationship between thrust specific fuel consumption and overall engine efficiency	GR2.3🟢
	d. Identify general trends in specific thrust and thrust specific fuel consumption among the engine types: turbojet, low bypass ratio turbofan, and high bypass ratio turbofan	
	e. Identify the general trends in specific thrust and thrust specific fuel consumption for turbofans as a function of compressor pressure ratio, fan pressure ratio, and bypass ratio	GR2.1🟢, GR2.2🔴, GR2.4🟢, F9🟢, F10🔴, F11🔴, F16🔴, F17🟢
	f. Explain the difference between parametric cycle analysis and engine performance analysis	F4🔴, DP I🟢, DP II🟢
PERFORMANCE KEY: 80%-100%🟢 60%-80%🟡 < 60%🔴	g. Explain the significance of, and use, corrected mass flow rate and mass flow parameter	GR 2.10🟢, F8🔴
	h. Calculate additive drag	F14🟢
	i. Select an appropriate engine cycle given mission requirements, engine performance characteristics, and/or cost impacts	GR1.2🟡, DP II🟢, DP III🔴

Aero Engr 361 • Spring 2001

Tracking Problems, Changes, and Impact

NOTE: The nine Educational Outcomes shown in this section and used prior to the Spring 02 offering have been consolidated down to the three outcomes previously shown.

Educational Outcomes (Previous Offering)	A / P	Assessment and Performance	A / P	Problem Status (Spring 02 Offering)
1. Explain the fundamentals of one-dimensional compressible duct flow including simple area changes, Rayleigh flows, and Fanno flows	A: yellow / P: green	**Prob:** Assessment data collected but not yet analyzed for conclusions **Action:** Used results from GR#1 and homeworks to demonstrate higher emphasis	A: yellow / P: ?	GR and hmwk questions will be continuously refined to provide better assessment
2. Explain the fundamentals of normal and oblique shock waves	N/A			
3. Demonstrate an ability to use 1. and 2. above to solve compressible flow problems.	N/A			
4. Explain the types and uses of aerospace propulsion devices including air breathing and rocket engines	N/A			

Aero Engr 361 • Spring 2001

Tracking Problems, Changes, and Impact

Educational Outcomes (Previous Offering)	A / P	Assessment and Performance	A / P	Problem Status (Spring 02 Offering)
5. Demonstrate an ability to perform parametric cycle analyses of modified gas generator cycles.	N/A			
6. Demonstrate an ability to complete engine performance analyses of modified gas generator cycles.	N/A			
7. Demonstrate an ability to perform basic performance analyses of solid and liquid rocket systems.	N/A			
8. Demonstrate an ability to communicate technical information in written and graphical forms.	A: green / P: yellow	**Prob:** Quality of DP final turn-in (writing, organization, presentation) was poor **Action:** Emphasize use of Technical Writing Guide; ensure poor work is not accepted/rewarded	A: green / P: ?	Fix to be aided by CPL, Instructor, and cut-sheet emphasis
9. Demonstrate good performance as a contributing member in teamwork exercises	N/A			

Aero Engr 361 • Spring 2001

Course Statistics

Fullness Indicator: 5.6 Min/page (same as Spring 00 offering)

