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Air Force Institute of Technology

Graduate Education Program
Cost/Benefit Analysis

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EXECUTIVE SUMMARY

At the request of the Air University commander, Booz·Allen & Hamilton assessed the costs and relative benefits of three select alternatives for providing a focused Graduate Education Program (GEP) for the United States Air Force (USAF). The size of the GEP for purposes of this study was assumed to be 230 M.S. degrees and 35 Ph.D. degrees awarded annually for Fiscal Years (FYs)99, 00 and 01 (AFIT/CC, 1998). The three alternatives studied are:

- A restructured Air Force Institute of Technology (AFIT).
- A multisource alternative.
- A single-source alternative.

The current in-residence AFIT faculty has been reduced by 30 professors over the past two years. Programmed reductions of 43 additional staff positions are planned by FY00. This restructured AFIT is represented in the first alternative. The multisource alternative would transfer production in the GEP to high-quality Civilian Institutions (CIs). Maintaining only a small oversight and administrative staff, AFIT would manage conduct of the GEP at CIs. The single-source alternative reflects an offer from the Miami Valley Economic Development Coalition to combine the resources of four Ohio universities to provide GEP to the Air Force.

Each alternative meets the following five objectives (Multiple Sources, 1998) of a GEP to some extent.

- Fill advanced degree quotas established by the Air Force Education Requirements Board (AFERB).
- Provide research and consulting services to the USAF and the Department of Defense (DOD) on unique technology focused subject matter.
- Focus and respond to the changing technological direction of the USAF and DOD.
- Promote a sense of USAF organizational culture and professionalism among graduates.
- Provide specified advanced education and training to foreign students.

A. Study Methodology

1. Costs. Costs for purposes of this study were gathered from the extensive cost analysis that has been completed on various alternatives to date. AFIT costs are provided from the AFIT Resources and Programs Director (AFIT/RP), a 1995 "Outsourcing Feasibility Study" conducted by the Air Force Management Effectiveness Agency, and internal AFIT cost studies. Costs for

the multisource alternative were obtained directly from the 13 institutions that AFIT faculty and senior leadership studied in mid-1997. Costs for the single-source alternative were provided in two unsolicited proposals submitted to AFIT/CC in 1997 and 1998 (Miami Valley Economic Development Council, 1998). Traditional cost accounting methodologies use Net Present Value (NPV) as a standard. NPV considers the opportunity cost of performing the alternative. Costs in this study are represented in terms of NPV.

2. Benefits. In order to assess the relative benefit of the GEP, a series of benefits and subbenefits are derived from the five GEP objectives. Thus, accomplishing the GEP objectives will contribute some measurable benefit to the USAF. The analysis assigns relative weights to the objectives, benefits, and subbenefits by means of pairwise comparisons. Pairwise comparison means to weigh each against the other, in pairs. A decisionmaking analysis tool is used to score each alternative on the extent to which the alternative satisfies the benefit or subbenefit, then aggregates those scores to arrive at a composite benefit score for each alternative.

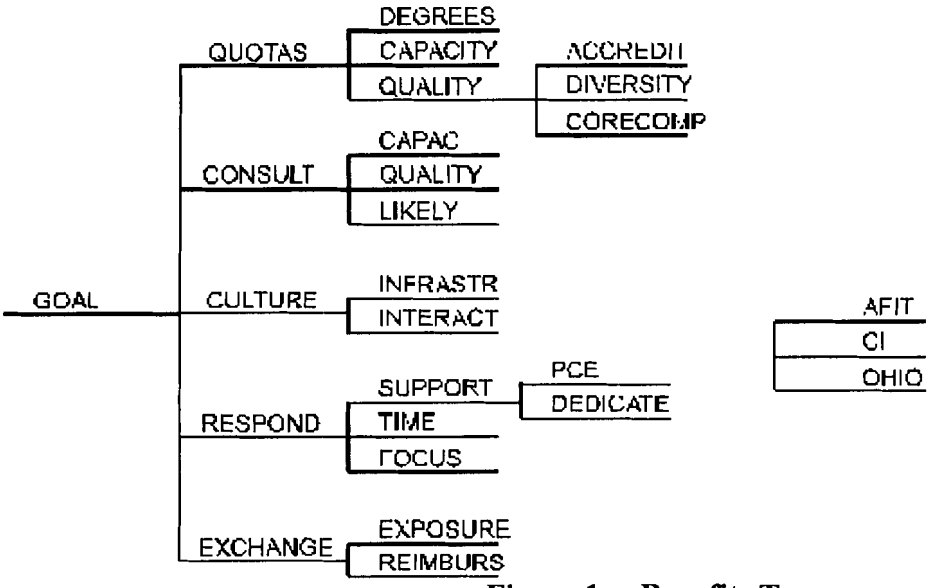

Figure 1.—Benefits Tree

3. Cost/Benefit Ratio. Combining costs and benefits determines the true value of each alternative. The cost/benefit ratio represents the dollar cost (in NPV terms) per unit of benefit. Thus, a lower cost/benefit ratio is preferred. Figure 2 shows cost/benefit ratios.

Alternative	Costs (NPV) ($K)	Benefits	Cost/Benefit Ratio	Ranking
Restructured AFIT	74,606	639	116.7	1
Multisource	55,006	111	495.5	3
Single-source	38,019	250	152.1	2

Figure 2.—Cost, Benefits, and Cost/Benefit Ratios

The restructured AFIT alternative is the most cost-effective. It provides the most benefit for the money, while the multisource alternative is the least cost-effective.

B. Risk Assessment/Sensitivity Analysis

The study explored four excursions from the baseline assessment. They assessed the impact on costs and benefits if major assumptions in the baseline analysis were inaccurate. The four excursions were based on the following scenarios:

- USAF advanced academic degree quotas are increased by one-third.
- Lower tier schools are selected for the multisource alternative.
- Requirements for research and consulting are deleted from the USAF GEP objectives.
- Restructured AFIT costs are increased to equate its cost-effectiveness to that of the next most cost-effective alternative (the single-source alternative).

These excursions revealed interesting insight as to the strength of continuing with a restructured AFIT over the multisource or single-source alternatives. For instance, increasing the number of degrees produced at AFIT annually still does not make either of the other alternatives more cost-effective. Similarly, reducing the costs of the multisource alternative by trading quality for cost still would not make that alternative more cost-effective.

The third excursion shows that if we eliminate research and consulting for the USAF and DOD at AFIT—thus making the AFIT "product" essentially advanced degrees only—AFIT is only slightly less cost-effective than the single-source alternative.

Finally, in the fourth excursion, raising AFIT costs to make its cost/benefit ratio the same as the next closest alternative (multisource alternative), the study reveals that AFIT costs would have to rise by over $22M, a 30% increase.

C. Conclusions and Recommendations

This study defines a set of benefits to the USAF and DOD by investing in AFIT. They attempt to describe the contributions to USAF's mission in unique areas. Those areas are the unique technologies and the focus on the direction of future technologies that will or likely will impact the future of warfare as conducted by the USAF. Assigning numerical values to the measurable aspects of these benefits and objectives allows us to develop a cost/benefit ratio for each of the three alternatives requested in the study.

The restructured AFIT alternative is clearly the highest cost alternative, yet it yields an even higher relative benefit value. It costs 36% more than the next most expensive alternative, yet it provides 156% more benefit than any other alternative. The primary contributor to AFIT's extreme benefit is its ability to focus on unique technologies that are key to the evolution of the

USAF's warfighting capability. In analyzing the benefits of a program such as the GEP, the multisource or single-source alternatives cannot provide the unique benefits to the extent that a restructured AFIT can.

The USAF should maintain the restructured AFIT as the institution to satisfy its GEP objectives. Of the alternatives evaluated, a restructured AFIT provides the most cost-effective solution. The USAF should continue to restructure AFIT as defined in this alternative to meet the objectives of a USAF graduate education program.

SECTION I
REQUIREMENT

A. Introduction

USAF's mission is to defend the United States through control and exploitation of air and space. In order to perform this mission, the Air Force organizes, trains, and equips its forces to conduct assigned military missions. Not every military mission can or should be performed by one Service. However, the USAF is particularly suited to provide certain services to military commanders around the world. The USAF develops, trains, sustains, and integrates the elements of aerospace power to produce core competencies (Booz·Allen & Hamilton, 1998): air and space superiority, global attack, rapid global mobility, precision engagement, information superiority, and agile combat support.

AFIT's mission is to support the Air Force and national defense through responsive graduate and Professional Continuing Education (PCE), research, and consultation (AU Catalog, AFIT, March 1997). The specific requirement for the GEP includes graduate-level programs with degree-granting accreditation, consultation services, and research on topics of particular interest to the USAF and DOD. This analysis focuses on the graduate degree-granting education, research, and consultation requirements currently satisfied by AFIT residence and CI programs.