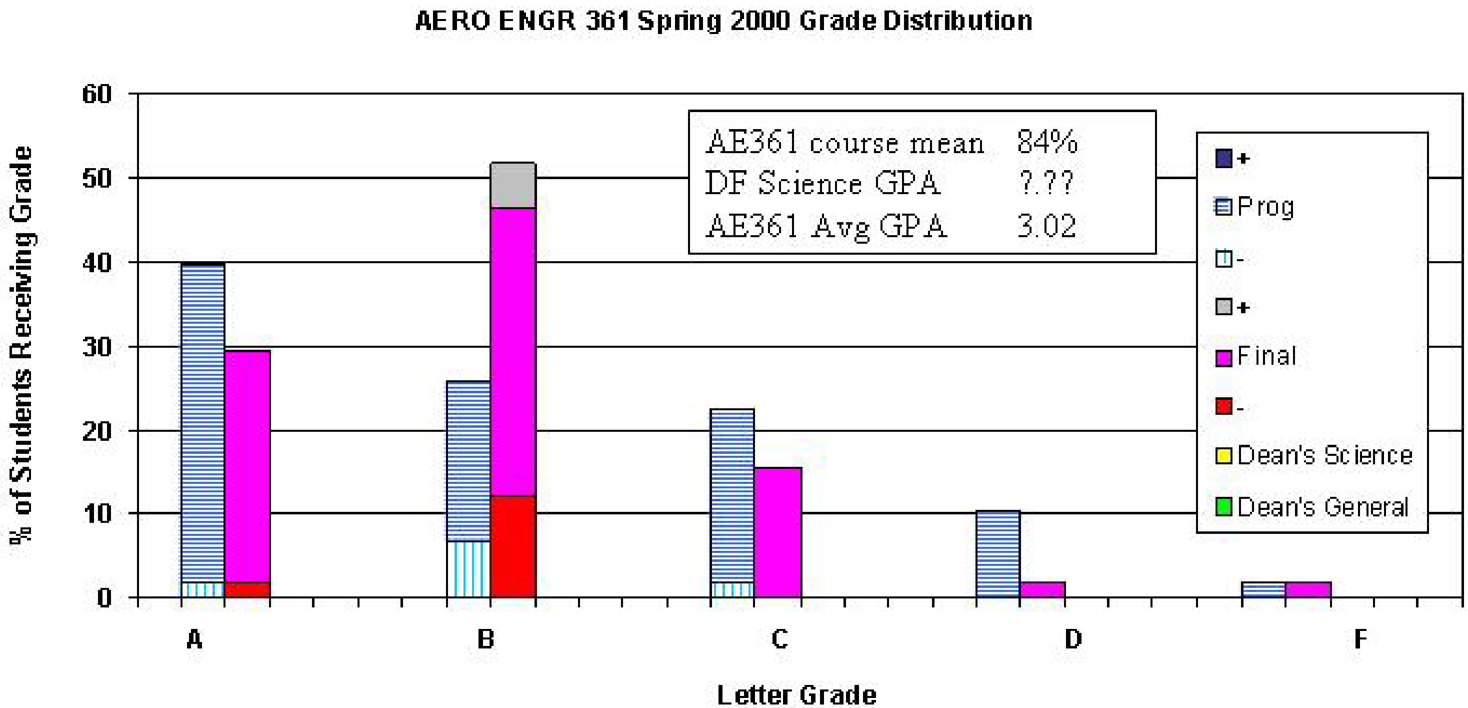


Table D.14 Comprehensive Examination Questionnaire Matrix

DISCIPLINE SPECIFIC COMPREHENSIVE EXAMINATION QUESTIONS
FLIGHT MECH DISCIPLINE ASSESSMENT
AERONAUTICAL ENGINEERING

ITEM	DISCIPLINE OUTCOME	QUESTION	COMMENT
1	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	How many degrees of freedom does an aircraft have and how would you categorize them? a. 3; all rotation. b. 6; 3 translation and 3 rotation. c. 6; all rotation. d. 5; 3 rotation and 2 translation. e. 6; u, v, w, x, y.	AE315 / AE351 (38) This question targets students' understanding that the three translational-modes affect aircraft performance, and the three rotational-modes affect aircraft stability. Understanding these six modes forms the foundation for understanding aircraft flight mechanics. **Ans: b.**
2	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	In general, how will fixed canards affect the static longitudinal stability of an aircraft? a. They tend to stabilize the aircraft. b They tend to destabilize the aircraft. c. They do not affect aircraft stability but have an effect on aircraft control. d. They do not affect aircraft stability or aircraft control.	AE315 / AE351 (40) This question targets students' understanding of longitudinal stability and how longitudinal stability is affected by the position of the aircraft aerodynamic center relative to the center of gravity. Canards cause the aircraft aerodynamic center to move forward, thus longitudinally destabilizing the aircraft. **Ans: b.**
3	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	Increasing the size of the vertical tail on the F-16 would: a. increase its static directional stability (also called weathercock stability). b. decrease its static directional (or weathercock) stability. c. not affect static directional (or weathercock) stability significantly.	AE351 (45) This question targets students' understanding of directional aircraft stability. Aircraft static directional stability depends on the size (surface area) of the vertical stabilizer as well as the location of the vertical stabilizer's aerodynamic center from the aircraft center of gravity. **Ans: a.**
4	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	Which of the following improves an aircraft's static roll stability? a. removing wing dihedral. b. increasing the size of the ailerons. c. mounting the wing low on the fuselage. d. adding wing dihedral.	AE351 (48) This question targets students' understanding of the aircraft design features that affect static lateral stability. Students should understand that static roll stability is increased by increasing wing dihedral. **Ans: d.**

		e. increasing aileron deflection.	
5	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	A pilot is experiencing left and right oscillations while attempting to achieve a tracking solution. Which dynamic stability mode is at fault and how could it be corrected? a. Short Period; move the cg forward. b. Phugoid; decrease airspeed. c. Dutch Roll; increase damping. d. Spiral; increase diehard. e. Roll; increase the time constant.	AE352 (51) This questions targets students' understanding of aircraft dynamic stability, and how it affects a particular tracking task, that is, how it affects keeping the pipper on target. Students need to understand the aircraft's five dynamic modes, and how degraded conditions for each can be corrected. **Ans: c.**
6	Demonstrate the ability to analyze and design simple aircraft and feedback control systems	If pitch rate is the parameter "fed back" in an aircraft feed back control system, the resulting aircraft response will be: a. an improvement in lift to drag ratio. b. a change in the aircraft's longitudinal dynamic stability. c. a decrease in stall speed. d. guaranteed positive longitudinal static stability. e. a change in elevator control power.	AE352 (53) This question targets students' understanding of feedback control systems. Students must recognize that aircraft motion parameters sensed by a control system are used to initiate a corrective action that will affect one or more aircraft dynamic stability modes. In this case, the question targets the aircraft's longitudinal dynamic stability. **Ans: b.**
7	Demonstrate the capability to apply a variety of analysis tools including structured programming	On a root locus plot, to have stable roots, the root or roots selected must be in the: a. right half plane. b. left half plane. c. region above the real axis. d. region below the real axis.	New Question This questions targets students' understanding of, and ability to use analysis tools to make design decisions affecting aircraft static and dynamic stability. Root locus plots show migration of dynamic stability roots as the gain of the feedback control system is varied. **Ans: a.**
8	Demonstrate an understanding of the fundamentals of aircraft performance, stability, control, and flight test	To achieve longitudinal static stability, the aerodynamic center of the aircraft must be: a. behind the aircraft center of gravity. b. in front of the aircraft center of gravity. c. at the same location as the aircraft center of gravity. d. at the quarter-chord location relative to the aircraft wings.	New Question This question targets students' understanding of the fundamental requirement for aircraft static longitudinal stability. Students need to know this fundamental relationship for longitudinal static stability. **Ans: a.**

Table D.15 Senior Survey Template: Exit Interview Form

Questionnaire 1: Cadet Responses on Program Educational Outcomes:

HOW WELL DID THE AERO-ENGR PROGRAM PREPARE YOU TO HAVE THESE OUTCOMES?

Aero program Educational Outcome	Level of Confidence 1 2 3 4 5 Low High	Course or Courses Where Presented (learned)	Comments: Please provide helpful comments
(1) Use fundamental knowledge of aerodynamics, aerospace structures and materials, propulsion, flight mechanics-stability and control, aircraft design or aircraft engine design, to solve aeronautical engineering problems.			
(2) Plan and execute experimental studies, and formulate sound conclusions from analysis of the empirical data resulting there from.			
(3) Use good problem solving skills, modern technology tools, and fundamental knowledge outside aeronautical engineering to solve problems.			
(4) Develop and evaluate engineering designs that meet customer needs.			
(5) Communicate effectively using oral, written, graphical and electronic formats.			
(6) Work effectively as a member of a multidisciplinary team.			
(7) Perform effective research, and possess the skills to engage in independent learning.			
(8) Informatively discuss the impact of engineering on present-day societal and global contemporary issues to include Air Force aerospace capabilities and requirements.			
(9) Make morally responsible judgments about legal, environmental, and ethical implications of engineering, management and business decisions			

Questionnaire 2: Cadet Responses on Program Objectives:

HOW CONFIDENT ARE YOU THAT YOU CAN MEET THE FOLLOWING OBJECTIVES WHEN YOU WORK IN YOUR NEXT JOB?

Aero program Objective	Level of Confidence 1 2 3 4 5 Low High	Course or Courses that prepared you for this objective	Comments: Please provide helpful comments
(1) That you have a breadth of integrated, fundamental knowledge in engineering, basic sciences, social sciences, and humanities; and depth of knowledge in aeronautical engineering			
(2) That you can communicate effectively.			
(3) That can work effectively on teams, and that you will grow into being a team leader.			
(4) That you have the capability to learn on your own, and as applicable, you will be successful in graduate school.			
(5) That you can use you knowledge and skills to solve Air Force engineering problems that are both well and ill-defined.			
(6) That you know and will practice your ethical, professional, and community responsibilities as embodied in the USAF Core Values.			

Questionnaire 3: Cadet Responses on Program: General:

RELEVENT TO YOUR EDUCATIONAL EXPERIENCES IN THE AERO-MAJOR TO DATE, PLEASE RESPOND TO QUESTIONS BELOW

Item	Indicate level of agreement 1 2 3 4 5 Low High	Comments: Please provide helpful comments
1. The Objectives of the Aero-Engr Program were clearly presented to me		
2. I understand the objectives of the Aero-Engr Program.		
3. The educational outcomes of the Aero-Engr program were clearly presented to me		
4. I understand all 9 educational outcomes		
5. The educational outcomes of every course in the Aero-Major were made clear to me.		
6. The course sequence in the Aero-Major is understood and consistent with meeting the Aero-Engr educational outcomes		
7. Primary strength of the Aero-Major is:		
8. Primary weakness of the Aero-Major is:		

Table D.16
Aero Council Survey: Class of 2002

Overall, virtually everyone I spoke with or who completed a survey was still happy with their choice of major. They complained about the work load, but almost all of them said that they had learned more than they thought they would, and it was a good opportunity. On the whole, they are proud to graduate from this major, and would not go back and choose another given the chance.

Things most Aero Majors have described as the major's BEST points:

1. Quality facilities and faculty.
2. Diversity of courses offered.
3. Opportunities for research.

Things most Aero Majors have described as the major's WORST points:

1. Time/work demand that is significantly greater than other majors and prevents cadets from truly gaining a deep understanding the material.
2. Lack of connectivity between aero courses that are taken at the same time, or in sequence.

Attributes of the major where cadets have the MOST confidence:

1. Use good problem solving skills, modern technology tools, and fundamental knowledge outside aeronautical engineering to solve problems.
2. Communicate effectively using oral, written, graphical and electronic formats.
3. Work effectively as a member of a multidisciplinary team.
4. That can work effectively on teams, and that you will grow into being a team leader.

Attributes of the major where cadets have the LEAST confidence:

1. Plan and execute experimental studies, and formulate sound conclusions from analysis of the empirical data resulting there from.
2. Develop and evaluate engineering designs that meet customer needs.

3. That you can use you knowledge and skills to solve Air Force engineering problems that are both well and ill-defined.

4. The educational outcomes of the Aero-Engr program were clearly presented to me.

Final Comment: **As hard as I tried, I could not find anyone with any constructive criticism on changing the order of courses. Most of the majors seemed satisfied with the sequencing of the courses they have taken and are taking. Most all of them are very pleased with combining Aero 482/483 with Engr 410.**