AFIT contributes to the development of the Air Force core competencies by leading the direction of critical technologies for the future. These unique core focus areas—air vehicles, special weapons, information warfare, environmental management, meteorology, logistics and acquisition, and sensing—form the central thrust areas of its curriculum and research efforts. AFIT's course offerings are designed to ensure that the graduates and the research contributions of the institute provide sufficient resources for application and consultation on unique technologies that contribute directly to the Air Force's seven core competencies, and to the exploitation of air and space power.

B. Graduate Programs

Air Force personnel carry out the core competencies of the Service. Similarly, AFIT has identified primary education areas its considers its core competencies. These competencies can be identified as "an education and research thrust which supports both current and future Air Force/DOD research and educational requirements" (AFIT/EN, 1998). Graduate curriculums are derived by identifying the academic programs and research necessary for producing the education core competencies.

Figure 3 illustrates AFIT's education core competencies and the degree programs designed to support them. Each AFIT degree program supports at least one education core requirement.

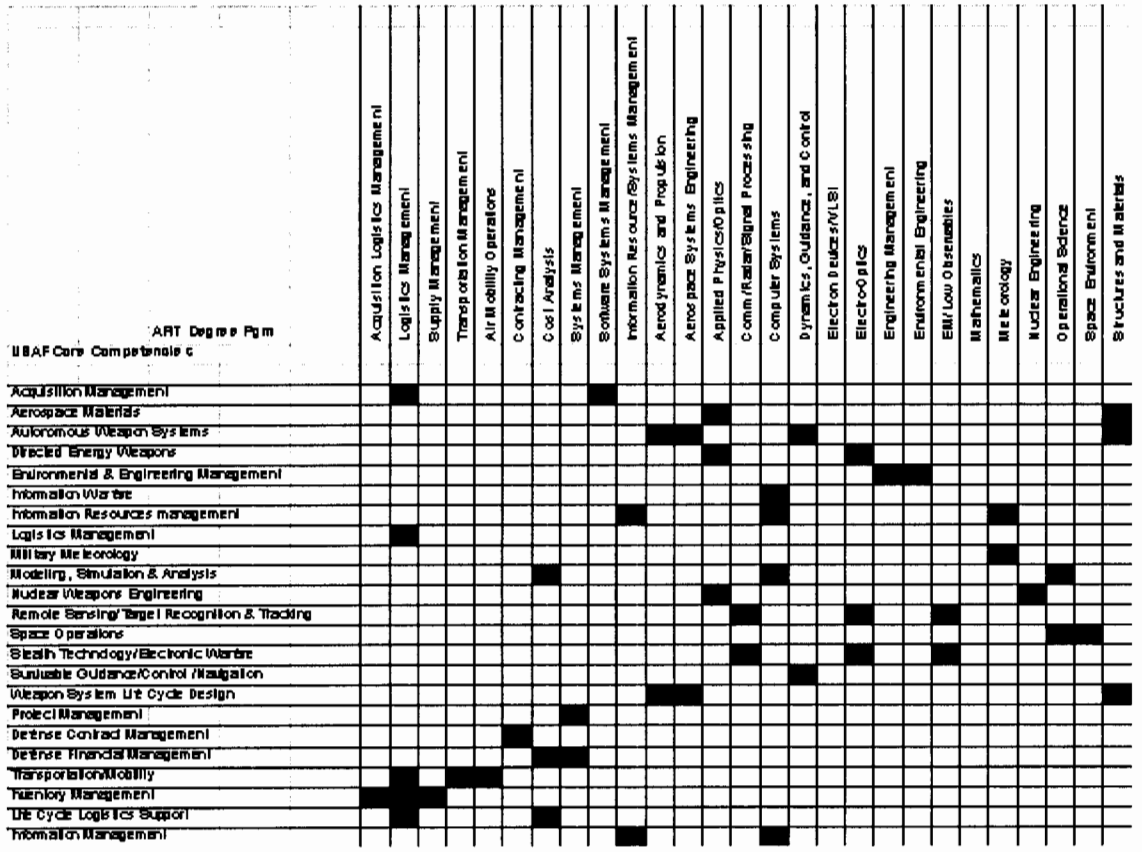

Figure 3.—USAF Technology Focus Areas and Required Graduate Programs To Sustain Those Focus Areas (Source: Air Force Graduate Education Core Competency Needs briefing, AFIT/EN, 1998)

The specific requirement for the number of graduates to fill designated Advanced Academic Degree (AAD) is defined by the Air Force Education Requirements Board (AFERB) and illustrated by the following quotas. (Note: While the academic degree requirement to fill some of these quotas can be provided by a CI, the following quotas are earmarked for graduates from the in-residence AFIT program.)

FY98 Quotas	Masters of Science	Duration (mos)	Ph.D.	Duration (mos)
Program				
Computer Systems	15	18		
Computer Systems/EDP Systems	1	18		
Data Processing	4	18		
Computer Systems/Software Engr.	11	18		
Business Mgmt./Accounting	1	18		
Numerical Methods in EDP		18	1	36
Operations Research/Command & Control	1	18		
Ops Research	23	18	2	36
Space Ops	3	18		
Operational Analysis	12	18	1	36
Engineering and Environmental Mgmt.	18	18		
Contracting Mgmt.	7	15		
Acquisition Logistics Mgmt.	1	15		
Supply Mgmt.	3	15		
Logistics Mgmt.	10	15		
Cost Analysis	9	15		
Software Systems Mgmt.	1	18		
Transportation Mgmt/Air Mobility	12	12		
Transportation Mgmt.	7	15		
Info Resources Mgmt.	11	18		
Aeronautical Engr./Aerodynamics	1	18	2	36
Aeronautical Engr./Stability & Control	2	18		
Aeronautical Engr. Structures	2	18	2	36
Aeronautical Engineering	6	18	2	36
Astronautical Engineering	4	18		
Matl Science & Engr/Structural Materials	2	18		
Matl Science & Engr/Elec & Opt Mtls.	2	18		
Matl Science & Engr/General	1	18	2	36
Electrical Engr/waves	2	18		
Electrical Engr/Electrical circuits & devices	1	18		
Software Engr.	1	18		
Electrical Engr./Digital	1	18		
Electrical Engr./Info Systems/Comm	1	18		
Electrical Engr./Info Systems/Sat Comm	1	18		
Electrical Engr./Communications/RADA	6	18		
Electrical Engr./Guidance & Nav Ctl Syst.	1	18		
Electrical Engr./Guidance & Control	2	18		
Electrical Engr./Electro-Optics	5	18		
Electrical Engr./Observables reduction	5	18		
Electrical Engineering	12	18	2	36
Mechanical Engineering	2	18		
Nuclear Engr./nuclear rad effects		18	1	36
Nuclear Engineering	1	18		
Systems Engr/Ops Research	2	18		
Computer Engr/AI	1	18		
Computer Engineering	2	18		
Meteor/Atmospheric Dynamics	2	18		
Meteor/Special areas	3	18		
Meteor/Analysis & Forecasting	2	18		
Meteor/Radiative Transfer	1	18		
Meteor (physical Met)	2	18		
Meteorology/Interact grap	3	18		
Meteorology	5	18		
Physics/nuclear physics	1	18		
Physics/Optic lasers		18	1	36
Physics/optics	1	18		
Physics	1	18		
Total quota/average duration	237	17.58	16	36

Figure 4.—Quotas for In-Residence AAD billets, FY98 (Source: AFIT/RPB)

C. Research and Consultation Services

The unique application of technology to defense creates an entire field of research and information requirements. As illustrated in figure 4, the list of highly specialized technological areas of study and research, and their applications to the business of defense is a long one.

An Air Force GEP must provide research and consultation services on a broad range of unique USAF and DOD topics of interest. While the amount of research and consultation provided by the GEP is not defined as a requirement, it is generally agreed that the GEP should provide USAF and DOD agencies ready access to high-quality research and consulting on unique topics. Research support is typically provided by students and faculty under USAF or DOD sponsorship. At AFIT, this research generally supports a master's thesis or doctoral dissertation.

D. Study Focus

This study evaluates the relative cost-effectiveness of three alternatives for providing the objectives of a USAF GEP for the requirements of FY99, 00, and 01. It will use as its basis for study, an evaluation of five overall objectives for the GEP.

E. Objectives of the Graduate Education Program

To satisfy the requirements outlined in section I, the GEP must meet certain objectives. The main objectives are to fill the advanced academic degree quotas identified by the AFERB, and to provide focused intellectual capital in the form of consultation and research services to USAF and DOD agencies. Additional objectives include:

1. • Focusing and responding to the changing technological direction of the USAF and DOD.

2. • Promoting a sense of USAF organizational culture and professionalism.

3. • Providing specified advanced education and training to foreign students as required.

SECTION II
ANALYTICAL FRAMEWORK, GROUND RULES, AND ASSUMPTIONS

The structure of this analysis closely adheres to that recommended by the USAF and DOD. The following guidance has helped establish a framework for this analysis.

4. • Department of Defense Instruction (DODI) 7041.3, Economic Analysis for Decisionmaking.

5. • Air Force Instruction (AFI) 65-501, Economic Analysis.

6. • Air Force Manual 65-506, Economic Analysis.

This framework allows for comparing costs and benefits for competing organizational alternatives to satisfy the GEP objectives. Every effort has been made to objectively identify reasonable organizational alternatives, estimate their costs, and value their benefits. The analysis is designed to obtain agreement as to the scope of the objective, the definition of alternatives, and the rationale for defining and valuing benefits. These are the three areas where the most subjectivity is typically found. Costs are relatively objective, and have been captured here through data collection and analysis from several earlier studies.

A. Study Period

The period over which costs and benefits will be evaluated is five years (FY97–01). This period includes costs for providing 230 M.S. graduates and 35 Ph.D. graduates to meet FY99, 00, and 01 quotas (AFIT/CC, 1998), and to support research and consulting demands.

B. References

Raw cost data will be provided from three previous studies:

7. • AFIT Horizons Briefing (December 1994).

8. • AFIT Graduate Education Restructuring Study (September 1995).

9. • AFMEA Study (July 1995).

10.

C. Sources of Identification and Valuation

Sources for the identification and valuation of benefits include literature (periodicals, point papers) and interviews with USAF and DOD personnel.

D. Degree Quotas

Quotas for in-residence and CI slots, and the degreed programs in which students are required to be placed, are identified by the AFERB and the registrar's office at AFIT (AFIT/RR, 1998). To provide a common student load to be evaluated for each alternative, this study assumes that 230 M.S. degrees and 35 doctorates will be awarded each year for FYs 99, 00, and 01 (AFIT/CC, 1998).

For purposes of this analysis, graduating the requisite number of students to satisfy the indicated AAD quotas will be considered a key element of "meeting the objective of the graduate program."

E. Degree Requirements

The unique expertise necessary to sustain advancement in specific areas of military applications of technology for the Air Force generates requirements for M.S. and Ph.D. degrees. Courses that satisfy those requirements are described in the AFIT briefing "Air Force Graduate Education Core Competency Needs," AFIT/EN, 1998, and the AFIT Catalog, September 1996.

F. Benefits of Each Alternative

We will provide quantitative assessments of the benefits of alternatives to the maximum extent possible. The assessments are made using an analytical hierarchy process that compares the benefits' importance to the GEP objectives. Then, the extent to which each alternative provides that benefit is determined. These assessments determine the importance of the benefit and the effectiveness of the alternative in meeting the benefit. Thus, a quantified measure of benefits is derived.

G. Deliverables

For purposes of this analysis, the product of research is defined as a document, or "deliverable." This is distinguished from consulting services, which are defined as "hours of focused time." The value of research can be quantified in dollars using feedback from AFIT thesis sponsors and the data gathered from civilian institutions. Methodologies employed in the "AFIT Research, Cost and Benefit" factbook (October 1997) will be used to identify the hours and cost required to duplicate the in-residence thesis and dissertation research at a typical CI. The value of consulting services is assumed to be identical across alternatives; costs differ, however.

The research and consulting services valuation assumes that civilian institutions have the inclination and capacity to perform the research for the USAF or DOD. A separate qualitative benefit assesses the likelihood of this assumption.

As AFIT is currently structured, consultation services are provided as inherent parts of AFIT's mission at no additional charge (Cost and Value, Tab C, p. 23). No additional manpower

is required for the research or consulting services that AFIT provides. The average number of hours of consulting services provided by the AFIT/LA faculty for FYs 96 and 97 was 2,638 hours per year (source: AFIT/LA). The EN school provided 3,580 hours of consulting service in FY97. For comparative purposes, the costs and benefits of providing 6,218 hours will be examined for each alternative in this study.

Programmed downsizing through FY00 will not impact AFIT's ability to satisfy objectives related to research and consulting services (6,218 hours of consulting annually, support of 230 theses and 35 dissertations for FYs 99, 00, and 01). For purposes of this study, a restructured AFIT would maintain that capability to support research and consulting services.

H. Current Year Discount Rates

Current-year discount rates and base-year 1997 inflation indices are obtained from SAF/FMC (February 1998).

SECTION III
ALTERNATIVES

Three alternatives will be compared for this study. All provide a program that meets each of the GEP objectives to some degree.

A. Alternative 1—A Restructured AFIT

AFIT recognizes that it cannot continue to operate "business as usual" in the face of increasing budget cuts and overall DOD downsizing. This alternative recognizes the programmed downsizing of 31 staff members (30 faculty, 1 admin) since FY96, and the phasing out of 43 additional staff by FY00. School enrollment and subsequent faculty and administrative staff size are based on projected graduate degree quotas, which are in turn based on academic specialties required to produce education core competencies. Restructure includes the merging of the School of Logistics and Acquisition Management (LA) and the School of Engineering (EN) by the beginning of FY00, which results in one consolidated graduate school. This restructure decreases personnel only (i.e., no change in equipment, facility, or overhead allocation rate costs).

When calculating costs for this alternative, we included only those costs that would be eliminated should AFIT/LA and EN be closed (the marginal costs for running an in-residence program). They are faculty and administrative staff, facilities, utilities, and equipment, as well as allocated overhead elements such as support directorates' personnel, equipment, and facilities. Sponsored research grants will not be saved by closing AFIT; they will simply be redirected (probably to CIs).

Note: Since thesis and dissertation support is such a key element of the in-residence AFIT experience, we consider the costs for providing such support and define them as being "in addition to" those for simply providing classroom instruction. Since costs for faculty salaries are included in the PE84752 line, only costs for student salaries are added costs for research. Those costs as well as costs for travel, materials, and equipment are considered to be constant across all alternatives. Approximately one-third of a faculty member's time is consumed with thesis and dissertation research. AFIT faculty and student salaries pay for all labor costs associated with this research. Therefore, no additional explicit costs for research are included in the restructured AFIT alternative.

B. Alternative 2—Obtain Degreed Graduates and Research and Consulting Services from Civilian Institutions (CIs) (The Multisource Alternative)

Continue operating the CI directorate at AFIT. Unique courses tailored to the USAF requirements may be provided if they do not already exist. Eliminate the AFIT/LA and EN schools (faculty, facilities, equipment, allocated overhead). Receive all research and consulting

services from a CI. Augment the CI directorate at AFIT with six personnel responsible for proper student placement and degree focus, and coordination of the research and consulting efforts with the appropriate agencies. Institutions evaluated as candidates for this alternative rank among the top in the U.S.

Members of the AFIT faculty visited a number of universities in mid-1997 to assess the institutions' ability to provide the curriculums required to satisfy graduate education core requirements. A total of 14 were determined as able to furnish sufficient courses and programs of the quality required to satisfy the USAF GEP requirements. Several universities were determined to be able to provide the engineering curriculums. They were: Naval Postgraduate School, Massachusetts Institute of Technology (MIT), Syracuse University, Carnegie-Mellon University, George Washington University, University of Maryland, George Mason University, Georgia Institute of Technology, University of Florida, Oklahoma State University, Texas A&M University, University of Texas at Austin, University of New Mexico, and Stanford University. Only one institution, the Naval Postgraduate Institute, was determined to have sufficient capability to provide the logistics and acquisition management curriculums.

C. Alternative 3—Obtain Degreed Graduates and Research and Consulting Services from Those Institutions Offered in the Ohio Proposal (The Single-Source Alternative)

Replace AFIT instructors with faculty from an Ohio state schools consortium (Miami Valley Economic Development Council, 1998). Retain the AFIT/LA and EN schools (in terms of curriculums). Courses would be conducted at one or more sites off base. A six-member USAF administrative/liaison staff would be located at AFIT (Wright-Patterson Air Force Base (WPAFB)) to provide guidance and focus the curriculums and research and consulting efforts to ensure that USAF requirements are satisfied. The USAF will provide a $7M research grant annually. Consulting services will be acquired on a fee for service basis. Students will be expected to use USAF labs to conduct research. Student and faculty travel between a central campus and the campuses of the four participating universities (Ohio State University, University of Dayton, University of Cincinnati, and Wright State University) would be minimized.

SECTION IV
COSTS

A. Tuition Rates

Tuition rates at CIs, for the purpose of this study, are projected to increase at the rate of 7.1% annually (National Center for Education Statistics, 1998). Annual tuition rates for the single-source alternative, although not explicitly stated in that proposal, are assumed to increase at the USAF Operations and Maintenance (O&M) composite inflation index provided by SAF/FMC.