Table D.17a

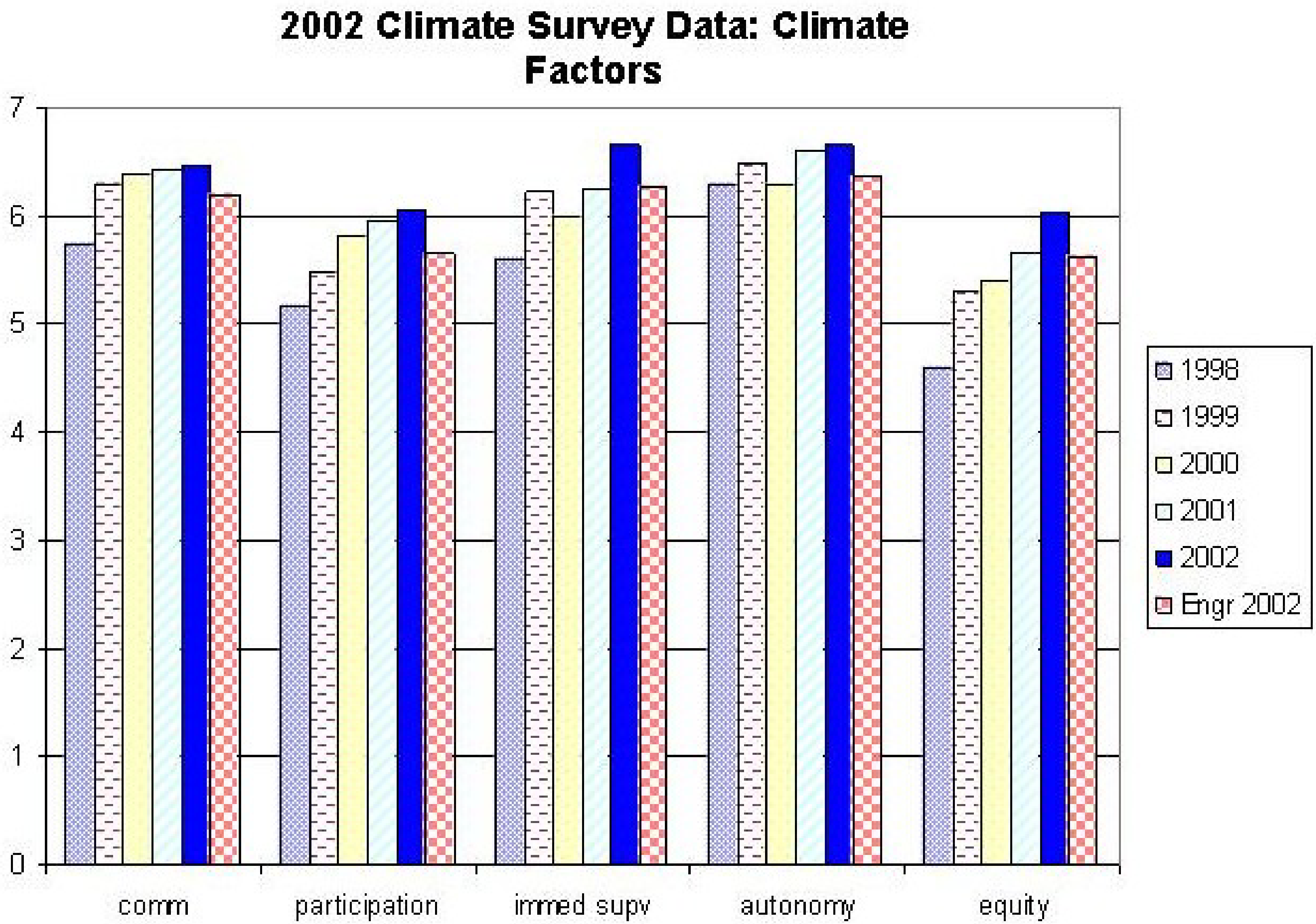

2002 Climate Survey Data: Climate Factors
7
6
5
4
3
2
1
0
comm
participation
immed supv
autonomy
equity
1998
1999
2000
2001
2002
Engr 2002

Table D.17b

2002 Climate Survey Data: Outcome Factors

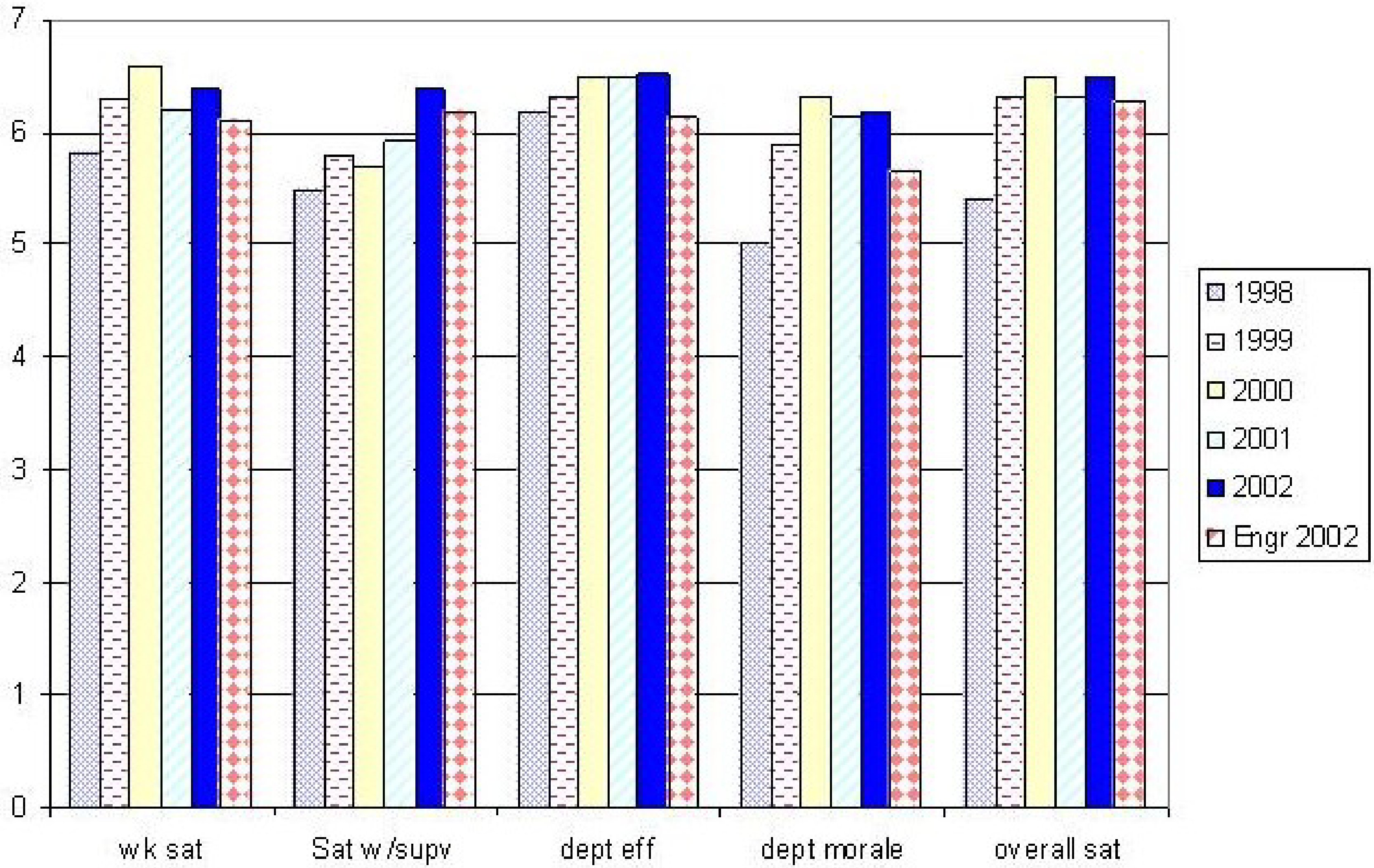
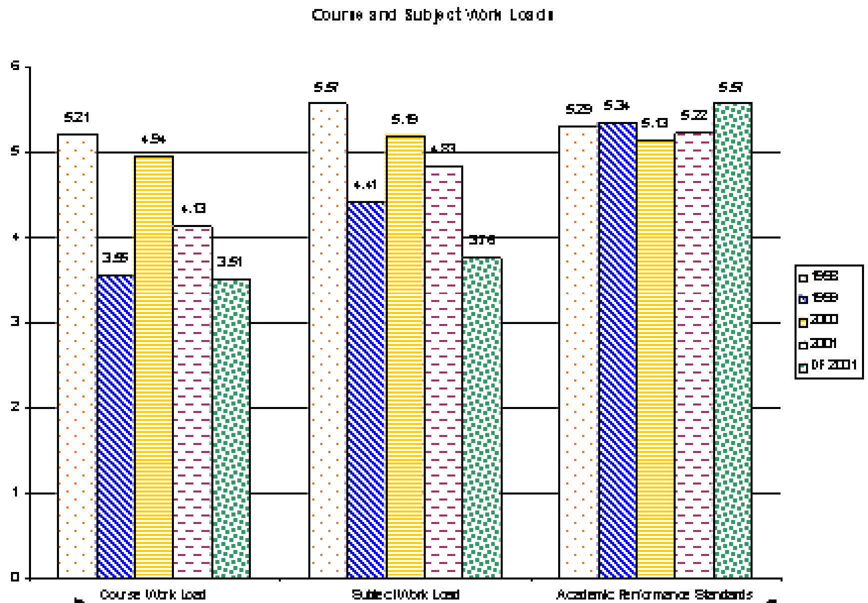