B. Cost Calculation

This section includes costs for satisfying three years' worth of USAF GEP graduate requirements (FY99–01). Figure 5 shows where cost elements associated with each degree program and research and consulting are incurred. For example, the FY99 Ph.D. graduates create costs for each alternative over FY97, 98 and 99. Thus GEP program costs for the period of this study are incurred over five years, FY97–01.

	FY97	FY98	FY99	FY00	FY01
FY99 Requirement					
Degree Program					
M.S.		x	x		
Ph.D.	x	x	x		
Research and Consulting			x		
FY00 Requirement					
Degree Program					
M.S.			x	x	
Ph.D.		x	x	x	
Research and Consulting				x	
FY01 Requirement					
Degree Program					
M.S.				x	x
Ph.D.			x	x	x
Research and Consulting					x

Figure 5.—Cost Elements and Fiscal Year Phasing

Annual research and consulting services costs for the three years (FYs 99–01) are included in those fiscal years.

C. Cost Summary

Total costs are summarized in figure 6 below. Costs represent those incurred to satisfy the FY99–01 requirements for satisfying quotas and providing research and consulting services. Costs are represented in terms of Net Present Values (NPV). NPV considers the opportunity costs of performing the alternative. In this case, the no-risk alternative to paying these costs is to invest them in treasury bills (thus, the discount factor applied to cost streams is based on the interest rates for Treasury notes with five-year maturities as contained in Appendix C of OMB Circular A-94).

	BY97 ($ thousands)						
Alternative	**FY97**	**FY98**	**FY99**	**FY00**	**FY01**	**TOTAL**	**NPV**
Restructured AFIT	$1,929	$16,420	$31,180	$23,375	$9,777	$82,681	**$74,606**
Multisource	$1,063	$5,437	$20,218	$19,899	$15,304	$61,921	**$55,006**
Single-Source	$891	$5,394	$15,676	$15,357	$10,761	$48,080	**$42,832**

Figure 6.—Cost Summary

D. Cost Elements

This section defines costs for the three alternatives. Detail on the costs can be found in Appendix A—Detailed Costs. As described in section III, a good deal of analysis has been performed on the costs of AFIT. This study uses these cost analyses as modified by AFIT/RP.

1. Alternative 1—Restructured AFIT

Figure 7 summarizes the costs of this alternative.

AFIT Costs ($K)	**FY97**	**FY98**	**FY99**	**FY00**	**FY01**	**TOTAL**
PE84752 (TY$)	$1,561	$13,592	$24,106	$17,787	$6,156	$63,201
Assigned BOS costs (TY$)	$158	$1,479	$2,544	$2,159	$761	$7,100
A-76 Inflators (TY$)	$290	$2,524	$4,477	$3,303	$1,143	$11,737
SUBTOTAL (TY$)	$2,008	$17,595	$31,126	$23,249	$8,060	$82,038
SUBTOTAL (BY97$)	$2,008	$17,124	$29,591	$21,604	$7,323	$77,650
FMS Offset	$79	$704	$1,211	$1,028	$346	$3,368
RESEARCH	$0	$0	$2,800	$2,800	$2,800	$8,400
TOTALS (BY97$)	$1,929	$16,420	$31,180	$23,375	$9,777	$82,681
NPV	$1,894	$15,527	$28,405	$20,514	$8,266	$74,606

Figure 7.—Restructured AFIT Alternative Costs

a. PE84752 Costs. These costs pay military and civilian faculty salaries, and cover administrative operations to support AFIT in residence. Costs were determined through an activity-based costing exercise performed by AFIT/RP (AFIT/RP, 2 April 1998).

b. Assigned Base Operating Support (BOS) Costs. These costs pay utilities, maintenance, and other common support efforts such as police, fire, security, and services. BOS costs are documented in "AFIT Outsource Feasibility Assessment," AFMEA, July 1995, and provided by AFIT/RP, 2 April 1998.

c. A-76 Inflators. These costs are typically included in cost competition analyses and are intended to present a more "activity-based" cost. The A-76 factors used to arrive at costs are documented in "AFIT Outsource Feasibility Assessment," AFMEA, July 1995, and provided by AFIT/RP, 2 April 1998.

d. FMS Offset. These costs are provided by foreign governments as "tuition" for their students. Costs are provided by AFIT/RP, and act as an offset (negative cost) of the alternative.

e. Research.

- Costs represent those for equipment, travel, and other direct activity associated with AFIT research. The figure of $2.8M represents direct costs associated with research and is included across all alternatives.

- Labor in the form of student salaries is equal across all alternatives, so it is not included in this study. Labor in the form of faculty salaries is included in the PE84752 costs documented above. These costs were reimbursed from other USAF and DOD sponsoring agencies to support master's thesis and dissertation efforts in FY97, and are assumed to remain constant across the three years of this analysis.

- The typical "level of effort" of research per thesis is six months; the effort for each dissertation is two years (AFIT, 1998). For ease of analysis and comparability, research costs for three years are assumed to represent the requirement for FY99–01.

2. Alternative 2—Multisource Alternative

Figure 8 summarizes the costs of this alternative.

Multisource Alternative Costs ($K)	FY97	FY98	FY99	FY00	FY01	TOTAL
USAF Support Staff	$510	$510	$510	$510	$510	$2,549
Tuition	$514	$4,594	$7,180	$6,900	$2,599	$21,787
Academic Ops Cost	$39	$333	$500	$461	$167	$1,499
RESEARCH	$0	$0	$11,500	$11,500	$11,500	$34,500
CONSULTING	$0	$0	$529	$529	$529	$1,586
TOTALS (BY97$)	$1,063	$5,437	$20,218	$19,899	$15,304	$61,921
NPV	$1,043	$5,141	$18,419	$17,463	$12,939	$55,006

Figure 8.—Multisource Alternative Costs

a. Increased USAF staff support. Dispersing the student population and course load to CIs creates an oversight and administrative support requirement. Increased curriculum oversight to ensure focus on the unique requirements of the USAF will be mandatory. Administrative support to students will be required as well. The USAF will provide two officers and four civil service employees who will be assigned to HQ/AFIT at WPAFB. Costs include direct costs for salaries and benefits, and indirect allocated BOS costs.

b. Tuition. Tuition costs were obtained from the target institutions visited in mid-1997 (AFIT/CC, 1998). Based on these assessments, an average student year of tuition costs $15,313 (BY98$). The FY99 requirement for 230 18-month M.S. degrees and 35 three-year doctorates results in costs spread across five fiscal years. For ease of analysis, M.S. students are assumed to begin their program 18 months prior to the final day of the fiscal year of the requirement. For example, students satisfying the FY99 requirement begin their program in mid-FY98. Ph.D. students are assumed to begin their program three years prior to graduation.

c. Academic Operations. Academic operations include administrative support such as faculty textbooks, supplies, leases and licenses, and other incidentals. These costs amount to $1,100 annually (AFIT/RP).

d. Research. Research costs were provided by the institutions during the mid-97 visits. Costs are assumed to include the $2.8M annual requirement for equipment, travel, and other direct costs described in the restructured AFIT alternative.

e. Consulting. The total number of hours of consulting services provided by AFIT last year was 6,218. While this support was "funded" with faculty salaries, consulting services in the other two alternatives are costs above and beyond those for tuition. Costs assume an average of $85/hour.

3. Alternative 3—Single-Source Alternative

Figure 9 summarizes the costs of this alternative. Note that these cost elements are identical to those for the multisource alternative.

Single-Source Alternative Costs ($K)	FY97	FY98	FY99	FY00	FY01	TOTAL
USAF Support Staff	$468	$468	$468	$468	$468	$2,338
Tuition	$385	$3,439	$5,375	$5,164	$1,945	$16,308
Academic Ops Cost	$39	$333	$500	$461	$167	$1,499
RESEARCH	$0	$0	$7,000	$7,000	$7,000	$21,000
CONSULTING	$0	$0	$529	$529	$529	$1,586
TOTALS (BY97$)	$891	$4,239	$13,870	$13,621	$10,108	$42,730
NPV	$875	$4,009	$12,636	$11,954	$8,546	$38,019

Figure 9.—Single-Source Alternative Costs

a. Increased USAF staff support. The requirement for management and administrative support is considered to be the same as the multisource alternative. That support is two officers and four civil service employees. This analysis assumes that these personnel are provided offices at the new school facility at no additional cost to the USAF. Costs for the support staff include direct costs for salaries and benefits.

b. Tuition. Tuition costs were obtained from an unsolicited proposal provided to AFIT/CC in early 1998. That proposal includes annual tuition costs per student of $11,000 (BY98$). The FY99 requirement for 230 18-month M.S. degrees and 35 three-year doctorates results in costs spread across five fiscal years. For ease of analysis, M.S. students are assumed to begin their program 18 months prior to the final day of the fiscal year of the requirement. (Note that the average duration for an AFIT MS program is 17.58 months). For example, students satisfying the FY99 requirement begin their program in mid-FY98. Ph.D. students are assumed to begin their program three years prior to graduation.

c. Academic Operations. Academic operations include administrative support such as faculty textbooks, supplies, leases and licenses, and other incidentals. These costs amount to $1,100 annually (AFIT/RP).

d. Research. Research costs were provided by the institutions during the mid-97 visits. Costs are assumed to include the $2.8M annual requirement for equipment, travel, and Other Direct Costs (ODCs) described in the restructured AFIT alternative.

e. Consulting. The total number of hours of consulting services provided by AFIT last year was 6,218. While this support was "funded" with faculty salaries, consulting services in the other two alternatives are costs above and beyond those for tuition. Using an industry average of $85/hour, annual consulting costs are estimated as a separate element of cost for this alternative.