Table D.18a Graduate Survey: Course and Subject Work



I believe too many courses were required to complete my academic major

I believe the amount of work required in my majors courses was excessive

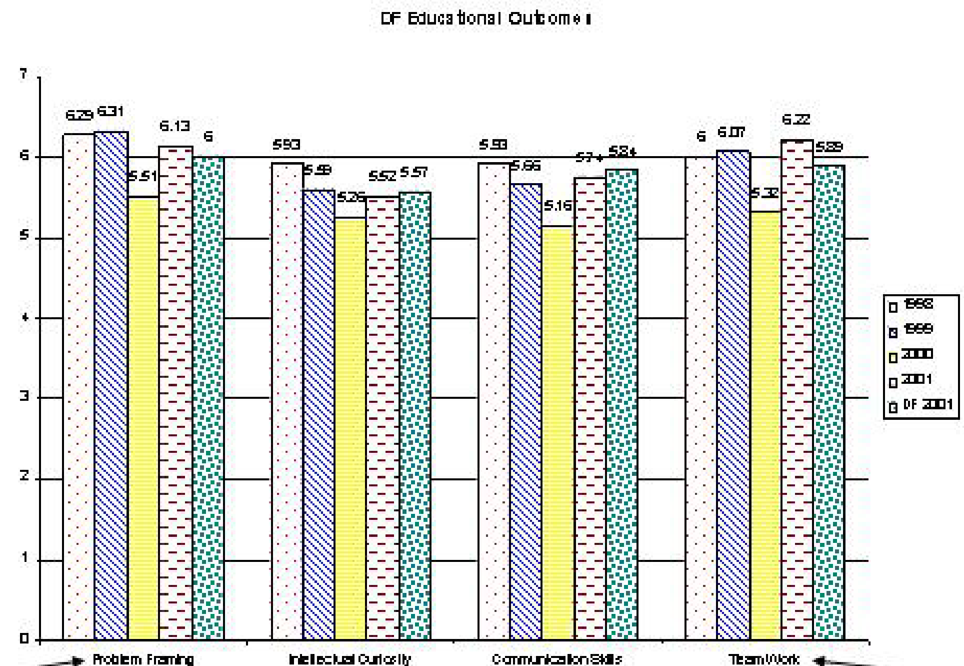
I believe the standards expected in my majors courses were reasonable

Synopsis: (1) Cadets believe the aero-engr course load is high compared to DF wide programs. Curriculum revisions may impact this opinion in the future.
(2) Cadets believe the academic standards in the aero-engr major are high compared to DF-wide standards.

Actions: (1) Use Aero Seminar to strengthen indoctrination for the 2° cadets entering the aero-engr major. Discuss the spectrum of content and overall workload requirements
(2) Query 1st Class cadets to obtain details on course load and work load attitudes

Loads

Table D.18b Institutional Educational Outcomes



I believe my majors courses enhanced my ability to frame and resolve ill-defined problems.

I am interested in learning more about the discipline in which I majored.

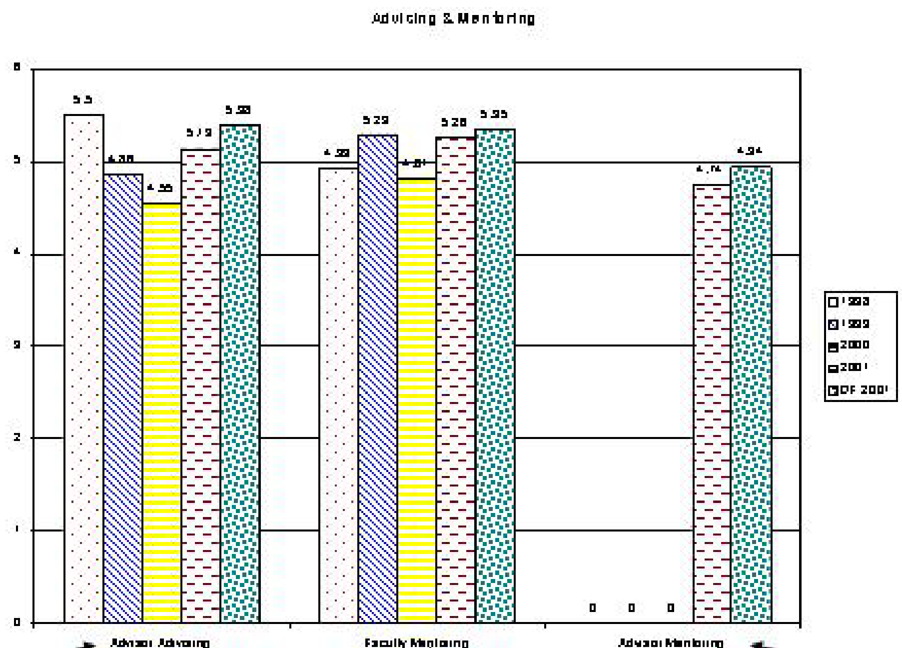
I believe my majors courses allowed me to developed my communication skills.

I believe my majors courses helped me work effectively with others.

Synopsis: Overall acceptable attainment of DF Educational Outcomes. Room for improvement in Communication skills development.

Actions: Develop/implement plan for com-skills development across DFAN Curriculum Comment: Program Thread being developed.

Table D.18c Advising and Mentoring



I am satisfied with the quality of academic advising I received from my primary faculty advisor

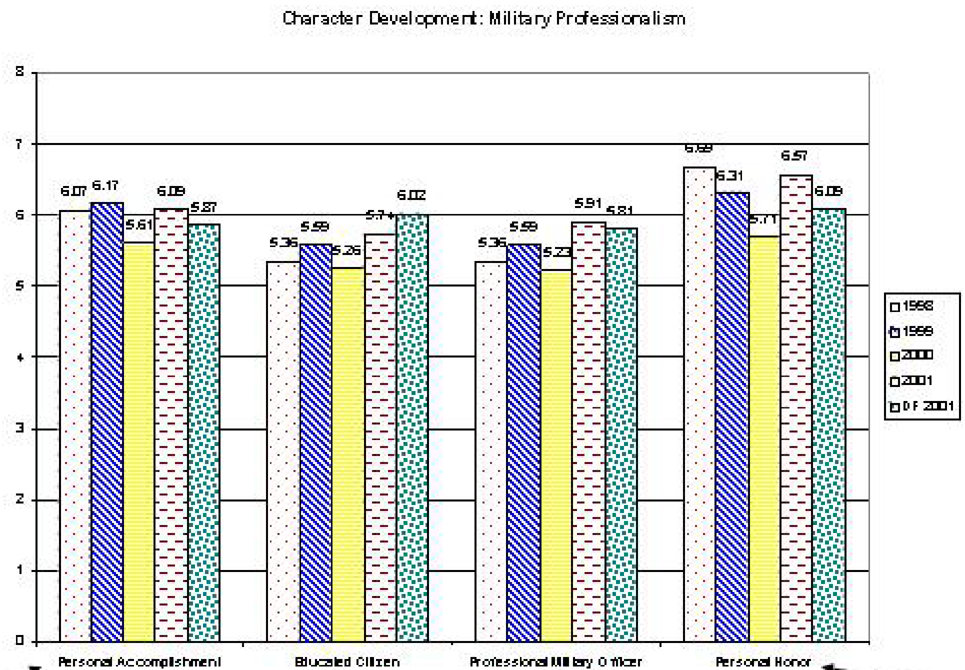
…I value the mentoring I received from members within my academic major

…I value the mentoring I received from my academic advisor

Synopsis: DFAN needs to improve on mentoring aero-majors

Actions : Conduct more career-interaction sessions
- extend the aero seminar
- elevate AIAA student section activities
- Schedule "talk-time" in certain courses

Table D.18d Character Development & Military Professionalism



I am proud of what I accomplished in my academic major.

I believe the courses I completed as part of my academic major prepared me well to become an educated citizen.

I believe the courses I completed as part of my academic major prepared me well to become a professional military officer.

I will abide by the spirit of the honor code after graduation

Synopsis: Aero majors believe their experiences in the aero major are contributing to their character development to become military professionals. Cadets are proud of their accomplishments in the program.

Actions: Faculty should continue to be good role models for the cadets, and take more opportunity to discuss character development issues in open classroom forums.

Table D.19 a
End of Course Critique

USAFA END-OF-COURSE INSTRUCTIONAL ASSESSMENT SYSTEM

DIRECTIONS: COMPLETION OF THIS QUESTIONNAIRE IS VOLUNTARY. YOU ARE FREE TO LEAVE SOME OR ALL ITEMS UNANSWERED.

USE A NO. 2 PENCIL
Fill the Oval Darkly and Completely.
Do Not Make Stray Marks. Erase Completely.
Leave Questions Blank That Don't Apply.

START HERE:

KEY: QUESTIONS 1–23, 27–34

E	=	EXCELLENT	(6)
VG	=	VERY GOOD	(5)
G	=	GOOD	(4)
F	=	FAIR	(3)
P	=	POOR	(2)
VP	=	VERY POOR	(1)

T4A 310 ENGR

I. TO PROVIDE DIAGNOSTIC FEEDBACK TO THE INSTRUCTOR

1. INSTRUCTOR'S ABILITY TO STIMULATE MY INTEREST WAS: VP P F G VG E
2. QUALITY AND TIMELINESS OF FEEDBACK ON GRADED WORK WAS: VP P F G VG E
3. INSTRUCTOR'S ABILITY TO PROVIDE CLEAR, WELL-ORGANIZED INSTRUCTION WAS: VP P F G VG E
4. INSTRUCTOR'S ABILITY TO PRESENT ALTERNATIVE EXPLANATIONS WHEN NEEDED WAS: VP P F G VG E
5. INSTRUCTOR'S USE OF EXAMPLES AND ILLUSTRATIONS WAS: VP P F G VG E
6. VALUE OF QUESTIONS AND PROBLEMS RAISED BY INSTRUCTOR WAS: VP P F G VG E
7. INSTRUCTOR'S KNOWLEDGE OF COURSE MATERIAL WAS: VP P F G VG E
8. AS A MILITARY ROLE MODEL or CIVILIAN PROFESSIONAL ROLE MODEL, MY INSTRUCTOR WAS: VP P F G VG E
9. ENCOURAGEMENT GIVEN STUDENTS TO EXPRESS THEMSELVES/ PARTICIPATE WAS: VP P F G VG E
10. INSTRUCTOR'S CONCERN FOR MY LEARNING WAS: VP P F G VG E
11. AVAILABILITY OF EXTRA HELP WHEN NEEDED WAS: VP P F G VG E
12. INSTRUCTOR'S ENTHUSIASM WAS: VP P F G VG E

II. TO PROVIDE INFORMATION ABOUT THE COURSE

13. COURSE ORGANIZATION WAS: VP P F G VG E
14. CLARITY OF COURSE OBJECTIVES AND REQUIREMENTS WAS: VP P F G VG E
15. THE DEGREE TO WHICH THE COURSE MET ITS STATED OBJECTIVES WAS: VP P F G VG E
16. INTELLECTUAL CHALLENGE AND ENCOURAGEMENT OF INDEPENDENT THOUGHT WERE: VP P F G VG E
17. REASONABLENESS (DIFFICULTY AND AMOUNT) OF ASSIGNED WORK WAS: VP P F G VG E
18. EVALUATIVE AND GRADING TECHNIQUES (TESTS, PAPERS, PROJECTS, ETC.) WERE: VP P F G VG E
19. QUALITY AND USEFULNESS OF COURSE TEXT(S) WERE: VP P F G VG E