SECTION V
BENEFITS

Benefits represent the value that is derived from the alternative. While they can be qualitative or quantitative in nature, each benefit listed here is measured using a relative weighting scheme.

This section is divided into two parts. The first defines the benefit—what is being measured and how it is being measured. The second part illustrates the ratings (the extent to which each alternative satisfies each benefit) as well as their justification.

Figure 10 illustrates the benefits that are assessed in this analysis by means of a hierarchical tree. Note that the very basic node of the tree, the "goal," is defined in section I as: to provide an Air Force GEP meeting specific USAF technology requirements.

Under this goal are five objectives. Each is defined in section II.

- Objective 1: The primary objective of the GEP is to fill the quotas identified by AFERB.
- Objective 2: Provide focused intellectual capital in the form of consulting and research services to USAF and DOD agencies.
- Objective 3: Focus and respond to the changing technological direction of the USAF and DOD.
- Objective 4: Promote a sense of USAF organizational culture and professionalism among graduates of the GEP.
- Objective 5: Provide specified advanced education and training to foreign students as required.

Under each objective are several benefits that are designed to measure the extent to which the objective is attained. Those benefits may in turn be broken down into still more benefits (referred to here as subbenefits). Finally, once the lowest level of benefit or subbenefit is identified, each of the three alternatives is weighed against to the other two in a series of pairwise comparisons to determine the extent to which the alternative provides the benefit.

For example, the extent to which alternatives satisfy the quotas specified by AFERB (Objective 1) is measured by the benefits indicated by DEGREES, CAPACITY, and QUALITY. In a similar manner, the extent to which alternatives satisfy the "Quality of Education" (QUALITY) benefit is measured by the subbenefits ACCREDIT, DIVERSITY, and CORECOMP. The subbenefit ACCREDIT, speaks to the number of years the institution is

accredited. That is, the number of years for which the institutions are accredited is a measure of the quality of an educational institution, which is in turn a measure of the extent to which that institution can be expected to satisfy AFERB quotas for graduates.

A. Benefit Scores

The relative importance and value ratings described in the following sections yield the following benefit scores for each alternative:

- Restructured AFIT: 639
- Multisource Alternative: 111
- Single-Source Alternative: 250

Benefit values are relative; that is, they only have meaning in relation to each other. In this analysis, the restructured AFIT alternative was found to be more than twice as beneficial as the single-source alternative (639 to 250) and almost six times more beneficial than the multisource alternative. Detailed weightings and values are described in appendix B.

B. Definition of Benefits

Figure 10 illustrates a "benefits tree" that includes benefits and subbenefits derived from the five basic objectives. A total of 16 benefits and subbenifits are illustrated here and defined below.

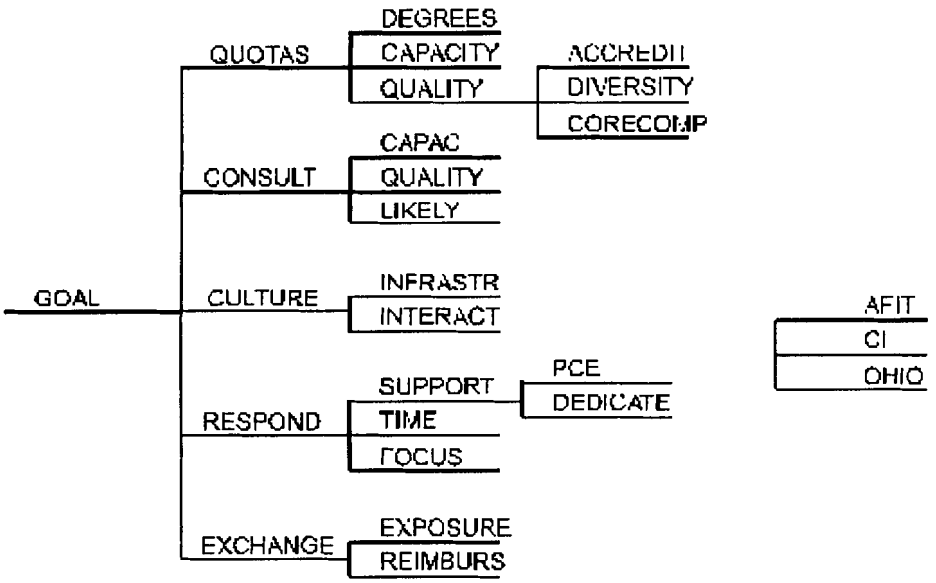

Figure 10.—Benefits Tree

This section defines the benefits against which the three alternatives will be compared. As described above, benefits are grouped under the objectives they support. The abbreviations for the objectives, benefits, and subbenefits are included in parentheses in the following paragraphs.

1. Objective 1—Fill the quotas identified by AFERB (QUOTAS). This is the primary objective of the USAF in-residence graduate education program. Quotas are filled with graduates in the disciplines dictated by annual releases from AFERB and AFIT/RP.

- **Benefit 1A—Specific technology focused degrees and courses offered (DEGREES).** This benefit measures the extent to which each alternative offers the full range of graduate programs and courses required to meet USAF quotas.

- **Benefit 1B—Capacity to fill all quotas (CAPACITY).** This benefit measures the extent to which each alternative offers adequate capacity (student slots) in the appropriate degree programs to meet USAF quotas.

- **Benefit 1C—Quality of academic education (QUALITY).** This benefit measures the quality of the education received by students. It is further broken down to three subbenefits, which are more measurable.

  - **Subbenefit 1C1—Duration for which master's degree is accredited (ACCREDIT).** This benefit measures the period of time for which the master's degree program is accredited. A long duration is considered to be indicative of a solid and established institution with a quality master's program.

  - **Subbenefit 1C2—Diversity of student population and academic professors (DIVERSITY).** This benefit measures the likelihood that the alternative offers a diverse student and faculty population. A diverse faculty would hold degrees from several different universities; a diverse student population would come from different cultural and socioeconomic backgrounds. Diversity is considered a good feature. It brings fresh ideas and approaches into the learning environment.

  - **Subbenefit 1C3—Portion of student population and academic faculty focusing on USAF and DOD core competencies as a primary pursuit (CORECOMP).** This benefit measures the extent to which USAF and DOD technology focus areas are shared by the alternative's institution(s). It considers the primary areas of academic and research study of the majority of students and faculty, and measures those against USAF technology focus requirements. A high score indicates consistency with pursuits that interest the USAF and DOD.

2. Objective 2—Provide consultation and research services to USAF and DOD agencies (CONSULT). The USAF GEP should be recognized as the source of focused research and consulting services for unique USAF and DOD interests. Benefits associated with this

objective measure the ease, interest, and focus with which the USAF and DOD interests are served by the alternative.

- **Benefit 2A—Capacity of alternative to provide focused research and consultation services (CAPAC).** This benefit measures the alternative's ability to provide the amount of research and consulting demanded by USAF and DOD customers. It considers availability of key research and consulting personnel, and access to labs and equipment.

- **Benefit 2B—Likelihood of alternative to provide focused research and consultation services (LIKELY).** This benefit measures the likelihood that the institution will be willing and able to provide the research and consulting demanded in a timely manner. Benefits are measured in relative terms. It considers the relative importance of USAF/DOD research to the university's overall research and consulting focus. This benefit acknowledges that universities focus on different areas of research for different reasons.

- **Benefit 2C – Quality of focused research for USAF/DOD (QUALITY).** This benefit measures the extent to which the research performed satisfies the USAF or DOD customer. Quality is measured by the past performance of the institution with respect to research, and is largely a function of past accomplishments of the faculty, the college entrance scores of the students, and the supporting research facilities (labs, etc.) close to the school.

3. Objective 3—Focus and respond to the changing technological direction of the USAF and DOD (RESPOND).

- **Benefit 3A—Support of existing USAF/DOD technology requirements (SUPPORT).** The following subbenefits measure the extent to which each alternative provides the courses and programs that in turn furnish the skills and expertise to satisfy key areas of focus/for the USAF/DOD.

  - **Subbenefit 3A1—Portion of instructors contributing to AFIT continuing education (PCE).** This benefit measures the portion of the faculty contributing to course content, or actually teaching, for the USAF Professional Continuing Education (PCE) Program. An exchange of ideas and experience between the PCE and graduate education programs is beneficial for both programs.

  - **Subbenefit 3A2 – Number of faculty exclusively dedicated to USAF GEP (DEDICATE).** This benefit measures the number of faculty members assigned exclusively as instructors in the USAF GEP. Faculty exclusively assigned tend to take a more focused approach to teaching, with the ability and desire to interject practical, real-world applications.

- **Benefit 3B—Time required to establish courses providing focused curriculums to satisfy USAF and DOD requirements (TIME).** This benefit measures the extent to which the institutions represented in the alternative can respond to rapidly evolving requirements by establishing new courses for USAF students. A high score here represents flexibility in the ability to create new, focused courses quickly to meet demands. Because no "industry average" is available, benefits are measured in relative terms.

- **Benefit 3C—Ability to quickly determine USAF and DOD areas of focus (FOCUS).** This benefit measures the ability of the school to recognize emerging technological and management developments and their specific relevance to USAF and DOD core competencies. It also determines the extent to which those schools react with senior USAF and DOD leadership to quickly interpret those emerging relevant developments.

4. Objective 4—Promote a sense of USAF organizational culture and professionalism among GEP students (CULTURE).

- **Benefit 4A—Amount of time spent interacting with USAF and DOD superiors, subordinates, and peers (INTERACT).** This benefit measures the amount of time students spend interacting with other USAF and DOD personnel. It includes social as well as professional interaction.

- **Benefit 4B—USAF and DOD infrastructure support provided to students (INFRASTR).** This benefit measures the amount of administrative, supervisory, and career progression support provided to students. It is considered key to providing an environment that fosters organizational identity and professional focus.

5. Objective 5—Provide Specified Advanced Education and Training to Foreign Students as Required (EXCHANGE).

- **Benefit 5A—Foreign students' exposure to USAF and DOD culture (EXPOSURE).** A major focus of this objective is to expose foreign students to the practices, attitudes, and underlying organizational culture of the U.S. military. This benefit measures the extent to which foreign students are provided that exposure.

- **Benefit 5B—Monetary Reimbursement (REIMBURS).** This benefit measures the likelihood of any financial reimbursement provided to the U.S. for permitting foreign officers and government workers to attend the USAF GEP. Note that the reimbursement must be made to the U.S. Government and not to an educational institution.

C. Benefit Ratings and Justification

This section describes the weights and values placed on the benefits defined in the previous section. Each of the five objectives is valued with respect to its contribution to achieving the overall goal of the USAF residence graduate education requirement. Then, for each of the five objectives, some benefits are defined; each benefit is valued with respect to its importance in measuring the objective. Finally, there is, in some cases, a set of subbenefits. These subbenefits are measured with respect to their importance in measuring the benefit. Under the lowest level of benefit or subbenefit, each of the three alternatives (restructured AFIT, multisource, and single-source) is scored to determine the extent to which that alternative satisfies the benefit or subbenefit.

Figure 11 illustrates the hierarchy of the overall goal, the five objectives to attain it, and the benefits under those objectives. The decimal values in the boxes are the relative ratings of the objectives, contribution toward meeting the GEP goal. Note that the total contribution of the five objectives equals 100%.

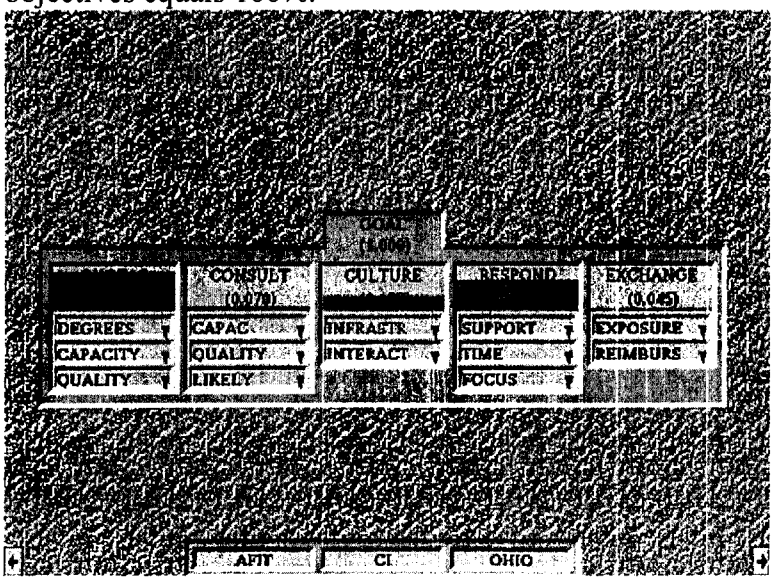

Figure 11.—Goals, Objectives, and Benefits

It is important to note that these "relative importance" values are derived from pairwise comparisons between alternatives for each of the benefits described in the previous section. *Detail of all pairwise comparisons is included in appendix B.* Figure 2 in appendix B illustrates the pairwise comparisons that result in the percentages listed in figure 11.

1. Objective 1—Fill the quotas identified by AFERB. The three measurable benefits that support this objective include:

- Specific technology focused degrees and courses offered.

- Capacity to fill all quotas.

- Quality of academic education.

The ability of the institution to furnish specific courses that lead toward a specific USAF technology-focused degree contributes a lopsided 65.5% of importance. The quality of the education provided at the institution contributes 25%, while the capacity of the institution (ability to handle USAF-specified student loads) is not as important, contributing 9.5%.

- **Benefit 1A—Specific technology focused degrees and courses offered (DEGREES).** The restructured AFIT alternative offers all degrees and courses required of the USAF graduate education program. It satisfies the specified benefit moderately more than the single-source alternative; and much more than the multisource alternative. The following ratings result from the pairwise comparisons documented in appendix B. **Relative benefit scores: AFIT (69.6%); Ohio (Single-Source) (22.9%); CI (Multisource) (7.5%).**

- **Benefit 1B – Capacity to fill all quotas (CAPACITY).** The three alternatives provide this benefit equally well. That is, each alternative provides an institution that is large enough to provide the requisite number of graduates to satisfy quotas. Note that only faculty and classroom size are measured. The following ratings result from the pairwise comparisons documented in appendix B.
  Relative benefit scores: AFIT (33.3%); Ohio (33.3%); CI (33.3%).

- **Benefit 1C – Quality of academic education (QUALITY).** This benefit measures the quality of the education received by students. It is further broken down to three subbenefits, which are more measurable.

The relative importance of the following three subbenefits describes the overall benefit of "Quality of Education."

- Duration for which master's degree is accredited.

- Diversity of student population and academic faculty.

- Portion of student population and academic faculty focusing on USAF and DOD technology focus as a primary pursuit.

The portion of the student and faculty body working on or supporting a degree in an area related to a specific USAF technology focus is considered a much stronger contributor to satisfying this benefit than the other two subbenefits. It contributed 69.1% of total importance, while the other two subbenefits are about equally important (16% and 14.9%).

  - **Subbenefit 1C1—Duration for which master's degree is accredited (ACCREDIT).** Both the restructured AFIT and multisource alternatives would

be conducted at institutions with superior academic accreditation credentials. AFIT is currently accredited for a maximum duration. The institutions in the CI alternative are all top-rate universities presumed to have the maximum accreditation duration. The single-source alternative has not applied for accreditation. It is reasonable to presume that it would receive accreditation, but possibly for less than the maximum duration. It is also reasonable to expect student reluctance in enrolling at an unaccredited institution. The following ratings result from the pairwise comparisons documented in appendix B.
Relative subbenefit scores: AFIT (45.5%); Ohio (9.1%); CI (45.5%).

- **Subbenefit 1C2 – Diversity of student population and academic professors (DIVERSITY).** The multisource alternative would clearly offer the most diversity with regard to student body and faculty. Both the restructured AFIT and single-source alternatives would offer the same level of diversity. While the current AFIT faculty is somewhat diverse in that very few instructors have received doctorates from the same universities, the students clearly have common backgrounds and goals. The single-source alternative and AFIT are likely to seek faculty from the same sources. Students may be exposed to a more diverse population if they travel to other Ohio campuses for instruction or research and consulting work. The following ratings result from the pairwise comparisons documented in appendix B.
Relative subbenefit scores: AFIT (11.7%); Ohio (20%); CI (68.3%).

- **Subbenefit 1C3 – Portion of student population and academic faculty focusing on USAF and DOD core competencies as a primary pursuit (CORECOMP).** The restructured AFIT alternative would provide students and faculty more dedicated to pursuing degrees and research in areas directly related to USAF technology focus requirements. In a similar manner, those in the single-source alternative would be focused on USAF technology focuses, but a guarantee of $7M of research funding each year without specific USAF and DOD sponsors, coupled with a presumably inherent lack of long-term commitment to research and curriculum development in the USAF and DOD's underlying core competencies would tend to lower this alternative's score. Multiple degree programs in the multisource alternative preclude extensive USAF/DOD focus. The following ratings result from the pairwise comparisons documented in appendix B.
Relative subbenefit scores: AFIT (50%); Ohio (41.5%); CI (8.6%).

2. Objective 2—Provide consultation and research services to USAF and DOD agencies. Three measurable benefits that support this objective include:

- Capacity of alternative to provide focused research and consultation services.

- Likelihood of alternative to provide focused research and consultation services.

- Quality of focused research for USAF/DOD.

The likelihood of the institution (represented in the alternative) to provide focused research and consulting contributes 53.7% of total importance to the objective. The quality of that research represents 36.4%. The capacity of the institution to provide the appropriate research and consulting accounts for 9.9%.

- **Benefit 2A—Capacity of alternative to provide focused research and consultation services (CAPAC).** The multisource alternative would allow a virtually unlimited capacity, constrained only by cost (which is not assessed here). A large university has many ways to provide research and consulting services for a fee, and could be expected to obtain the required talent to provide services better than the other alternatives. The Restructured AFIT alternative allows for shared resources among AFIT, the USAF and DOD labs, and the USAF product centers to provide focused research and consulting; capacity is very great. The single-source alternative would have similar capacity to the restructured AFIT, but may be constrained by a lack of familiarity with the USAF and DOD infrastructure from which this surge capacity could be required. The following ratings result from the pairwise comparisons documented in appendix B.
  Relative benefit scores: AFIT (29.3%); Ohio (22.3%); CI (48.4%).

- **Benefit 2B—Likelihood of alternative to provide focused research and consultation services (LIKELY).** Since AFIT exists to enhance the USAF and DOD's core competencies, the restructured AFIT alternative best satisfies this benefit. Both the multisource and single-source alternatives involve universities whose primary focus is research, but research in areas of interest and import to that particular institution. It is unlikely that either would be able to provide the focused consulting demanded of AFIT faculty. The single-source alternative, with an annual USAF research grant of $7M, is more likely to focus in the areas of the USAF's core competencies than the CI alternative. Universities in the CI alternative are more likely to focus on research for which they can obtain notoriety, larger research grants, and individual professor tenure and distinction. The following ratings result from the pairwise comparisons documented in appendix B.
  Relative benefit scores: AFIT (64.9%); Ohio (27.9%); CI (7.2%).

- **Benefit 2C—Quality of focused research for USAF/DOD (QUALITY).** It is reasonable to presume that research and consulting at a top university would be high quality. It is likely to be performed by distinguished faculty and/or very academically gifted students. In a similar manner, AFIT research and consulting projects have been very well received, as stated by the numerous letters of appreciation received over the years (AFIT, 1998). AFIT's facilities and proximity to Wright Labs and the Aeronautical Systems Center (ASC) provide it unique opportunities to repeatedly satisfy research and consulting customers. This study did not pursue evidence of

focused research and consulting by schools in the single-source alternatives. However, such research is unlikely to be as focused as that in the other two alternatives. The following ratings result from the pairwise comparisons documented in appendix B.
Relative benefit scores: AFIT (38.7%); Ohio (10%); CI (51.4%).

3. Objective 3—Focus and respond to the changing technological direction of the USAF and DOD. Three measurable benefits that support this objective include:

- Support of existing USAF/DOD technology focused requirements.
- Time required to establish courses providing focused curriculums to satisfy USAF and DOD core competency quotas.
- Ability to quickly determine USAF and DOD areas of focus.

The benefit measuring the extent to which an alternative's curriculums and research is targeted towards USAF core competencies is clearly the most important, providing 59.8% of total importance. The amount of time required to develop a new course or program contributes 22.4% of importance. The ability of an institution to recognize relevant emerging technological and management developments contributes 17.7%.

- **Benefit 3A—Support of existing USAF/DOD technology focus requirements (SUPPORT).** This benefit measures the extent to which each alternative provides the courses and programs that in turn furnish the skills and expertise to satisfy key technology requirements.

Two subbenefits provide a measurable indication of an alternative's relative contribution to the overall SUPPORT benefit:

- Portion of instructors contributing to AFIT continuing education.
- Number of faculty exclusively dedicated to USAF GEP.

The number of faculty exclusively dedicated to the USAF graduate education program is the most important contributor to satisfying this benefit. It receives 60.5% of total importance. The portion of faculty contributing to continuing education contributes 39.4%.

  - **Subbenefit 3A1 – Portion of instructors contributing to AFIT continuing education (PCE).** This benefit measures the portion of the faculty contributing to course content, or actually teaching, for the USAF PCE Program. At least 25% of AFIT/LA faculty currently contribute to the continuing education program via direct instruction or curriculum development. The portion is smaller out of the AFIT/EN school, primarily because it does not offer as many continuing

education courses. However, this figure represents considerably more instructors than would be contributing in either of the other two alternatives (single or multisource). Continuing education courses are very focused on unique USAF requirements; there would be no reason why CI instructors would want to contribute to such programs. It is more likely, however, that an instructor at the single-source institution would have the right experience and inclination to be a valuable contributor to a continuing education program than a CI instructor. The following ratings result from the pairwise comparisons documented in appendix B.
Relative subbenefit scores: AFIT (74.2%); Ohio (18.3%); CI (7.5%).

- **Subbenefit 3A2—Number of faculty exclusively dedicated to USAF GEP (DEDICATE).** This benefit measures the number of faculty members assigned exclusively as instructors in the USAF GEP. All faculty in the AFIT alternative contribute to the GEP; after all, it's the reason for AFIT's existence. Conversely, a relatively small percentage of faculty in the other two alternatives would be solely dedicated to the USAF GEP. The multisource alternative would be the lower of the two. Faculty in the single-source alternative would be exclusively dedicated to the USAF GEP during the two-or three-year period that they would be assigned to the program; however, the USAF GEP is not likely to be viewed as a career for these instructors. The following ratings result from the pairwise comparisons documented in appendix B.
Relative subbenefit scores: AFIT (69.6%); Ohio (22.9%); CI (7.5%).

- **Benefit 3B—Time required to establish courses providing focused curriculums to satisfy USAF and DOD core competency quotas.** This benefit measures the extent to which the institutions represented in the alternative can respond to rapidly evolving requirements by establishing new courses for USAF students. AFIT can cite several examples of rapid development of new courses and programs. The masters in air mobility degree program was in place six months after being requested from Headquarters, Air Mobility Command (HQ AMC). Five months elapsed from the time that Wright Laboratory's Materials Directorate identified a requirement for a program in materials science and engineering. While neither the multisource or single-source alternative can be expected to respond quickly, it is likely that the single-source alternative would be more responsive. The following ratings result from the pairwise comparisons documented in appendix B.
Relative benefit scores: AFIT (69.9%); Ohio (23.7%); CI (6.4%).

- **Benefit 3C – Ability to quickly determine USAF and DOD areas of focus.** The benefit measures the ability of the school to recognize emerging technological and management developments and their specific relevance to USAF and DOD requirements. While close collaboration between AFIT faculty and USAF senior leadership has always been common, that relationship will take some time to develop in the other two alternatives. It is more likely to develop in a more focused program

like the single-source alternative where significant portions of the faculty will probably have either taught at AFIT previously or be retired USAF officers. The following ratings result from the pairwise comparisons documented in appendix B.
Relative benefit scores: AFIT (66.1%); Ohio (27.2%); CI (6.7%).

4. Objective 4—Promote a sense of USAF organizational culture and professionalism. Two measurable benefits that support this objective include:

- Amount of time spent interacting with USAF and DOD superiors, subordinates, and peers.

- USAF and DOD infrastructure support provided to students.

Each benefit is considered of equal importance in contributing to the overall objective of promoting a sense of organizational culture and professionalism.

- **Benefit 4A—Amount of time spent interacting with USAF and DOD superiors, subordinates, and peers (INTERACT).** This benefit measures the amount of time students spend interacting with other USAF and DOD personnel. At AFIT, students continually interact with officers from the USAF, Army, Navy, and foreign countries. Research is primarily conducted at USAF facilities and organizations. Frequent interaction with the "field" to assess the latest emphasis is common. This common interaction cannot be expected in the single-source or multisource alternative. The single-source alternative does insist on students performing research at USAF labs, thus promoting this interaction. The following ratings result from the pairwise comparisons documented in appendix B.
Relative benefit scores: AFIT (64.9%); Ohio (27.9%); CI (7.2%).

- **Benefit 4B—USAF and DOD infrastructure support provided to students (INFRASTR).** This benefit measures the amount of administrative, supervisory, and career progression support provided to students. Once again, the restructured AFIT alternative best provides this benefit because of its organic nature; administrative staff are collocated with students at the school, and USAF faculty are made up of officers who generally have their own experiences and insight into the USAF system. Students have many sources from which to gather information and support. The single-source alternative is likely to provide good support as well, because six USAF officers will be collocated with students to provide "liaison" between the school and the USAF. The multisource alternative is not likely to support unique USAF infrastructure requirements. The following ratings result from the pairwise comparisons documented in appendix B.
Relative benefit scores: AFIT (64.9%); Ohio (27.9%); CI (7.2%).

5. Objective 5—Educate some number of foreign exchange students every year. Two measurable benefits that support this objective include:

- Foreign students' exposure to USAF and DOD culture.

- Monetary reimbursement.

The relative importance of these two benefits in contributing to satisfaction of the objective.

- **Benefit 5A—Foreign students' exposure to USAF and DOD culture (EXPOSURE).** This benefit measures the extent to which foreign students are exposed to the practices, attitudes, and underlying organizational culture of the U.S. military. The restructured AFIT alternative provides an environment in which the majority of students and faculty are military—and its campus is on an Air Force installation. This is clearly the preferred alternative for experiencing U.S. military culture. The single-source alternative would include a student body made up primarily of USAF officers. Faculty in this alternative are likely to be retired USAF, or have some experience dealing in the USAF or DOD culture. USAF presence in the multisource alternative would be very small—a foreign student is much less likely to be exposed to USAF or DOD culture under this alternative. The following ratings result from the pairwise comparisons documented in appendix B.
  Relative benefit scores: AFIT (73.1%); Ohio (18.8%); CI (8.1%).

- **Benefit 5B—Monetary Reimbursement (REIMBURSE).** This benefit measures the likelihood that any financial reimbursement will be provided to the U.S. for permitting foreign officers and government workers to attend the USAF GEP. In FY97, foreign governments reimbursed the USAF approximately $987,000 (AFIT/RP, 1998), which equates to about $22,000 per student. Reimbursements are on an annual basis through the Foreign Military Sales (FMS) programs. An average annual tuition for a student in the single-source alternative would be $11,000 (see Section IV Costs). The average multisource cost per student year is $15,313 (AFIT, 1998). Of these tuitions, none goes toward the value added to the GEP from having the USAF administrative presence or populating the programs with primarily USAF officers. The reimbursement to the U.S. Government under the AFIT alternative can be thought of as defraying the *fixed* cost of running AFIT—*marginal* costs to admit foreign students are nominal. The following ratings result from the pairwise comparisons documented in appendix B.
  Relative benefit scores: AFIT (100%); Ohio (0%); CI (0%).

SECTION VI
RISK ASSESSMENT/SENSITIVITY ANALYSIS

Sensitivity analysis illustrates how changes in assumptions, and the subsequent impact on the values and ratings of the costs and benefits, change the results of the analysis. Baseline assumptions result in costs, benefits, and cost-effectiveness figures (cost/benefit ratio) for each of the three alternatives.

Excursions from the baseline assumptions in this study were made to determine their impact on the results. These excursions are only a few of the hundreds that could have been evaluated, but they are the most likely to be of interest to reviewers of this analysis.

A. Excursion A—Increase the Student Quotas by One-Third for FY99–01

If quotas are increased, both costs and benefit scores will be impacted. Assuming that the restructured AFIT alternative would be required to increase staff by about one-sixth (half of the quota increase) to accommodate the extra 88 students annually, costs for the PE84752 increase. In the other two alternatives, tuitions increase proportionately. In addition, costs for research increase proportionately for all three alternatives. (This assumption has a particularly large impact for the multisource alternative, which already has a large cost for research). Presuming that CIs are more able to accommodate surges in student population, the relative benefits to the multisource and single-source alternatives are greater than for the restructured AFIT alternative.

Adjusting costs and benefits for the assumptions for this excursion does not yield any change in the ranking of alternatives. The restructured AFIT alternative is still clearly the most cost-effective alternative. Resulting cost-benefit ratios are:

- Restructured AFIT: 139
- Multisource Alternative: 587
- Single-Source Alternative: 198

B. Excursion B—Evaluate the Multisource Alternative Assuming Second- and Third-Tier Schools.

If the USAF was willing to settle for universities outside the top 25, it could save on tuition costs. However, the quality of education would suffer. Benefits provided by the multisource alternative would be impacted such that the quality of both education and consulting services would decline to a level commensurate with the single-source alternative's. The restructured AFIT alternative would become more attractive from a benefits perspective. Since second-tier universities were not approached with requests for cost estimates, the tuition and

research/consulting costs for the multisource alternative are assumed to decrease by an arbitrary one-third.

Adjusting costs and benefits for the assumptions for this excursion does not yield any change in the ranking of alternatives. The restructured AFIT alternative is still clearly the most cost-effective. Resulting cost-benefit ratios are:

- Restructured AFIT: 115
- Multisource Alternative: 500
- Single-Source Alternative: 150

C. Excursion C—Delete Requirements for Research and Consulting From the USAF GEP Objectives

If the costs and benefits of consulting and research are eliminated from the analysis, the single-source alternative becomes slightly more cost-effective than the restructured AFIT alternative. That's because of the huge cost savings the USAF would realize if it does not have to fund $7M of research annually. In addition, research and consulting contribute a relatively small amount of value to the overall USAF GEP requirement. Eliminating that contribution has a much greater impact on lowering costs than it does on lowering benefits. The multisource alternative also becomes more competitive. Resulting cost-benefit ratios are:

- Restructured AFIT: 87
- Multisource Alternative: 233
- Single-Source Alternative: 71

Note: This excursion assumes that universities represented in the single- and multisource alternatives would still be willing to provide a USAF GEP. This is highly unlikely, based upon inputs from the Miami Valley Economic Development Coalition (single-source alternative). Furthermore, by eliminating costs and benefits of research, it is implied that AFIT's thesis and doctoral dissertation requirements would be eliminated—also not very likely.

D. Excursion D—Increase Restructured AFIT Costs To Equate Its Cost-Effectiveness to That of the Next Most Cost-Effective Alternative (The Single-Source Alternative)

In order for the single-source alternative to become as cost-effective as the restructured AFIT alternative, cost-benefit ratios must be equal. In order for this to occur, the NPV of costs for the restructured AFIT alternative would have to increase by $22,986,000 to $97,191,000, a 30% increase; or costs for the single-source alternative would have to decrease by $8,844,000 to $29,175,000, a 223% decrease.

Benefit scores could also increase or decrease by similar percentages to equate cost-benefit ratios.

SECTION VII
CONCLUSIONS AND RECOMMENDATIONS

This study defines a set of benefits to the USAF and DOD by investing in AFIT. They attempt to describe the contributions to USAF's mission in unique areas. Those areas are the unique technologies and the focus on the direction of future technologies that will or likely will impact the future of warfare as conducted by the USAF. Assigning numerical values to the measurable aspects of these benefits and objectives allows us to develop a cost/benefit ratio for each of the three alternatives requested in the study.

The restructured AFIT alternative is clearly the highest cost alternative, yet it yields an even higher relative benefit value. It costs 36% more than the next most expensive alternative, yet it provides 156% more benefit than any other alternative. The primary contributor to AFIT's extreme benefit is its ability to focus on unique technologies that are key to the evolution of the USAF's warfighting capability. In analyzing the benefits of a program such as the GEP, the multisource or single-source alternatives cannot provide the unique benefits to the extent that a restructured AFIT can.

The USAF should maintain the restructured AFIT as the institution to satisfy its GEP objectives. Of the alternatives evaluated, a restructured AFIT provides the most cost-effective solution. The USAF should continue to restructure AFIT as defined in this alternative to meet the objectives of a USAF graduate education program.

APPENDIX A—COST WORKSHEETS

APPENDIX A—COST WORKSHEETS

The following worksheets detail the derivation of the costs for the restructured AFIT, multisource, and single-source alternatives. In general, the sources of these costs are:

- Restructured AFIT Alternative—AFMEA Study, July 1995, and AFIT/RP Activity-Based cost analyses.
- Multisource Alternative—Major universities visited in mid-1997.
- Single-Source Alternative—Unsolicited proposal and subsequent response to follow-up questions from AFIT/CC, April 1998.

APPENDIX B—PAIRWISE COMPARISON OF ALTERNATIVES

APPENDIX C—WORKS CITED

WORKS CITED

AFIT (1998), *Level of Effort for Research,* unpublished document, Wright-Patterson AFB, OH.

AFIT/CC (1998), *AFIT Grad Ed Alternatives—A Discussion,* unpublished document, Wright-Patterson AFB, OH.

AFIT/EN (1998), *Air Force Graduate Education Core Competency Needs,* unpublished briefing, Wright-Patterson AFB, OH.

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Miami Valley Economic Development Coalition (1998), *Response to Air Force Background Paper: Issues for Discussion—Ohio Privatization Proposal,* Dayton, OH.

National Center for Education Statistics (1998), web page.