III. TO PROVIDE A GENERAL EVALUATION

20. THE COURSE AS A WHOLE WAS: VP P F G VG E
21. RELEVANCE AND USEFULNESS OF COURSE CONTENT WAS: VP P F G VG E
22. AMOUNT YOU LEARNED IN THE COURSE WAS: VP P F G VG E
23. THE INSTRUCTOR'S EFFECTIVENESS IN FACILITATING MY LEARNING IN THE COURSE WAS: VP P F G VG E

IV. TO PROVIDE GENERAL INFORMATION ABOUT YOURSELF

24. PRIOR TO TAKING THIS CLASS, I WAS INTERESTED IN THE CONTENT OF THIS COURSE.
 - Yes
 - No
 - Neutral
25. THIS COURSE IS:
 - in my MAJOR
 - in my MINOR or PROGRAM REQUIREMENT
 - a CORE REQUIREMENT
 - an ELECTIVE
26. GRADE I EXPECT TO RECEIVE:
 - A
 - B
 - C
 - D
 - F
 - PASS

V. ADDITIONAL ITEMS
(Ask Your Instructor for the Questions)

27.–34. VP P F G VG E

35.–56. 1 2 3 4 5 6 7 8 9 10

ADAPTED FROM
OFFICE OF EDUCATIONAL ASSESSMENT
University of Washington
Seattle, WA 98195

USAFA FORM 154, AUG 95 PREVIOUS EDITION WILL BE USED

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Table D.19b

DFAN Student Critique Summary

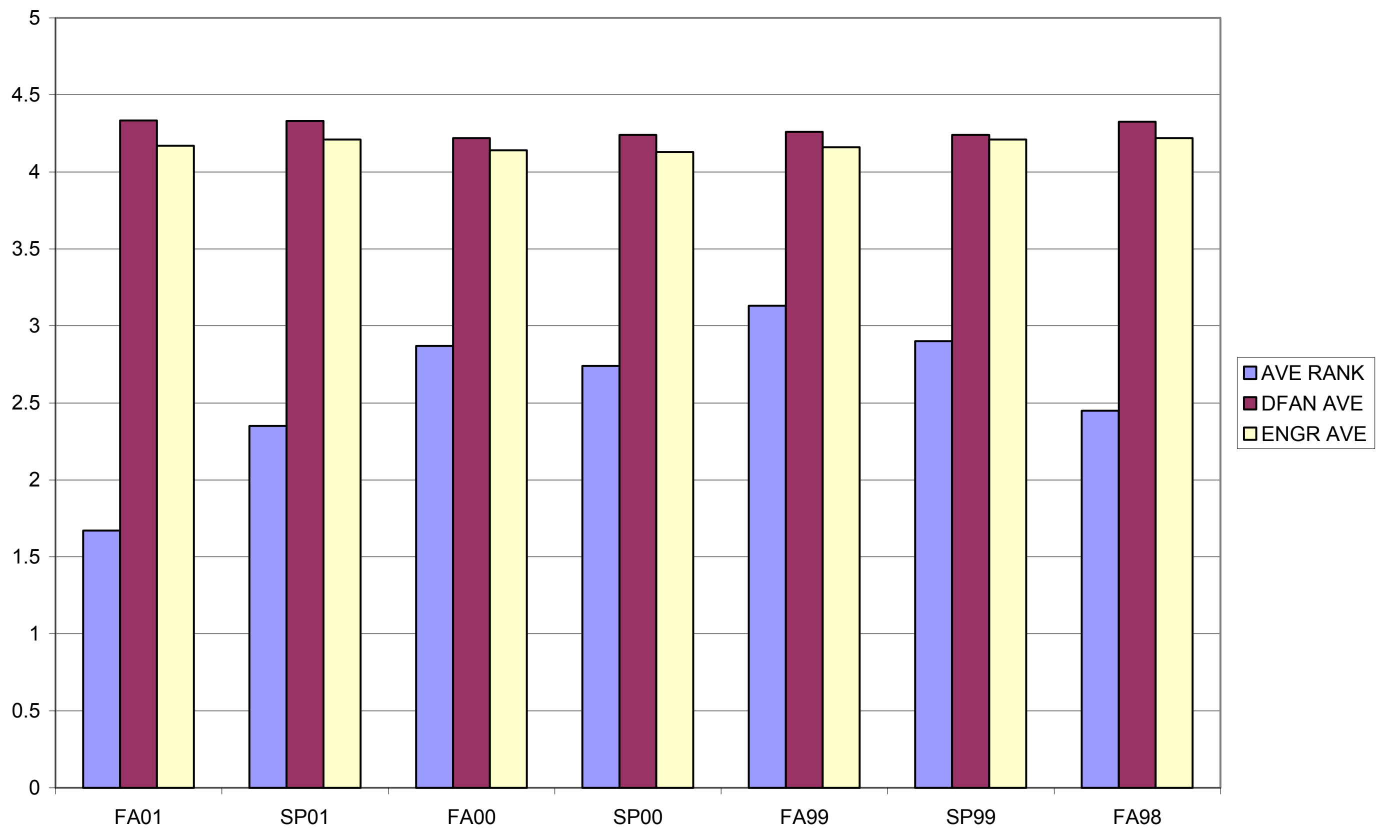

Table D.20

Course Policy Letter: Sample

UNITED STATES AIR FORCE ACADEMY
Department of Aeronautics

Engr 310 - Energy Systems
Course Policy Letter

Fall 2000 LtCol Haven

GENERAL

Course Description: Welcome to Engineering 310, Energy Systems. This course is about energy, its use and importance. The course is concerned with energy systems such as hair dryers, bicycle pumps, car engines, gas turbine engines, jet engines, power plants, air conditioners, refrigerators, etc. Energy is extremely important to each of us and we should develop an appreciation for the efficient use of this resource commodity. The study of thermodynamics is fundamental to the production of electricity as well as propulsion. Understanding the concepts presented in Engr 310 is challenging; therefore, your success depends directly on your conscientious study of the subject material. The course structure will aid you in learning the energy concepts and knowledge you need to be an effective Air Force officer and an educated citizen.

Educational Outcomes: By successfully completing Engr 310, you will have a fundamental understanding of classical thermodynamics and energy transfer systems measured by your ability to:

1. **Explain the 1st and 2nd Laws of Thermodynamics.**
2. Explain fundamental terms and concepts of Thermodynamics.
3. Use the 1st and 2nd Laws of Thermodynamics to solve basic energy system problems.
4. Use good problem solving skills to solve instructional exercises, analyze experimental data, and complete an energy systems design.
5. Use good engineering practices to include technical communication and effective teamwork skills.

Prerequisite: Physics 110

Instructors: USAFANet addresses, office assignments, and telephone numbers for the instructors teaching this course are:

Instructor	E-Mail Address	Office	Phone
Col Barlow	Neal.Barlow@usafa.af.mil	6H27	3-4010
Dr. Byerley	Aaron.Byerley@usafa.af.mil	AL120	3-3436
LtCol Haven*	Brenda.Haven@usafa.af.mil	6H24	3-8489
Dr. Havener	George.Havener@usafa.af.mil	6H39	3-2427
Capt Krueger**	Todd.Krueger@usafa.af.mil	6F53	3-8564
Capt Mitchell	Tony.Mitchell@usafa.af.mil	6F53	3-8519
Capt Nowlin	Scott.Nowlin@usafa.af.mil	6H39	3-3438
Capt Thompson	Brad.Thompson@usafa.af.mil	6H39	3-8505

*Course Director, **Assistant Course Director

Course Materials: Course Lesson Notes, Lab and Design Project Handouts, Property Table Handouts.

Extra Instruction Policy: To encourage cadets to complete assignments ahead of time, no extra **instruction**

(EI) will be allowed within 24 hours of an assignment due date. Cadets are responsible for coming to EI prepared to cover specific material and are expected to have attempted to complete assignments they need help with prior to scheduling EI. EI will not to be used as a substitute for class work. Illness or other special circumstances may allow exceptions to this rule.

GRADING:

Basis for Grade Assignment: We will use the following grade contract

If your average score is…	**≥ 90%**	**≥ 80%**	**≥ 70%**	**≥ 60%**
You will earn a grade of at least	A	B	C	D

+/- grades may be awarded, but cut lines for these grades will not be published.

Graded Events: Your grade in the course will be based on the following inputs:

Individual Effort			Group Effort		
2 GRs	@ 200	400 points	TJ Lab	1 Written Submittal	30 points
Final		300 points	VCR Lab	1 Written Submittal	25 points
IP Points		50 points	Design Project	Multiple Written Submittals	195 points
Sub-Totals		750 points			250 points
TOTAL					1000 points

Progress Grade: Your grade at prog (26% of the total grade) will consist of GR 1, Design project turn-in #1 (35 pts), and 25 Instructor points.

GR/Final Exam Policy:

1) Graded reviews and the final exam will be closed notes. You will be allowed to use a property tables supplement for the 2nd GR and final exam. During examinations, you may use one constants and conversions sheet that is provided in your course handout, and you may write notes in the spaces provided. You will be able to obtain new copies of this sheet off the common network drive. All GRs will be cumulative and administered during common GR periods. The final exam will be a comprehensive evaluation of your understanding of the course material. A score of less than 50% on the final exam may result in a lower course grade than called for by the grading contract, additionaly, an exceptionally good score on the final may increase your course grade.

2) The top 5% of those in the course who also have achieved at least a 95% average going into the final exam are exempt from taking the final exam. The course order of merit for these cadets will be based on their standing in the course prior to the final exam.

To pass this course you must do both of the following:

1) Achieve ≥ 60% overall average (out of 1000 points)
2) Achieve ≥ 55% on a combined average of the IP points, graded reviews and final exam (out of 750 points)

Late Penalty: All graded work is to be turned in on time. Work turned in less than 24 hours late will receive a 25% (of total available) grade reduction. Work turned in 24-48 hours late will receive a 50% (of total available) grade reduction. Labs and design project turn-ins submitted more than 48 hours late will receive a 0, but must be satisfactorily completed to avoid an incomplete course grade.

PROJECT REQUIREMENTS

Details for the design project and labs will be provided during the course. Accomplish all assignments for this course in a professional manner. Needless to say, your work should be punctual and concise, as well as technically and grammatically correct.

DOCUMENTATION STANDARD
The documentation standard for all assignments in this course is the MLA Handbook for Writers of Research Papers.

GROUP WORK:
The design project and labs will be accomplished in teams. You are allowed, and encouraged, to choose different groups for each of the group projects. However, for all design project work you will keep the same team members.

CLOSING
We continually strive to improve this course. It is designed to be "hands-on" and application oriented to stimulate your interest and improve your learning experience. It is my sincere hope you will enjoy this course and be changed for the better by the experience and the material you learn. Welcome to thermo!

BRENDA A. HAVEN, LtCol, USAF
Engr 310 Course Director

Group Effort Information:
Each of the following assignments is "group effort":

Assignment		Group	Pt Value
VCR Lab	1 Written Submittal	Group of 2-3 students	25 points
TJ Lab	1 Written Submittal	Group of 2-3 students	30 points
Design Project	multiple Submittals	Group of 2-3 students	195 points
Total			250 points

Statements: The VCR Lab and the Turbojet Lab are best accomplished in small teams of 2 to 3 students so that cadets may clarify and reinforce the course materials and the more challenging conceptual questions. This has been the group size historically for the labs.

The design project is also done in groups of 2 to 3 students. The project is complex and open-ended; working in a group setting allows multiple approaches to be considered and team members to play devil's advocate with each other. These two factors enhance the learning process. For cadets who contribute more or less to the project, peer evaluations are used to assign their individual grades. Historically, the design project group sizes have been between 2 and 3 students.

VCR, TJ LABS, and DESIGN PROJECT: