6-6-1994

Air Force Institute of Technology Yesterday...Today...Tomorrow 1919 - 1994

Air Force Institute of Technology

Ernest R. Keucher [Editor]

AIR FORCE INSTITUTE OF TECHNOLOGY

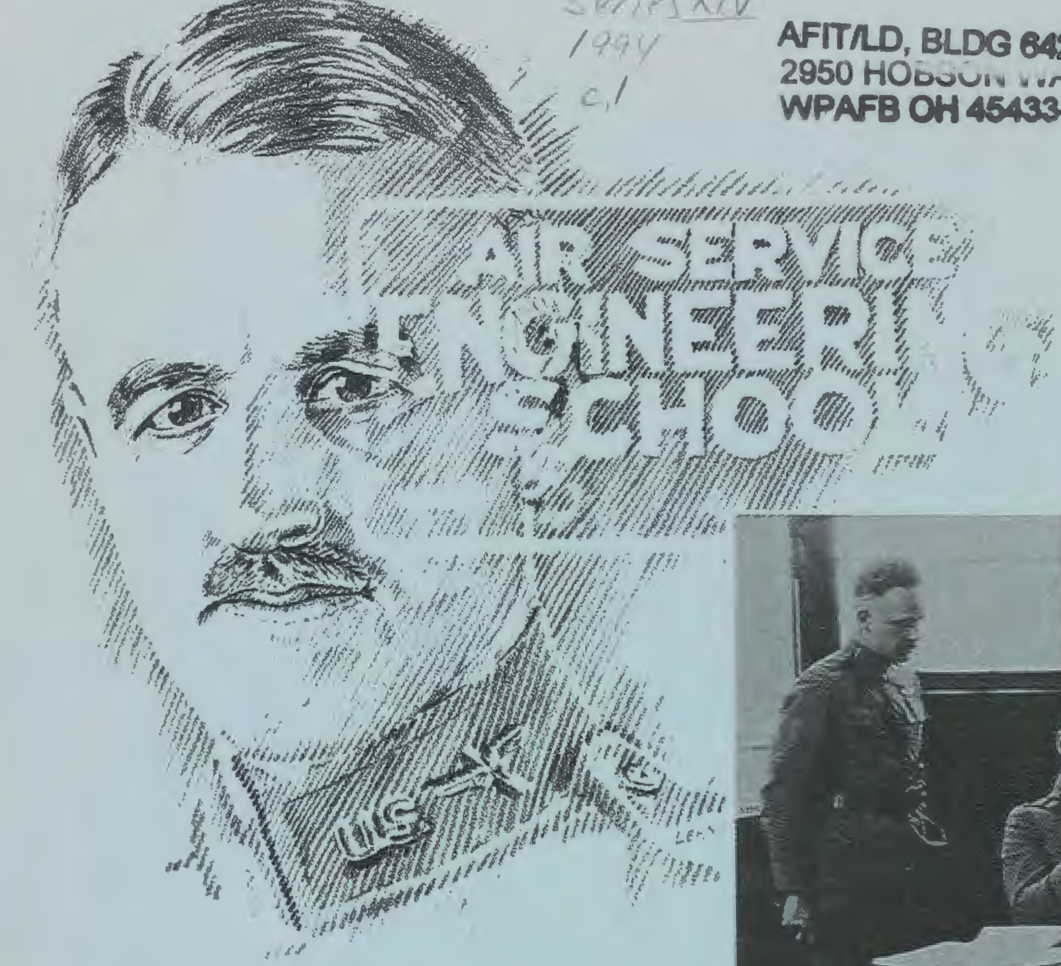
1919 1994

75th Anniversary

Air Force Institute of Technology

YESTERDAY
TODAY
TOMORROW

1919 — 1994



Col Thurman H. Bane seated in his office at McCook Field.

The Class of 1922.

A lesson in navigation for the Class of 1925.

Air Force Institute of Technology
Yesterday . . . Today . . . Tomorrow 1919 - 1994

6 June 1994

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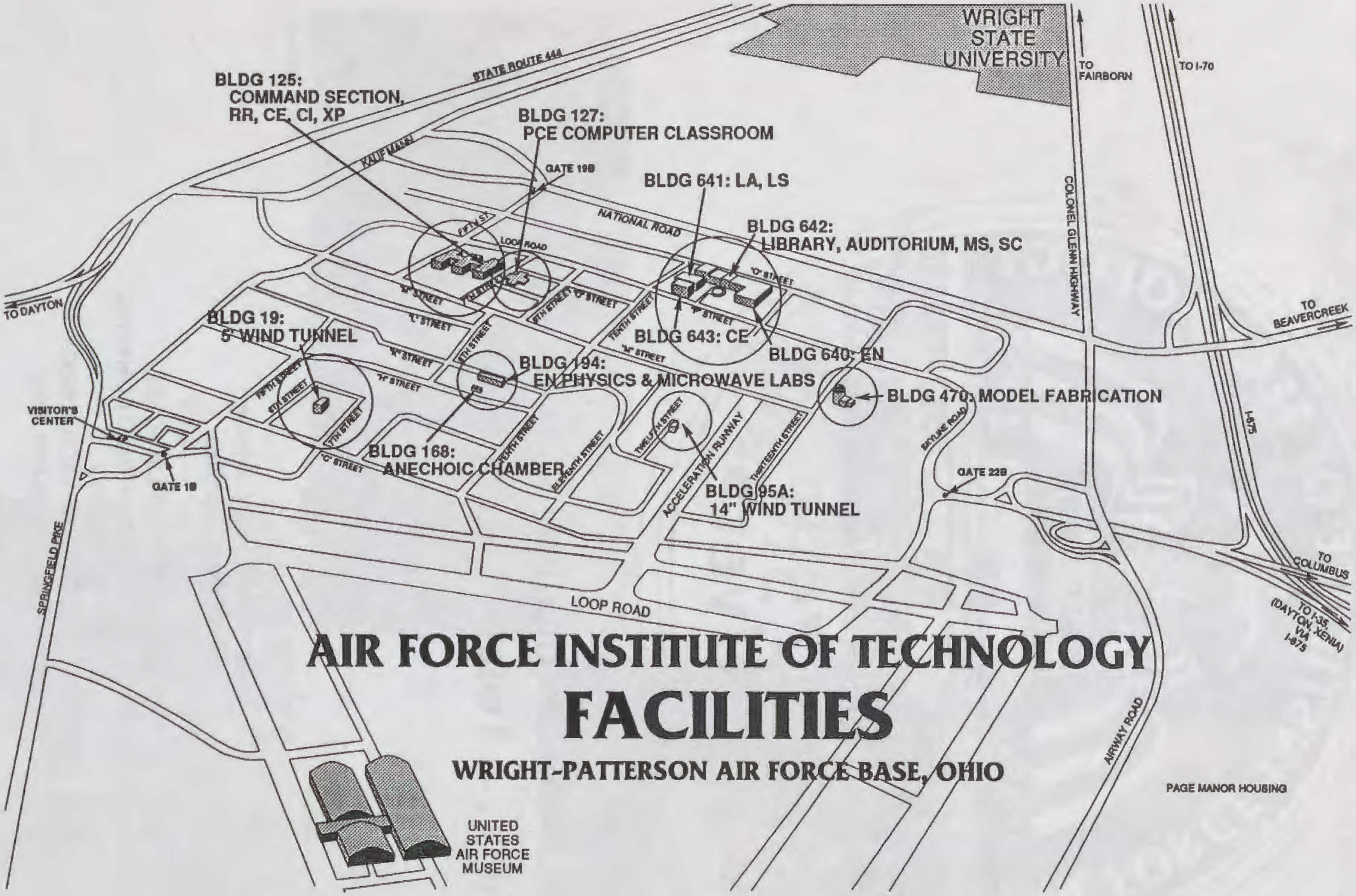
DEPARTMENT OF THE AIR FORCE
AIR FORCE EDUCATION & TRAINING COMMAND
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
Wright-Patterson Air Force Base, Ohio



The AFIT facility manager was responsible for over 508,823 sq ft of classrooms, technical laboratory, library, shops, computer labs, a 750 seat auditorium, and two dedicated computer rooms for 11 mainframe systems.

Bldg.	Size (Sq. Ft.)	Primary Use
125	6,251	Academic/Lecture Hall
	28,287	Classrooms
	130,079	Office
640	6,615	Academic
	13,689	Library technical/professional
	33,387	Technical Classes
	71,687	Technical/Laboratory/shops
641	1,596	Computer Space
	6,310	Library Technical/Professional
	74,802	Technical Training Classes
642	136,000	Library/750 seat auditorium offices
19	16,853	5 ft Wind Tunnel
79C	2,350	Storage
95A	1,552	14 in Wind Tunnel
127	3,222	Classroom
168	2,283	Anechoic Chamber
194	12,261	Electric-Optic (IR) Laser Lab
470	39,282	Model Fabrication Laboratory

America was born on the first wave of modern technology. As the frontier moved westward -- to the Pacific coast, to Alaska, -- technology moved with it and advanced through our social fabric. Then came a different kind of frontier: the air. For the past 75 years, aviation has been in the forefront of American technology. It is no longer limited to the air; we have already entered the era of operations in space.

Since the first military airplane, the United States Air Force and technology have moved together. Today the Air Force is irreversibly committed to technology; and that commitment to technology is an inexorable commitment to education.

The Air Force Institute of Technology (AFIT) embodies the Air Force commitment to education. Sixty years ago, at McCook Field, it was established as the Air School of Application. It has evolved with the Air Force, always on the leading edge of technology, until it became the Institute as we know it. For 60 years AFIT has provided educated men who have contributed not only to the Air Force, but to the Department of Defense and to American society as a whole. AFIT graduates today occupy high positions in uniform, in civilian government positions, and in the world of commerce.

Now AFIT is poised for its seventh decade. We are ready to move into the educational future: not only to educate for today's challenges, but to carve out totally new professional disciplines to meet the further challenges of operating in space. Never before in our history have the Air Force and AFIT been better prepared to meet the challenges of a technologically intensive future. On this occasion, our 60th Anniversary, I am happy to share with you AFIT's proud heritage and bright prospects for the future.

Gerald E Cooke

GERALD E. COOKE, Major General, USAF
Commandant
Air Force Institute of Technology

This publication extends the 1979 Sixtieth Anniversary Edition of the AFIT history to include the last fifteen years. Reading this volume you will see the evolutionary changes in academic curricula and research needed to satisfy the educational requirements in the Air Force. The education AFIT has provided for thousands of students has built a solid foundation that propelled the Air Force into the Space Age, allowed the nation to have "Global reach -- Global power" capability, and resulted in the Air Force becoming the best in the world. The Air Force transformation into an air and space force of tomorrow will now provide new challenges for the Institute.

On the occasion of our 75th anniversary, I join General Cooke, AFIT Commandant from 1978-1980, in sharing with you AFIT's proud heritage and challenges for the future.

Joseph P. Koz

JOSEPH P. KOZ, Colonel, USAF
Commandant
Air Force Institute of Technology

FOREWORD

I wish to thank Dr. Janusz Przemieniecki, Institute Senior Dean, who served as an expert consultant on the assembling of this publication. Additionally, Col Joseph Koz, Commandant, provided all the aid needed to bring this project to fruition.

Several professors were very generous of their time and effort to furnish timely inputs, additional insights, and words of encouragement toward completing this compilation. I thank Dr. Robert Henghold, Dr. John D'Azzo, Dr. Charles J. Bridgman, Dr. G. Ronald Christopher, Col Richard M. Hanes, Col Bennie Wilson, Lt Col Phil Miller and Lt Col Wayne Maricle for their helpful efforts, as well as many others who read the draft(s) and furnished useful comments and constructive criticism.

I was inspired during my research, to read *Yesterday . . . Today . . . Tomorrow*, AFIT's first 60 years from 1919-1979, written by the AFIT Department of Humanities' Capt Sanders Laubenthal -- [it is the first chapter of this publication] -- I commend it to you for your edification to learn where AFIT has been.

Thanks also to the printing plant and AFIT graphics staff support in assembling and printing the 32 former and current commandants' photographs from the best copies available. NASA public relations graciously furnished information regarding astronauts and identified those whose education was furnished via AFIT.

Several administrative and staff members were generous with their expertise, including Gene Lehman, Capt Dan Hicks and Mrs. Maxine Shroyer. Mrs. Fran Collinsworth, Ms. Becky Semler, Greg Smith, Dr. Ron Christopher, Maj Phil Westfall, Lt Megan Curran and Dr. Janusz Przemieniecki were all quite involved in the multiple sets of statistics, ultimately assembled into the several concise graphs within the report. Thank you, all.

ERNIE KEUCHER
Center for Distance Education
1992-1993 Historian
30 April 1994

TABLE OF CONTENTS

AFIT Facilities [map] iv
General Cooke and Colonel Koz' Preface v
Foreword vi

CHAPTER ONE -- AFIT HISTORY: FIRST SIXTY YEARS, 1919-1979 1-1

CHAPTER TWO -- LEADERSHIP AND ORGANIZATION 2-1
2-1: Early History 2-1
2-2: 1980s: Period of Growth 2-5
2-3: Changes in Key Personnel 2-5
2-4: 1990s: Period of Consolidation 2-6
2-5: AFIT Deans 2-7
2-6: AFIT Commandants 2-8
2-7: Biographical Sketches of AFIT Commandants 2-8
2-8: Photographs of Commandants -- 1919-1994 2-11
2-9: Comparison of AFIT Organization in 1985 and 1994 2-27

CHAPTER THREE -- MISSION AND FUNCTION 3-1
3-1: Graduate School of Engineering (EN) 3-1
Degrees awarded by the resident schools in AFIT (graph) 3-2
3-2: Graduate School of Logistics and Acquisition Management (LA) 3-5
3-3: School of Systems and Logistics (LS) 3-9
Professional Continuing Education (PCE) course completions: School of Systems and Logistics (graph) 3-11
3-4: School of Civil Engineering, MWR and Services (CE) 3-15
Professional Continuing Education (PCE) course completions: School of Civil Engineering, MWR and Services (graph) 3-17
3-5: Civilian Institution (CI) Programs 3-21
3-6: Directorate Missions and Functions 3-23
3-7: Program Reviews 3-28
3-8: Science And Technology Educational Forecast (STEF) 3-29
3-9: AFIT Board of Visitors 3-29
3-10: Accreditation 3-30

CHAPTER FOUR -- CONTRIBUTION TO SCIENCE AND TECHNOLOGY 4-1
4-1: The Doctoral Program 4-1
4-2: Contributions to Air Force Research and Development 4-4
4-3: Significant Research 4-5
Adaptive and Reconfigurable Flight Control -- Professor M. Pachter 4-5
CFD: Numerical Modeling of High-Speed Flows -- Dr. Philip S. Beran 4-6
Chemical Laser Kinetics -- Major Glen Perram 4-7
Control/Structures Interaction Research -- Professor Brad S. Liebst 4-7
Electro-Optical Sensors and Signals -- Dr. Byron Welsh 4-8
Fatigue, Fracture and Failure of Composite Materials -- Professor S. Mall 4-9

Knowledge-Based Software Engineering -- Major Paul D. Bailor 4-9
Mathematical Modeling -- Professor Dennis W. Quinn 4-10
Nonlinear Optics -- Professor Won B. Roh 4-11
Nuclear Radiation Transport -- Professor Kirk Mathews 4-11
Nuclear Weapon Fallout Modeling -- Professor Charles J. Bridgman 4-12
Parallel Computation (Software Design and Application) -- Professor Gary B. Lamont, Lt Col William C. Hobart, and Professor Thomas C. Hartrum 4-13
Semiconductor Materials and Device Characterization -- Professor Yung Kee Yeo and Professor Robert L. Hengehold 4-14
Shell Structure Analysis -- Professor Anthony N. Palazotto 4-15
Smart Weapons - How to Find and Identify Targets -- Professor Steven K. Rogers 4-15
Threat Characterization For Advanced Aircraft Materials -- Lt Col Kenneth W. Bauer 4-17
4-4: Significant Consulting 4-17
4-5: Astronauts 4-19

CHAPTER FIVE -- SIGNIFICANT EVENTS 5-1
5-1: AFIT Association of Graduates merger with The AFIT Foundation 5-1
5-2: ACE 5-2
5-3: APDP 5-2
5-4: DAU 5-2
5-5: Distance Learning 5-3
5-6: Four Facilities Erected 5-4
5-7: Quality Air Force (QAF) 5-6
5-8: DERA 5-7
5-9: DISAM 5-7
5-10: Dayton Area Graduate Studies Institute 5-8
5-11: Schedule 'A' for AFIT Faculty 5-9
5-12: Gifts 5-9
5-13: The AFIT Forum 5-10
5-14: Military Faculty Tenure 5-10

CHAPTER SIX -- AWARDS 6-1
6-1: Institute Awards 6-1
6-2: Presidential Recognition by President Reagan for an AFIT Dean 6-3
6-3: Professional Recognition of Faculty 6-3
6-4: Faculty Awards 6-4
6-5: Emeritus Awards and Personnel Changes 6-7
6-6: Student Awards 6-9
6-7: Association of Graduates Awards 6-11
6-8: Civilian Awards 6-12

CHAPTER SEVEN -- THE VISION 7-1

ACRONYMS A-1
NAME INDEX I-1

Chapter One AFIT History: First Sixty Years
1919 - 1979

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Editor's Note

Chapter One of this publication is an accurate computer-scanned reaccomplishment of the 1979 '60th Anniversary Edition' of the Air Force Institute of Technology history, from 1919 through 1979, written by Capt Sanders A. Laubenthal, entitled "Yesterday Today Tomorrow." Page numbers are used as 1-1, 1-2, etc., to differentiate between the previous (i.e., 1979) publication and the 1980 through 1994 History Edition which cover subsequent years; the two segments together encompassing the entire 75 years since AFIT's inception.

The editor wishes to thank Professor Sam Epstein for his scanning support, Mr. Tim Pillion of Defense Printing for his attention to detail and Ms. Nancy Wiviott for her proofreading prowess.

Ernest R. Keucher, Editor

Table of Contents

YESTERDAY

"No Man Can Efficiently Direct Work about Which He Knows Nothing. . . ." 1-2
Air School of Application 1-4
Air Service Engineering School 1-4
Air Corps Engineering School 1-10
The Graduates Go to War 1-18
Reopening of the Engineering School 1-26
"A Source of Stimulation to the Imagination of Officers" 1-31
Years of Development 1-38
"PRESIDENT SIGNS DEGREE GRANTING BILL. . . ." 1-52
Building a "Space Age Campus" 1-61
The Air Force Enters Space 1-70
Years of Expansion 1-73
To the Moon 1-80
Years of Austerity 1-82
The Exploration of Space 1-88

yesterday . . .

The Class of 1920.

"No Man Can Efficiently Direct Work about Which He Knows Nothing. . . ."

It was November 1918, less than three weeks after the signing of the Armistice. Colonel Thurman H. Bane, head of the Technical Section of the Division of Military Aeronautics, was writing from Dayton to the Director of Military Aeronautics in Washington.

> Authority is respectfully requested to inaugurate at McCook Field an Air Service School of Application similar to the Ordnance School of Application at Sandy Hook Proving Ground, N.J.
>
> The object of this school would be to give the proper technical training to the permanent officers of the Air Service. . .
>
> . . . Our old flyers are familiar with conditions at San Diego before the war – such conditions do not spell progress. We worked until noon only. If the entire afternoons had been devoted to good sound technical training, we would have been in much better shape to have handled the war expansion. . . . The Air Service will never be a complete success until all officers in command of Air stations and in staff positions understand the game from its very foundation. . . . No man can efficiently direct work about which he knows nothing.

Bane spoke from experience; he was one of those "old flyers." He had begun his career as a cavalry officer. But in 1916 he had been part of the Mexican Punitive Expedition, the first occasion on which the Army's air arm went to war. One day, while patrolling a stretch of flat border country thick with cactus, mesquite, and alkali dust, Bane had looked up from his saddle at a flight of kite-like stick and fabric planes passing overhead. As he followed their course across the sky, he was impressed with the advantage that aerial reconnaissance had over scouting from horseback. Perhaps he also guessed that the fragile biplanes passing overhead were precursors of greater things. He applied for transfer to the Aviation Section of the Signal Corps.

Less than ten years had passed since the Army bought its first airplane and told Lieutenant Benjamin Foulois to teach himself to fly it. But a Signal Corps Aviation School had opened in late 1912 at North Island, San Diego, California; and in November 1916 Bane went there to earn his wings.

A few years earlier, the aviation school had offered a substantial academic program, with lectures on aerodynamics and design, the theory and operation of aviation engines, and related subjects. But by the time Bane arrived, the school had been reorganized; and the emphasis had shifted to experimentation and flying training. Officers with previous military experience were in short supply in the air service; Bane, who had background in ordnance as well as cavalry, was a valuable asset. In March 1917, before he even finished his flying training, he was appointed Assistant Secretary to the Aviation School; two months later he was Secretary, second only to the commanding officer of the school.

By that time the United States had entered the war in Europe. The war had already called attention to the potentialities of aircraft for combat as well as

reconnaissance, and Congressional appropriations for aircraft were becoming more generous. But to Bane it was obvious that the progress of American aviation depended on theoretical knowledge and technical skill. He had no formal training in engineering; but he brushed up on the mathematics he had used in his ordnance work, studied articles on aerodynamics in the magazine *Aviation*, and read everything he could find on aeronautical techniques and engineering. Soon he was able to put together a course in aeronautics and design which met with prompt acceptance at the Aviation School. Bane was asked to join the teaching staff and to serve as officer in charge of the experimental shops -- an important task, since all new instruments and accessories for airplanes were tested and demonstrated by the personnel of the Aviation School.

But Bane was not destined to remain long in San Diego. Late in 1917 he was promoted to lieutenant colonel and transferred to Washington, where he served as a member of the Joint Army and Navy Technical Board and later as Executive Officer of the Air Division of the Signal Corps. In May 1918, when the Technical Section of the Division of Military Aeronautics was established in Washington, he was placed in charge.

He was now deep in the details of the "war expansion" he later referred to in his letter. His office procured technical information, including the general specifications for all aircraft and their equipment; appraised the military value of the data; and coordinated its work with the Bureau of Aircraft Production in Dayton. Bane, a colonel by August 1918, was responsible for many of the important decisions on air policy; the need for closer association between the Division of Military Aeronautics and the work in Dayton led to his being ordered to Dayton on temporary duty. There, at the end of the war, he wrote his letter asking for authorization to establish an Air Service School of Application at McCook Field.

McCook Field, founded in the fall of 1917, had officially replaced San Diego as the site of the Signal Corps's aviation engineering and experimental activities. It stood at the confluence of the Miami and Mad rivers just north of Dayton, on what had been the farm of General Anson McCook and his seven sons, the "fighting McCooks" of Civil War fame. In May 1918 when President Woodrow Wilson relieved the Signal Corps of responsibility for aviation development and created an Air Service within the War Department, the organization at McCook had been known as the Airplane Engineering Department; in August of that year it became the Airplane Engineering Division, reporting directly to the Chief of the Army Air Service.

After the signing of the Armistice, the government decided to consolidate the various Air Service engineering activities at McCook Field, under the name of the Technical Division, Air Service, U.S. Army. Colonel Thurman Bane was placed in charge of the consolidation and, on 1 January 1919, became first chief of the new Division and commanding officer of McCook Field. For a while he did not have much time to pursue his school project -- which was being held in abeyance anyway while the postwar planners decided what to do with the Air Service.

McCook Field was small, only 254 acres; it had been leased as a temporary wartime facility and hastily built up to accommodate the various technical, engineering, and production departments which had sprung up during the war. Its 69 buildings -- hangars, shops, laboratories, offices, wind tunnel, hospital, and the like -- were already over-crowded with some 1500 military and civilians. The consolidation brought the organizational total to 19 sections and 75 branches, which Bane somehow had to coordinate into an efficient Technical Division.

As commander of a post that functioned as a huge experimental laboratory, with about 400 scientists, engineers, and technicians engaged in a large number of research and development projects, Bane decided that the best plan was to adopt some of the methods of private industry. He had the value of each project carefully weighed and its results appraised and devices set up to measure the progress of each undertaking. At the same time, in the face of postwar cutbacks and a growing demand for scientists and technicians in industry, he had to battle to keep the appropriations and staff necessary to continue the work.

Bane resolved part of the problem by turning over some of the research projects to private firms. But it seemed clear that the only way to insure a body of technical experts for the Air Service was to train some. He pursued the idea of an Air Service School of Application and finally, almost a year after his original request for authorization, received a letter from the Director of the Air Service ordering him to begin the course of instruction on 10 November 1919.

Air School of Application

The instruction had actually begun, informally, several months earlier, in June 1919. During the war, partly through Colonel Bane's efforts, an aeronautical engineering school for experienced Army and Navy pilots had existed for a few months at the Massachusetts Institute of Technology (MIT). When the war was over and the school closed down, most of its Army personnel were transferred to McCook Field. Among them was Lieutenant Edwin E. Aldrin, who had received a masters degree from MIT in aeronautical engineering before returning to serve in the wartime school. He arrived at McCook in February 1919 and, after a short time, was appointed Chief of the School Section.

"And I was told I had to start a school," he commented years later, "which didn't please me too much; but the type of school was pretty well laid down by the commanding officer, Colonel Bane, because of his experience in the Ordnance Department, which had had a school of application. So the senior officers of the . . . Air Service . . . were ordered to McCook Field . . . approximately 10 lieutenant colonels and majors, and I was a first lieutenant. I had the job of starting a school from nothing."

Colonel Bane, as commanding officer of McCook, was the official commandant; and his executive officer was originally the assistant commandant. But both had heavy responsibilities, so most of the work actually fell on the shoulders of Lieutenant Aldrin. As secretary and later as assistant commandant, Aldrin ran the school for the first few years.

The group that gathered for the first official class on 10 November 1919 was small: Aldrin, another lieutenant, two majors, and four lieutenant colonels. They assembled in a hangar. Aldrin read them an introduction to the course and gave a copy of it to each officer. In the months that followed, the course envisioned by Colonel Bane became a reality. The classrooms were small frame buildings and hangars clustered along McCook's small grass runway, and the main educational tools were the blackboard and practical experience. On some evenings, prominent men from colleges and commercial plants delivered lectures illustrated by lantern slides.

The aims originally proposed by Bane had been modest:

> To give the proper technical training . . . so that Commanding Officers of flying fields will understand thoroughly technical maintenance of airplanes and motors, machine shop installation, shop management and cost accounting, and the operation of machine tools, power plant installation and operation, electricity, metallurgy, laboratory testing of fuels, gasoline, raw materials, etc., elementary aerodynamics not including applied design except in a general way (there would be no intention of making aeronautical engineers of the students).

The original idea had been, as Aldrin put it, to invite the senior officers "to participate in knowledge that was being developed and worked on at the Engineering Division first-hand. But, in order to do this thing well, they had to have certain fundamental preparations and review. This was the basis of the curriculum, and it was supposed to be on a problem basis. In other words, the question was put out. The student was supposed to go and get the answers the best way he could -- books, people, experts all over the place. In the mornings and in the afternoons we had laboratories; and this ranged from machine shop right on through to testing laboratories, instruments, engines, structural tests, and so forth."

In 1918 Bane had urged the selection of senior officers for the first class, so that they could be prepared to command flying fields. But in April 1920, even before the graduation of the first class, he was writing to the Inspector General, " . . . it is thought that all field officers in the Air Service should be given this course, and if all field officers are so educated, that all flying officers of the Air Service should be so educated. . . . Certainly, the minimum number of men handled . . . should be twenty a year."

Air Service Engineering School

Meanwhile, the battle of postwar reorganization of the War Department had been fought out in Washington. On 4 June 1920, Congress finally passed the National Defense Act which established the Air Service as a combatant arm of the Army. The school at McCook was officially renamed the Air Service Engineering School. The first class graduated in September.

Aldrin stayed on as Assistant Commandant and as the only military instructor, teaching subjects like

propeller design and basic aeronautical theory. The second class was considerably more junior: four majors, three captains, two lieutenants -- among them a Captain George C. Kenney who would one day achieve considerable fame. The trend toward less rank continued throughout the twenties: fewer majors, more lieutenants and captains.

McCook Field in those years was an ideal place for participation in the development of new knowledge, which Aldrin saw as the distinguishing characteristic of the school. From 1919 through 1921, McCook Field's progress reports to Washington were devoted almost entirely to experimental development and testing: the design (and sometimes the construction) of experimental, pursuit, attack, and observation planes; studies and layouts of other planes for night bombing, night attack, ground attack, and infantry liaison; work on air-cooled engines, cooling systems, and superchargers; and testing (and sometimes independent designing) of parachutes, leakproof tanks, photographic equipment, radio, aerial torpedoes, armament, and bombing equipment. At McCook the first cantilever monoplane and the first all-metal aircraft in the United States were designed and flown; the Barling bomber, the earliest U.S. "heavy" aircraft, was designed and later assembled at McCook for testing; and the first Air Service helicopter -- a purely experimental model, not destined to become operational -- was flown in mid-December 1922, with Colonel Bane as pilot. As Aldrin remarked, "Learning to fly different airplanes was a matter of just knowing what was in the cockpit and going out and trying it. As a result, I think I flew every single-engined airplane that was at McCook Field in the early days."

Aldrin left for the Philippines in early 1922, and Bane retired at the end of the year. But the Engineering School was firmly established, and its graduates were beginning to show their worth. The technological advances of the twenties made new aerial achievements possible, and many Engineering School graduates pioneered significantly both in technology and in flight. Maj Follett Bradley of the 1922 class was credited with having sent the first radio message from an airplane; he had also participated in the first air-directed artillery firing in the U.S. (in 1912) and in the 1922 Pulitzer Air Races. Lieutenant Harold R. Harris of the same class was a pioneer in the use of the parachute, which was being developed at McCook in those days. On 20 October 1922, while he was flight testing an experimental plane at McCook, something went wrong with the controls. When the plane went into a dive, Harris decided to take his chances with the parachute. He reached the ground safely, having made the first peacetime parachute jump from a disabled airplane in flight. Harris also earned 13 world flying records during his service career. Another member of the 1922 class, Lieutenant Burton F. Lewis, later served as project engineer for experimentation with aerial torpedoes and new aircraft types at McCook Field.

It was an era when practically every flight was an experiment, and when world records were continually made and then broken. Air races, altitude and endurance flights, and the like filled an important need, calling attention to the potentialities of flight when aviators were still thought of as kite-flyers or crazy birdmen. Many of the Air Service's test pilots -- among them Captain George C. Kenney, Lieutenant John A. Macready, Lieutenant James H. Doolittle, Captain Wendell H. Brookley -- went through the Engineering School at one time or another. Both Macready and Doolittle were in the class of 1923.

Macready was, among other things, another parachute pioneer. On 13 June 1924, while he was making a night airways flight from McCook Field to Columbus, Ohio and back, his engine died just as he was approaching Dayton. His first idea was to make an emergency landing, but the two flares he released failed to ignite. Even though no one had ever made an emergency jump at night, he decided to trust to his parachute and came down safely, though his parachute tangled in a tree and he required help to get to the ground.

Macready was already famous: a setter of world records. On 28 September 1921 he had climbed to 34,508 feet in an experimental Le Pere biplane designed and modified at McCook Field and souped up with an engine turbo-supercharger. On 2-3 May 1923, with Lieutenant Oakley Kelly, he made the first non-stop coast-to-coast flight, from Roosevelt Field, New York to Rockwell Field, California. En route, he made the first in-flight aircraft engine repair in Air Service history, replacing a defective voltage regulator switch while the Fokker mono-plane churned westward. The flight also set a new distance record for a single cross-country flight. Macready won the MacKay Trophy three times: once for the altitude flight, once for the transcontinental flight, and once for an endurance flight of 36 hours, 4 minutes and 32

seconds. He was the only person ever to receive it three times.

Orville Wright was the official observer for all Macready's high-altitude attempts to break world records. Macready remembered years later, "He was a man so conscientious that he just leaned over backwards." Macready would go up on a high altitude flight, and the instruments would read 45,000 feet, or something of the sort. Everything would be recorded by smoked paper, with nothing written down. "I almost broke that world's record many times," Macready recalled, "but there would be some little detail." Orville Wright had to verify the record before it went to the International Aeronautique in Paris, which determined whether it was a world record. But if the slightest detail, however insignificant, was not quite as it should be, Orville Wright would throw the whole business out and Macready would have to try again. Still, there was this to be said for his meticulous approach: if Orville Wright was the official observer, the world knew that the record was accurate.

Jimmy Doolittle had also won some fame as a pilot before he entered the Engineering School. He had wondered whether a single pilot could span the country in a single day; and before dawn on 5 September 1922 he had taken off from Pablo Beach, Florida to find out. Ten hours later he had landed at Kelly Field, Texas to refuel, then took off again and landed at San Diego after spanning the continent in 21 hours and 19 minutes.

His orders to McCook had already come through; within days after the transcontinental flight, he was at the Air Service Engineering School. For Doolittle, the school assignment had special significance: "In the early '20s, there was not complete rapport between the flyers and the engineers. The pilots thought the engineers were a group of people who zipped slide rules back and forth, came out with erroneous results and bad aircraft; and the engineers thought the pilots were crazy -- otherwise they wouldn't be pilots. So some of us who had had previous engineering training were sent to the . . . engineering school at old McCook Field. . . . After a year's training there in practical aeronautical engineering, some of us were sent on to MIT where we took advanced degrees in aeronautical engineering. I believe that the purpose was served, that there was thereafter a better understanding between pilots and engineers."

Even before he completed his work at MIT, Doolittle returned to McCook Field to take part in an Air Service testing program. His assignment was to take a pursuit aircraft -- a Fokker PW-7 with plywood wings -- almost to the point of structural failure in order to measure scientifically the effects of acceleration on the plane and on himself. He took the aircraft through loops at various airspeeds, single and multiple barrel rolls, power spirals, tailspins, and various other extreme maneuvers, so that the flight loads imposed on the wings under extreme conditions of air combat could be ascertained. He flew the Fokker so near its limit that, as he pulled out from the final dive of the tests, the wings failed (but fortunately did not come off). Upon his return to MIT, Doolittle used the test for his masters thesis, "Accelerations in Flight," which was eventually published in every technical language in the world. For his doctoral dissertation he studied the effect of wind-velocity gradient on flying characteristics, proving -- among other things -- that pilots could not sense wind direction without some visual reference: an important finding at a time when the interface between man and machine was just beginning to be studied. This project led into his pioneering work in the development of instrument flying. He assisted in the development of fog flying equipment, developed the artificial horizontal and directional gyroscope, and in 1929 made the first flight completely by instruments. In the midst of all this, he found time to win the Schneider Cup Race of 1925.

A third member of the class of 1923, Donald L. Bruner, made night flying possible through a series of experimental flights undertaken during his service at McCook Field. He invented the first revolving aircraft beacon, flew the first plane with electric lights, and developed the airplane landing light. In 1922 he established the first night airway in the United States, from McCook Field to Columbus, Ohio. He won the Distinguished Flying Cross for his pioneer work in night flying and was in charge of night flying at the National Air Races in 1926.

Similar pioneering work by Engineering School graduates went on through the twenties and for many years thereafter. Richard C. Coupland ('24) eventually held patents covering radio control of dynamic bodies, aircraft gun synchronizers, feed mechanisms for aircraft weapons, computing gun sights, aerial mechanisms, and various types of ammunition. Hugh Downey ('25) was active in the development of

retractable landing gear and pioneered in air service maintenance. Edwin R. Page ('25) worked in power plant development and was active in the development of self-seating fuel tanks. Lewis R. P. Reese ('25) was later active in bombsight development. A member of the 1926 class, Carl F. Greene, eventually developed pressure cabin airplanes and made the first successful test flights with them. He won the Collier Trophy for pioneering stratosphere flights. Greene also worked on the design and development of metal structural system wings to overcome high-speed flutter, as well as tricycle undercarriages and cowling for radial air-cooled engines. David G. Lingle ('26) did important work in the development of petroleum and fuels.

Marathon distance and endurance flights were important throughout the twenties. Burnie R. Dallas of the 1924 class was in charge of ground operations for the "Question Mark" endurance flight in 1929, when Maj Carl Spaatz and Capt Ira Eaker stayed aloft for 151 hours by refueling in mid-air. Capt Elmer E. Adler ('25) was a member of the Round-the-World Flight Committee. When five Air Corps planes flew on a goodwill tour of Central and South America, December 1926 to May 1927, they were led by Maj Herbert A. Dargue ('20); other Engineering School graduates were also on the tour. They flew in all kinds of weather and climate, braving uncharted mountains, jungles, lakes, and swamps. The flight was hailed as a diplomatic success; an ambassador from one of the countries visited remarked that it had done "more good than ten years of diplomatic correspondence."

By 1923 the Air Service School of Engineering had four more or less distinct courses, three for Air Service officers and one for employees of the Engineering Division. The one-year course in General Aeronautical Engineering, primarily airplane design and aircraft engine design, was the most substantial. The school also had a five-month course in Maintenance Engineering -- a practical course "for the purpose of training officers in the proper maintenance of aeronautical equipment" -- a three-month course in Maintenance Engineering for reserve officers; and a group of six evening courses in aerodynamics, metals, and the like for employees and officers of McCook Field.

Classrooms in the Engineering School -- or "McCook College" as it was sometimes nicknamed -- were often the forums for lively discussion. A member of the 1926 class wrote a playful account of the classroom scene for the *Air Service News Letter* (the fractured spelling and grammar were supposed to be part of the humor):

Old McCook colledge has again come to the forefront of educational institutions by winding up the 1st semester without no casualities. . . . The reason everything went so good up to Christmas was due to the fact that it was all about subjects like mathematics mechanics chemistry electricity & the etc. & all the instructor had to do was to learn you what he could & watch out you didn't go to sleep on him. . . . There wasnt no one wanted to fight about his own personal ideas on three moment equations . . . for the reason that he didnt have no ideas abt these things personal or any other kind. But . . . all was changed when some of the wizzards from the airplane section opened up the hanger door . . . and announced that they would proceed to learn us some airodynamics.

Gentlemen" says Mr. Gearhardt, removing his glasses & taking off his coat and vest, "it is my duty to open up a discussion on the airodynamics in general and the modern conception of DRAG -- "

"Why mention drag in the Air Service," says Major Milling with a hollo laugh, "I can prove to you Mr. Chairman that under the naval appropriations of 1924 the --"

"One moment Major," cries Dave Lingle, "If I can step out & get my briefcase -- I have some figures --"

"The DRAG of AIRFOILS & entire airplanes," yells Gearhardt, "in the air, the AIR -- AIR --"

"He wants air" says Mack Pike who is a lawyer & can spot the bonus of contention. . . .

"What I mean gents," resumes Gearhardt, thoughtfully hefting the inkwell "is that when we began to abandon the conception of Drag on the purely experimental basis of the attitude of the body in favor of a basis which would allow for a mathematical expression of functional relationship between the Lift and Drag components we saw that the attitude of the airfoil or of the airplane had no series of values which were susceptible to measurement in terms of such functions. . . . "

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"Question," yells Whitehead, pulling out of a 10,000 foot dive 2 feet above the surface of lake Saint Clare, "do you mean to say that in flying an airplane like for inst the PW 8 it dont matter what attitude you fly at?"

"How about a Martin Bomber" butts in Jawn Whiteley. I see a coupla times when I would of swapped all the mathematics in the colledge for a little better attitude & I dont mean maybe."

"What attitudes can a bomber get in if any," hollers Breene . . .

"Put down that chair leg Breene & come outside & I'll -- "

"You're a liar it was foggy & you can ask Bock if -- "

* * *

Mr. Gearhardt (emerging from under the desk): "Lecture's over gentlemen."

All sort themselves out, brush themselves off and exeunt. . . .

The class of 1926, however, was almost the last to use the old classrooms at McCook. The lease on the property had expired in 1921 and was being renewed annually at a considerable increase in rent. McCook was overcrowded and cramped for space and the wartime laboratory buildings, made of wood, were fire hazards and expensive to maintain. The flying field was really too small for aircraft testing, and too close to Dayton, so that it was a hazard to life and property. A hangar facing the field bore a huge sign, warning pilots: "This field is small. Use it all." New quarters for the experimental engineering and flight testing had become a necessity.

Capt Donald L. Bruner ('23) receives the Distinguished Flying Cross for pioneer work in night flying.

But Dayton was unwilling to see the laboratories go, and the Air Corps (as the Air Service was renamed in 1926) wanted to keep them in Dayton because of the area's industrial facilities. In 1924 a group of Miami Valley businessmen, organized as the Dayton Air Service Committee, had presented the U.S. government with more than 4,500 acres of land purchased with several hundred thousand dollars collected in a local drive. The land was adjacent to 40 acres which the government had already purchased near Fairfield, Ohio, northeast of Dayton -- an area known as Wilbur Wright Field. In 1925 the government began to clear the land donated by the Dayton Air Service Committee, and in 1926 buildings began to go up.

Macready with Orville Wright. Wright verified the records of Macready's altitude flights.

1st Lt John A. Macready ('23), in the gear used for early high-altitude flights.

McCook Field.

The Class of 1925 (Aldrin, as Assistant Commandant, is seated second from the left).

In 1925, the curriculum included "aeroplane wing fabric design." Here, a J-N4D "Jenny" trainer undergoes fabric tests.

Maj Carl Greene (left) with an early pressure cabin airplane.

The Class of 1931 (Chidlaw is second from left in the front row).

Left: Capt George Holloman with his Q-2 radio-controlled target drone.

Center: The Boeing 299, prototype of the B-17.

Right: The Army Aeronautical Museum, where the Engineering School was located in the late thirties.

Air Corps Engineering School
Early Years at Wright Field

When the class of 1927 graduated from the Air Corps Engineering School (as it was now called), McCook Field was already being dismantled. No class entered that summer. But on 12 October 1927 the new facilities were dedicated at Wright Field, and a new class entered the Air Corps Engineering School in 1928.

In 1926, in connection with the reorganization of the Air Service as the Air Corps, the old Engineering Division had been grouped together with the Field Services Section and certain aeronautical procurement activities, to form the Materiel Division. This new division had six sections, one of which was Experimental Engineering: an arrangement which remained in effect until 1939. The Air Corps Engineering School was also a part of the Materiel Division, and the Chief of the Materiel Division acted as Commandant.

Wright Field was a placid place in the late twenties. In the summer of 1927 it had only 20 buildings; much of the military reservation was covered with forest. Signs were posted to mark the boundaries; and the Chief of the Materiel Division issued hunting permits to military and civilian employees and their friends, authorizing them to hunt in the area "north and east of the Huffman Dam and the Interurban Tracks." Another portion of the reservation was set aside as a wildlife refuge.

In moving from McCook to Wright Field, the Engineering School had exchanged its rather ramshackle frame residence for a much more imposing home in the Materiel Division headquarters building. The class of 1929 had its picture taken in front of this edifice, a handsome white concrete building with a flight of steps rising to a fourfold doorway flanked by iron lampposts. Nearly every class of the early and mid thirties had its picture taken on the same steps.

The physical setting was not the only thing that had changed. During the twenties there had been a change in philosophy regarding the government's role in aeronautical research. Between 1919 and 1922, Air Service engineers had designed and built 27 airplanes of all types at McCook Field. But after 1923, experimental activities began to decline. Money was scarce; and the infant aircraft industry, starving for contracts, was becoming vocal about its desire for a greater role in aircraft development: a contract for even one experimental airplane would have helped any of the struggling companies. Gen Mason M. Patrick, Chief of the Air Service at the time, had a problem on his hands:

> The manufacturers, or at least some of them who had designers of their own, were most anxious to secure orders for building planes according to their own designs. These, however, had to be submitted to the Engineering Division before they could be approved by the Chief of the Air Service. As such designs by outside agencies were passed upon by the Engineering Division designers and were really in competition with those which they created, there was the claim on the part of the manufacturers that the engineers at the Division always preferred, and gave preference to, designs which had originated with them. . . . It was claimed that this was throttling initiative, really preventing the more rapid development of aircraft designing -- as it was expressed: "taking the bread out of the mouth of the very hungry aircraft industry."
>
> Furthermore, at this same Engineering Division, aircraft were actually being built, not in numbers, but a few of an experimental character, and again the manufacturers complained that this was undue interference with their enterprises.

After studying the situation Patrick became convinced that the manufacturers had a valid point and that the Engineering Division should play a different role.

> I decided that we would build no more airplanes at the Division and, further, that no more aircraft designs would be created there. We would still maintain a designing staff, but its function would be to pass upon the designs submitted to the Air Service, while it would be available for consultation with outside designers, manufacturers, and those who had ideas to propose.

Despite the greater role given to aircraft manufacturers, the Air Service devoted almost 25 percent of its budget to research and development in the mid-twenties. A small nucleus of officers and civilians carried on the work at McCook Field and later at Wright Field. But as funds slowly dried up -- reaching a low point in 1927 -- the workforce of civilian aircraft technicians grew smaller.

This reduction in research had far-reaching effects. The Air Service and later the Air Corps now had to depend primarily on private aviation firms for aircraft designs. Since these firms were primarily interested in developing large, long-range aircraft which could serve as commercial airliners, attack and pursuit aircraft got relatively little attention. The major effort went into the development of bombers.

This fell in, however, with the concepts of employment that were becoming current in the Air Corps. Billy Mitchell's bombers had sunk the Ostfriesland in 1921; and he had championed the concept of strategic bombardment throughout the early twenties, using even his court-martial as a forum for his ideas. His views had influenced thought at the Air Corps Tactical School, where air doctrine was gradually taking shape. A bombardment manual written by Mitchell had been standard fare at the Tactical School since its founding in 1926, and in the thirties men who had worked with Mitchell during the bombing tests or served as his aides became instructors. Meanwhile the technology of aircraft production was catching up with Mitchell's theories. When Major General James Fechet, a proponent of the long-range bomber, became Chief of the Air Corps in 1927, the stage was set for the developments of the 1930s.

Even before the Barling bomber was designed and tested at McCook during Colonel Bane's tenure -- Lt Harold R. Harris ('22) had flown it in 1923 -- the technology required for building long-range bombers had been in the making. The Barling bomber had proved that great size was no deterrent to flight and provided data on building and handling large aircraft, but it had been obsolete before it was ever finished. By the late twenties, the technology for an all-metal bomber was available; at Fechet's insistence, development began on the all-metal Martin B-10.

As early as 1930, a small group of engineering and bombardment officers had been working on plans for bombers at Wright Field. Among them were Colonels Clinton W. Howard (of the Engineering School class of 1921) and Hugh Knerr, who had been promoting the concept of a low-wing, all-metal, multi-engined bomber. The Martin B-10 was built along those lines, complete with the retractable landing gear developed by Hugh Downey and others; when tested in 1932, it was the most powerful bomber in the world.

These changes in philosophy, doctrine, and technology had their impact on the Air Corps Engineering School. Because of the increasing importance of science and the need for specialization, the mission of the school had broadened: after 1926 the object of the school was "to train Air Corps officers in the higher phases of aeronautical engineering," providing "a general technical training from the standpoint of possibilities and limitations of Air Corps material and equipment, in addition to instruction in the fundamental principles and practices."

The original curriculum had been primarily application, consisting of student projects initiated and completed with a minimum of formal lecturing. Courses had been taken in consecutive order rather than concurrently, with each subject studied intensively for a relatively short period. When the scope of the curriculum was revised in 1926, the lecture method was put to greater use, and the first step was taken toward creating a permanent faculty.

The structure of the school in the mid-thirties was not greatly different from what it had been ten years earlier. The Chief of the Materiel Division was still the official Commandant; the Assistant Commandant was the one directly in charge of instruction and supervision of the activities of the school. He was also an instructor. By 1935 he had a staff consisting of two civilians: an acting Senior Instructor and an acting Secretary.

The Senior Instructor for some years was Ezra Kotcher, who had arrived at Wright Field in July 1928 as a junior aeronautical engineer. His potential as an instructor was quickly recognized, and within months he was assigned to the Engineering School as Instructor in Higher Mathematics. Laurence C. Craigie, a lieutenant in the class of 1935, remembered Kotcher clearly: "a full-time instructor and a fine engineer. . . . Everybody who went through Wright Field, and this includes people by the dozens who had three- and four-star rank, all look back on their relationship with Ezra Kotcher as being a very significant element in their career. He was that impressive as an individual.

. . ." Kotcher stayed on at the school until the outbreak of World War II.

Nearly everyone else on the faculty was a part-time instructor. The various branches of the Materiel Division furnished the instructors for the majority of the courses -- subjects like Depot Operation, Wind Tunnel Research, Physical Testing of Metals, Aircraft Inspection, Performance and Flight Testing. The Air Corps Engineering School regulations of 1937 commented, "It is realized that the instruction of the course is often an additional duty for the instructor assigned . . . but the teaching of highly specialized subject matter can be properly accomplished only by assigning it to the Branches concerned."

The school term now ran from the beginning of August to the end of July. The curriculum had been revised to appeal to a younger group of students, most of whom were graduates either of West Point or of civilian technical institutions. To provide the necessary background for this group, the school conducted a mathematics review by correspondence for the incoming class before the school year began.

There were four departments: fabrication, materials and structures, testing, and design. The 1935 catalog commented, "It is not to be expected that the curriculum of the Engineering School would follow that of a civil institution. . . . Many of the courses are not attainable in civil institutions . . . [Materiel Division] activities demand a breadth of curriculum such as can be properly supplied by no single civil institution." The student began with a review of fundamental courses such as mechanics, strength of materials, and thermodynamics, then gradually absorbed in proper sequence the information necessary for engine and airplane design. Finally he completed the year with a course in performance and flight testing.

The student was kept busy. The schedule was based on a 32-1/2 hour week of instruction during the fall term and a 29-1/2 hour week through the remainder of the year. The 1937 Regulations noted, "Flying, athletics, and required home study are not included in the tabulation of scheduled hours." The student was exhorted to remember the Army regulations governing required exercise -- "It is of utmost importance that students maintain themselves in good physical condition" -- and urged to observe extreme care in complying with the local flying regulations. He could fly cross-country on weekends within a 1000-mile limit (but not to the eastern seaboard), but he was advised that "no officer will take a cross-country flight if, in his opinion, the weather conditions do not warrant completion of the flight and his attendance in the classroom."

If he intended to return after dark, he had to say so, so that a night-flying airplane equipped with flares could be assigned. But if he only intended local flying, the airplanes on the incidental line were available every afternoon. School supplies were free; but the student was reminded, "The allotment of supplies for the year requires that there be no wastefulness."

What students remembered afterward, however, was not the thicket of regulations but the school personalities, like Kotcher, and the subject matter they studied. Craigie recalled,

> It was pretty largely math, strength of materials, the continuation of work we had had at West Point. It was at master's degree level, although we did not get a master's degree out of it. But a lot of the courses were not strictly academic . . . because the students that went to the engineering school were officers who were motivated to make a career in that materiel side of the business. . . . A lot of our courses and a lot of our instruction was related to the various activities of the Materiel Command, including supply and maintenance as well as research and development and design. . . . Theory and practical and administrative. It was a hell of a good 12 solid months of work.

Field trips were a highlight of the course. The class of 1935 used the facilities of the Fairfield Air Depot for their instruction in depot operation and attended the spring conference of the National Advisory Committee for Aeronautics (NACA) at Langley Field, Virginia. They also visited some twelve commercial factories strung from Ohio to Maryland: Goodyear Tire & Rubber, Bausch and Lomb Optical Company, North American Aviation, and the like.

Another highlight was the course in Airplane Design. Each year the Commandant assigned an airplane design problem for the consideration of the class. After analyzing the tactical requirements, the students completed a preliminary design covering the weight estimate and balance, performance estimates,

and stability calculations. They did a stress analysis of various components of the airplane and designed some detail parts. The class of 1934 designed an Army Corps observation airplane and a reconnaissance airplane for a future Air Force. The 1935 class produced a design for a basic training airplane. In 1936 an interceptor pursuit airplane was the object of interest, while the 1937 class turned its attention to designs for a short-range, slow-speed observation and liaison airplane.

By this time Wright Field was becoming built-up. No longer could the off-duty military man or civilian employee go hunting in the wooded part of the reservation. First, machine gun and bombing ranges had been charted in the area; tests took place on weekdays, so hunting was restricted to Sundays and holidays. The sport was further regulated when land was leased for use as pasture; finally, in the fall of 1931, the privilege was revoked altogether. The same year, the vast reservation was divided; the portion west of the Huffman Dam remained Wright Field, while the portion east of the dam, nearer Fairfield, was renamed Patterson Field, [for] a test pilot killed in a crash in 1918.

The Materiel Division headquarters was in the Wright Field portion -- a long white administrative building with a flagpole in front and a much larger laboratory building behind. Nearly the whole field was taken up with its associated shops, hangars, laboratories, and the like. By the late thirties Wright Field contained an experimental plant valued at some $10,000,000, with laboratory branches corresponding to the various large categories of air materiel: Aircraft, Power Plant, Propeller, Armament, Photographic, Equipment, Materials, AeroMedical, and Radio (this last branch actually belonging to the Signal Corps). The Air Corps went to some trouble to impress public opinion with its "aeronautical research center," advertising (among other things) "the largest propeller test rig in the world," capable of whirling a 45-foot propeller at very high speeds powered by a motor three times more powerful than any aircraft engine of the time. There were engine test stands, static test equipment, an altitude pressure tank, and many other groups of specialized testing equipment.

By the end of 1935, the Air Corps Engineering School was no longer resident in the long white building decorated with the insignia of the Materiel Division. It had, incidentally, acquired its own insignia in 1931: a coat-of-arms, azure with a sprinkling of gold stars and a border of clouds; the central design in the midst of all this was a Wright Flyer in gold. With this went a motto *Animis opibusque parati*, "Prepared in mind and resources." But heraldry did not necessarily guarantee elbow room. In the summer of 1935 the Engineering School moved out of the Materiel Division headquarters into the building next door, an impressive yellow-brick structure with a concrete facade featuring square pillars and a frieze of eagles: the home of the Army Aeronautical Museum. There the school remained until the outbreak of World War II.

When a class graduated, however, many of its members were likely to find themselves back in the Materiel Division. Assignment policies had changed since 1926, when the Engineering Division had complained that only three of that year's class of thirteen officers had been assigned to technical duties. At the commencement exercises of the class of 1937, the Commandant noted that the majority of the graduates were receiving assignments at the Materiel Division.

They often took on very responsible jobs. Laurence Craigie ('35), immediately after graduation, took over as project officer for all training and transport aircraft. "The project officer was the SPO" [systems project office], he commented. "I didn't have one airplane that I was responsible for. I had *all* trainers and *all* transports, and I had one engineer and a gal. So we were the SPO for training and transport airplanes. That little office was the point of contact between the aircraft industry as it existed in those days and the Air Corps."

At the 1937 commencement the Commandant, Brig Gen A. W. Robins, commented on the significance of the rating of Aeronautical Engineer which was awarded to each graduate.

> Nowadays there is some question as to just what the term engineer includes, as in a broad sense it might be applied to almost every trade or profession. It is well for the modern aeronautical engineer to be a specialist in some line. He must not allow his viewpoint to become narrowed for that reason, but should maintain a broad interest in all the branches of aeronautics.
>
> As to the future of aviation, there is no question. If the advance is as rapid in the next ten years as it has been in the last

five, we may even be flying to the moon.

Development of the Big Bombers

General Robins' prediction was slightly premature: it would be three more decades before a graduate of an AFIT program took part in a flight to the moon. But in the five years since the advent of the Martin B-10 bomber, graduates of the Air Corps Engineering School had been actively furthering the advance of aviation.

The Martin B-10 had performed well in the 1933 maneuvers -- so well, in fact, that it reinforced the belief that mass formations of high-performance bombers could accomplish their missions without support or escort. Faced with limited funds and the need to make difficult choices on how to spend them, the leaders of the Air Corps felt that the best course was to develop the long-range bomber. Colonels Howard ('21) and Knerr had evolved a ten-year plan which called for the development of four separate bombers, each to be larger than the last, faster, and able to carry bigger loads over greater distances. In 1933 the Air Corps got permission to embark on this project and ask manufacturers to submit designs for the first of the new bombers.

Most of the aircraft manufacturers assumed that the Air Corps wanted another two-engine model. But the Boeing Company of Seattle decided to go beyond that concept and design a bomber with four engines: a 35-ton monoplane with a 150-foot wingspread and heavy defensive armament. The Air Corps accepted the design and ordered an experimental model, the XB-15; meanwhile it announced another competition for flying models of multi-engined bombers.

The XB-15, finally delivered to the Materiel Division in 1938, had been designed for bigger engines than any yet developed; in the end, only the experimental model ever flew. The giant, underpowered craft had nevertheless provided a starting-point for the aircraft Boeing built for the second competition. This second bomber was a smaller version of the XB-15 -- 16 tons, with a wing-span of 104 feet -- and incorporated some features of Boeing's successful Model 247 transport. It had a slim, highly tapered fuselage marked by gun emplacement blisters, and its four engines were set in the leading edge of its single wing. Eleven months after the design was begun, a Boeing test pilot flew it to Wright Field (setting a new unofficial non-stop speed record in the process). At Wright Field it was entered as the XB-17 in a competition with the two-engine models and flown by both Boeing and Air Corps test pilots. But before tests were completed, the big aircraft crashed, killing some of its crew.

The opponents of Air Corps expansion promptly took advantage of this disaster and almost had Howard and Knerr's whole program cancelled. But one of the crew members who had survived the crash -- Lt Donald L. Putt -- wrote a report stating that the crash had been caused by a preflight error; that the XB-17 was basically a good airplane, and its development should go on. The advocates of bomber development argued for continuation and finally won authorization for 14 more planes. Thirteen were for service testing; one was to be taken apart for static testing at Wright Field. The first XB-17 was delivered in January, and by midsummer all the service test models were in the field. The fourteenth was not taken apart after all; Maj Gen Oliver P. Echols (once a captain in the class of 1927, but now chief engineer of the Materiel Division) ordered it converted into a flying model and equipped with turbo-superchargers to experiment with high-altitude performance.

In 1937 Wright Field had acquired the world's first experimental pressure cabin sub-stratosphere airplane for research and testing, and people like Carl Greene had been working with pressure cabins even earlier. Air Corps engineers collaborated with Boeing to install turbo-superchargers on the plane, and in January 1939 it took to the air over Seattle as the YB-17A. On the basis of its performance, the Air Corps ordered 39 B-17Bs, to be equipped with turbo-superchargers. The Flying Fortress would be able to climb into the stratosphere.

Other advances were being made. On 23 August 1937, Captains George V. Holloman ('35) and Carl J. Crane had made the first entirely automatic landing in aviation history. They had perfected the Airplane Automatic Landing System through two years of intensive research at the Instrument and Navigation Laboratory at Wright Field and conducted nearly all the flight tests. They won the MacKay Trophy for 1937. Also under development at Wright were such things as the True Air-Speed Indicator, the pressure cabin airplane, and the technology for broadcasting from the substratosphere. On 22 January 1938, Maj Carl F. Greene ('26) and Lieutenant Eugene H. Beebe ('37) made a successful broadcast

from a Lockheed XC-35 from an altitude of 21,000 feet, while Lieutenant Leonard F. Harman ('32) flew the airplane. As the *Air Corps Newsletter* described it,

> The windows of the plane were frosted with ice, and the outside thermometer indicated a temperature of 15 degrees below zero. Inside the supercharged cabin, however, the passengers rode in comfort. Because of the engine noise, the broadcasters spoke with their mouths almost against the microphone so that no one in the plane heard what the other was saying, except Lieutenant Harman. Holding the big plane steady in somewhat rough air conditions, he smilingly heard everything on his radio receiver, which was tuned in on a Chicago broadcasting station. The broadcast was effected over the National Broadcasting Company network.

Meanwhile the Howard and Knerr program was continuing. The B-19 was under development; it first flew in 1940 and served as a flying laboratory. The data gathered from its flights aided the development of the B-29.

In the late thirties, however, the struggle for the expansion of the Air Corps was still in progress. As late as the spring of 1938 the Assistant Secretary of War asserted that there was no military requirement for experimental four-engine pressure cabin bombers and told the Chief of the Air Corps to restrict experimentation and development to medium and light aircraft. General Headquarters (GHQ) Air Force, instituted in 1935, came under attack in 1939 for advocating a reorganization of the Air Corps which would allow it to operate on an equal status with the ground forces. Its current staff, including men like George Kenney ('21) and Follett Bradley ('22) were transferred to other posts.

The fate of American strategic air power seemed to be sealed. No one at the higher levels seemed to believe Billy Mitchell's prediction that war would come, all too soon, in the Pacific on a quiet Sunday morning.

Prelude to War

A survey taken at Wright Field in January 1939 revealed that the Air Corps had a severe shortage of engineering officers. For example, the project offices for bombardment and pursuit aircraft each consisted of one project officer plus one civilian assistant; with three or four projects to manage, they were unable to conduct adequate visits to the plants and at the same time keep operations and planning going adequately at the field. One partial solution recommended by the survey was to double the enrollment at the Air Corps Engineering School.

But events were taking another direction. In September 1938, after Neville Chamberlain's final trip to Munich to seek peace with Hitler, President Franklin D. Roosevelt had called a meeting of his top military advisors. The growing power of Hitler's Germany had made clear to Roosevelt the need to build American airpower, fast. "I want airplanes -- now -- and lots of them," he announced. He envisioned an American air arm of 10,000 first line combat aircraft of all types in production in 1940.

The Materiel Division went into high gear. In the past, the Air Corps had acquired about 200 airplanes a year; suddenly it was supposed to expand at an unheard-of pace. The responsibility of providing for the increased engineering, procurement, inspection, and testing -- with a goal of 5500 Air Corps aircraft in the inventory by 1 July 1941 -- was no small task. Even before the Military Appropriations Bill of 1940 had been voted on by Congress, the Materiel Division had started expanding to meet the demands of the program.

It attacked the problem simultaneously on four fronts: organization, personnel, buildings, and equipment. The Division was reorganized from top to bottom. The number of officers almost doubled, and the number of civilian employees rose almost in proportion. Buildings were converted, and ground broken for more. Equipment was improved. Almost the whole effort of the Division went into procurement and production. Even the Experimental Engineering branch was absorbed for the time in evaluating aircraft, checking analyses, and various other technical tasks revolving around the selection and equipping of aircraft types, since the spending of vast sums depended largely on their recommendations.

With personnel at a premium, the Division could not spare resources for the Air Corps Engineering School. By order of the Secretary of War in March 1939, its courses were suspended for the academic year 1939-1940.

It stayed closed for almost seventeen months while the Materiel Division labored to meet the demands of the expansion program. During that time, on 1 September 1939, Hitler marched into Poland; and Europe was suddenly plunged into war. The "lightning war" demonstrated all too clearly the power of the airplane in war: the Luftwaffe's Stuka dive bombers systematically destroyed the Polish aircraft on the ground and then proceeded to paralyze Poland's economic structure, attacking railroads, bridges, supply facilities, communication centers, and factories. Air Corps theorists like Muir Fairchild ('29) had been expounding concepts of strategic bombardment for years; now the other side had demonstrated how quickly a nation could be defeated by a mechanized war machine that used the airplane as its predominant weapon.

On 8 September 1939, Roosevelt declared a state of limited national emergency. George Kenney (a lieutenant colonel by then) and Carl Spaatz were sent to Europe as observers. At the Air Corps Tactical School that winter, Muir Fairchild called the attention of his listeners to the coming confrontation between the Luftwaffe and Britain. When this happened, he said, they would witness "a demonstration of the final and ultimate method of employment of air power in modern war."

Others besides Fairchild were watching events in Europe with deep concern. One issue was bomber defense: the war in Europe would prove or disprove the doctrine expounded in Air Corps circles for years, that fighter aircraft could not shoot down large bombers flying in defensive formation. The Stukas in Poland had been virtually unopposed. Air Corps leaders suspected that the doctrine was untenable and that they needed to develop better pursuit planes, soon. Especially -- as the Air Corps Board pointed out in January 1940 -- they needed to develop some kind of pursuit escort for bomber defense: either a long-range fighter, or a means whereby bombers could refuel accompanying fighters in flight, or a means by which bombers could carry, release, and recover high-performance pursuit aircraft.

They did not intend to de-emphasize bombers, however. The first B-17B to roll off the production line had set a new transcontinental record exactly one month before Hitler's invasion of Poland; Lt Col Leonard F. Harman ('32) -- now chief of the Bombardment Branch, Production Division at Wright Field -- and Col Stanley Umstead had flown it from Los Angeles to New York in just under 9-1/4 hours. A new model, the B-17C, appeared in 1940, with flat-paneled gun positions replacing the blisters in the early models and a "bath tub" (ball turret) gun position slung under the fuselage.

Through the spring of 1940 Kenney and other observers kept the War Department informed of the doctrinal lessons being demonstrated in Europe. Kenney pointed out, among other things, that the day of captive observation balloons and slow, vulnerable observation aircraft was past. A more impressive lesson was the need for long-range striking power: the British, who had little, missed the opportunity to cut the Germans' vulnerable supply lines in northern France. The Battle of Britain, from May to September 1940, showed still other important facts: the German bombers, designed for tactical support rather than strategic operations, lacked the range, armor, and firepower to do Britain the damage they intended; and the German fighters, operating in close support of the bombers, were no match for the high-performance Spitfire. Second-best performance was not good enough.

Against this ominous background the Materiel Division hurried ahead with the expansion program. By the summer of 1940 it could once again spare personnel for the Air Corps Engineering School. The Army Aeronautical Museum itself had closed its doors to casual visitors on 1 June 1940, and its exhibits were later removed from the building and placed in storage. But the Engineering School was able to resume operations on 1 August 1940 for the regular 12-month course.

Ezra Kotcher was still on hand as Professor, and the school planned to get an Assistant Professor to take over instruction in aircraft engine design and related theoretical and practical subjects. The student body, however, was extremely small: six first lieutenants, "probably the most homogeneous class the School has ever had," as the Assistant Commandant remarked in the *Air Corps News Letter*. They were not only all the same rank, but all had approximately the same age, service, education, and professional experience. All were formerly Reserve officers, and most had seen service with the airlines. Two of the six -- Bernard A. Schriever and Ralph L. Wassell -- would eventually be generals.

That fall the Materiel Division let contracts to Boeing for 500 B-17s and to Consolidated Aircraft

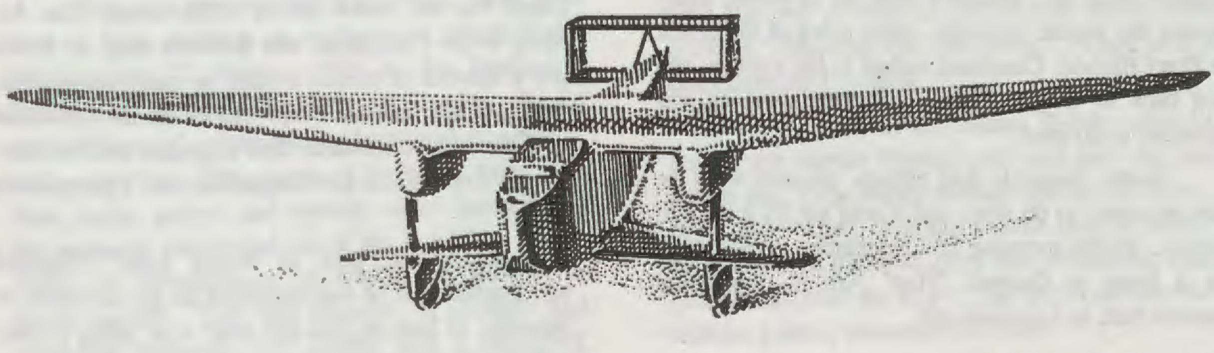
Corporation for 500 copies of another heavy bomber, the B-24. The Air Corps's heavy bomber production program was gathering speed. In the spring of 1941, as the threat to American security became increasingly apparent, President Roosevelt announced that production of the big aircraft would be stepped up to 500 a month. By this time the B-17D was making its first appearance, with leakproof fuel tanks, engine cowl flaps for better cooling in fast climbs, and a speed of over 300 miles per hour.

During this period the organization of the Air Corps was taking the shape it would carry into war. Air Corps leaders had long been struggling for greater autonomy, and at last they were getting it. On 20 June 1941 the Army Chief of Staff, Gen George C. Marshall, directed the establishment of the Army Air Forces, to give the air arm more unity of command and authority to manage its own affairs. When a new class arrived at the Museum building at Wright Field in August 1941, it entered what was technically the Army Air Forces Engineering School.

Things had changed at Wright Field since the leisurely days of the mid-thirties. No longer could casual visitors come onto the field to tour the flight line and museum; now only people with ironclad identifications and definite official business could pass the gates. Thousands of technicians, engineers, research experts, and craftsmen were at work on hundreds of projects. New aircraft designs and improvements in existing designs were being turned out on the drawing boards, while experimental airplanes and parts of planes underwent grueling structural tests. The propeller laboratory was by now the primary source of propeller engineering data in the United States. In the engine laboratories aircraft engines were subjected to operation tests at temperatures as low as 40 degrees below zero and as high as 180 degrees above. The equipment branch was planning and testing parachutes, rubber boots, heavy winter flying clothing, and other accessories. The materials laboratory had recently completed tests on a synthetic silk called Nylon, to be used as a parachute material, and on synthetic rubber materials used for the new self-sealing leakproof fuel tanks. Wright Field pilot-engineers conducted flight tests of experimental warplanes; not only the four-engined bombers, but pursuit aircraft like the Curtiss P-40, the Bell Aircobra P-39, the Lockheed twin-engined P-38, and the Republic P-41 had been proved in grueling tests at Wright Field in the recent past. Building construction was evident almost everywhere, from huge new engine test stands to a vast 400-mile-an-hour wind tunnel with one of the largest electric motors ever designed.

More and more, attention at Wright Field was being turned toward production engineering to speed the mass production of the new planes. The Materiel Division had "frozen" its development on the best of the existing planes and was ordering them in huge quantities, even while research and development moved ahead so that faster and better aircraft would be ready for mass production by the time the current best aircraft were outmoded.

The Engineering School class of 1942 had been told to expect assignments, after graduation, to work in the engineering and production phases of the Materiel Division. But the march of events was about to outpace the slower process of technical education. The graduation of the Class of 1942 was not going to occur.



Model of Woolsey Bomber, built by Capt Clinton F. Woolsey from bomber design submitted by him in airplane design course (1926).

The Graduates Go to War

On the eve of war, earlier graduates were scattered throughout the Army Air Forces, inside and outside the borders of the United States. Kenney, back from Europe, was at Wright Field as a brigadier general, assistant chief of the Materiel Division. Others, such as Edwin Page (a colonel by this time), Lawrence Craigie, Leonard Harman, and George Holloman, held various positions within the Division. Carl Greene had gone to Langley Field to serve as liaison officer to the National Advisory Committee for Aeronautics (NACA). Jimmy Doolittle, a major in the Air Reserve, had come back on active duty in the summer of 1940, to serve as an assistant supervisor for the Central Air Corps Procurement District, working with automobile manufacturers on the conversion of auto plants to manufacture airplane parts. In 1941 he had gone to Britain to observe British aviation technology, but by December 1941 he was back at his desk in Detroit. John Macready had also come back on active duty after some years of raising cattle and race horses; he was serving as an air base commander in California. Other graduates were already overseas; Lt Col Eugene L. Eubank ('30) had led a flight of 26 B-17s from Hamilton Field, just north of San Francisco, to Clark Field, Philippines in October 1941 -- a deployment which had helped prove the ability of long-range bombers to fly to the place where they were needed, in an era when planes were often shipped by sea.

The first week of December had passed routinely at the Engineering School -- classes in the Museum building, where some exhibits still stood awaiting storage; more classwork in the laboratories; homework after all the classes were over. On the weekend, Lt Don Coupland decided it was time to take a break and go flying cross-country. Sunday afternoon, while he was on the ground in Nashville, he had a radio on. Suddenly over the airwaves, interrupting the regular program, came news of the attack on Pearl Harbor. Coupland rushed to his airplane and flew back to Wright Field, to find out what he was supposed to do next.

Jimmy Doolittle had already decided what he was supposed to do next, and it was not fly a desk in Detroit. By the morning of 8 December, he had written a letter to General "Hap" Arnold, requesting transfer back to a combat unit.

Eugene Eubank, by that time, was already in one. Sunday 7 December was Monday 8 December on the far side of the International Date Line. Sometime after 0400 the phone rang in Eubank's quarters: a special message from the Air Headquarters in Manila, announcing the attack on Pearl Harbor.

At daylight he flew down to Manila to a meeting of the Far East Air Forces staff. About half of the B-17s in the Philippines were still at Clark; the rest had been sent to a dispersal base in Mindanao. Soon after dawn, one of the squadron commanders at Clark ordered the B-17s into the air, as a precaution against Japanese attack. By late morning, when Eubank got back, the planes had been recalled and were just coming in. Just before noon, orders came through for an attack on Japanese airfields in Formosa. The B-17s were on the field, being loaded with bombs, when the Japanese bombers came in over the Zambales Mountains behind Clark.

There had been no warning. Seconds after the Japanese planes were sighted, bombs were falling on Clark Field. Behind the Japanese bombers came strafers, who sighted their guns on the B-17s. Amid the smoke, Eubank and the squadron commander moved among the dispersed planes, directing the men's efforts in defending the aircraft and fighting fires. Some of the ground crews had gone into the B-17s and were firing the machine guns in the planes; others filled in among the anti-aircraft gun crews. But when the Japanese withdrew, there was not a flyable plane left on Clark Field.

Eubank and a handful of others began to try to salvage the situation: tend the wounded, fill enough craters to make a usable runway, guide in with flashlights the few planes that had been in the air. Sending half of the B-17s to Mindanao had been a fortunate move; Eubank's crews were able to repair only three of those which had been on the ground at Clark. There was not much left of Clark itself. The Air Force in the Philippines was left with only 17 B-17s and a handful of pursuit aircraft to carry on the war. And to make matters even worse, the B-17s would now have to be based at their dispersal field in Mindanao. Eubank and his companions had a job on their hands.

Meanwhile, back at Wright Field, Coupland had learned that he was supposed to go to school on Monday, at least to find out what was going to happen; but it was hardly possible for either students or

instructors to keep their minds on anything but the war. Ezra Kotcher, decades later, remembered sitting in his car with a student, listening to the car radio as Roosevelt spoke of the day of infamy and asked Congress to declare that a state of war existed between the United States and the Japanese Empire. Within a week Wright Field had moved to a wartime schedule, with three shifts of workers keeping offices open 24 hours a day. Before that, about Tuesday, the Engineering School closed its doors; Coupland and the others went to take their places among the Air Force's handful of technically trained officers in Production Engineering, Experimental Engineering, and other places where they were direly needed. Even Ezra Kotcher, after a few more months as a civilian was called into active service -- as the oldest lieutenant on the base.

By that time the handful of B-17s in the Far East had started their epic attempt to stem the tide of the Japanese advance south. They had had to fall back on Mindanao, but that did not stop them from flying missions against Japanese forces in and around Luzon. The B-17s were tough aircraft. On 14 December 1941 Capt Hewitt Wheless and his crew flew a B-17 over the 500 miles between the Mindanao base and Legaspi in southern Luzon, through heavy weather and 18 Japanese fighters, to bomb Japanese shipping in the bay there. The Zeroes managed to riddle the B-17 during its bomb run; three Zeroes were shot down, and another 15 pursued the bomber and emptied their guns into it for 30 minutes. But they failed to shoot it down. Somehow, with two engines dead, the oxygen system out, most of the control cables damaged, and one wheel gone, the B-17 kept flying. After 75 miles, the Zeroes gave up. Wheless flew the plane on, through rain and darkness, reached Mindanao, and crash-landed at a small airfield close to the base. The crew climbed out.

They and many other B-17 crews owed their lives at least partly to an engineer at Wright Field, Maj Leonard F. Harman ('32) of the Production Engineering portion of the Materiel Division. On the wall of Harman's office was a photograph of a pile of junk: more than 279 pounds of hydraulic lines, fuel lines, cocks, gauges, and controls which Harman and his engineers had ripped out of the B-17 fuel system during its development, to enable the bomber to absorb gunfire. They had replaced its complex and vulnerable hydraulic fuel system with a simplified, electrically controlled system using only self-sealing hose. Throttle controls and other equipment had also been re-designed to insure as efficient an operation under combat conditions as possible.

Before the end of the year the Japanese had discovered the Mindanao base; and the B-17s and the Far East Air Forces (FEAF) staff -- of which Eubank, head of the 5th Bomber Command, was a member -- had moved to a new base at Darwin, Australia. The mission of FEAF was now to organize advanced operating bases and use them to carry on the war. Eubank had found a suitable airfield in Java, and the Fortresses had moved up to help slow the Japanese advance southward.

Meanwhile Jimmy Doolittle had apparently had bad luck with his request for transfer to a combat unit. Kenney had reluctantly forwarded his request, and orders had come through -- to another desk, at Headquarters, Army Air Forces in Washington.

However, in January 1942 a concept had already taken shape in Washington: an air strike at Tokyo from the sea. The plan was to launch medium bombers from an aircraft carrier after transporting them close enough to strike Tokyo and other industrial cities; then the planes would cross the East China Sea to land in China. General Arnold chose Doolittle, now a lieutenant colonel, as the leader of the expedition.

The mission was planned with extreme care. The aircraft chosen was North American's B-25, but it had to be modified for the purpose. The highly secret Norden bombsight was replaced with a simple low-level bombsight called the "Mark Twain." At Wright Field, Doolittle supervised the removal of 1200 pounds of weight from the standard B-25, to allow for extra gas tanks. He called for volunteers, and the chosen crews went into special training at Eglin Field: no Army plane had ever before taken off so heavily loaded from an aircraft carrier. "You will have 500 feet in which to get the fully loaded bomber airborne," Doolittle told the crews. "I know it is possible, because I've done it."

On 1 April 1942, sixteen B-25s were lifted aboard the carrier Hornet, and next day the Hornet and its task force passed through the Golden Gate. At 0818 on 18 April, Doolittle's plane took off down the plunging deck into a 40-knot gale which was sending green water over the bows. The B-25 rose into the air without a hitch; the others followed.

The bombers swept in low over the Japanese coast. As Tokyo came into view they rose to 1500 feet and pinpointed the bombs on the oil stores, factory areas, and military installations. Some flew on to strike other targets -- Kobe, Yokohama, Yokusuka, Nagoya. Despite the best efforts of enemy gunners, all sixteen escaped out over the East China Sea.

In the rain and darkness over China, all 16 crews had to crash-land or bail out. Doolittle and most of the others were safely recovered by the Chinese. They had done something which the United States greatly needed at the time: struck back at the enemy in a way which gave Americans new confidence after the worst series of military reverses in their history. They had also seriously worried the Japanese, who decided to keep four army fighter groups in Japan at a time when they were urgently needed in the Solomons.

By this time the Wright Field engineers had helped develop yet another version of the B-17, the E model, more than five tons heavier than the prototype and forty percent faster. It had a power turret on top of the fuselage, a "dust bin" turret below, waist guns, tail guns -- and as May 1942 faded into June, some were already in the Pacific theater, where an attack on Midway was imminently expected.

At Midway, the primary mission for aircraft was to discover the Japanese fleet as early as possible and strike it before it could get within carrier range of the island. The tiny islet was crowded with various types of planes -- and they would all be needed, since the bulk of the Japanese navy was converging on the island. The burden of long-range search fell on the B-17s and the U.S. Navy's PBYs; the B-17s flew long arcs extending out 800 miles from Midway. Finally, on 3 June 1942, a patrol plane sighted Japanese vessels; and soon after began what was perhaps the most important single engagement of the Pacific naval war.

It was the first test of the B-17s against an attacking fleet, and it looked like an opportunity to prove at last that bombers could stop carriers. Nine B-17Es did surprise the Japanese transport force and its supporting craft some 570 miles from Midway on the afternoon of 3 June. The next day, during the real battle, B-17s with dive and torpedo bombers from the U.S. carriers hammered the Japanese carriers; one by one the ships caught fire and went down. By evening the Battle of Midway was essentially over.

As it turned out, the B-17s had not played a decisive role: there were not enough of them. The real test of the bomber was yet to come. But the Japanese later asserted that the B-17s had caused the ships to break formation in their efforts to avoid the bombs, so that they were less able to support each other and more vulnerable to dive-bomber attacks. And the B-17 had shown itself superior to the PBY for sea search: it could find the enemy and then hold onto the contact despite strong air opposition. At any rate, four of the most efficient Japanese carriers were at the bottom of the sea, and henceforth the enemy fleet would not roam the western and central Pacific at will. Its operations would be primarily defensive for the rest of the war.

While all this was happening in the Pacific -- through March, April, May, and June of 1942 -- the antisubmarine battle in the Atlantic had been under way. In the Eastern Sea Frontier and the Gulf Sea Frontier, German U-boats stalked American merchant ships; the First Air Force, under Major General Follett Bradley ('22), sent out patrols to look for U-boats and bombers to attack them. The U-boats were not easily damaged, but the harassment from the air made them shift their activities away from heavily patrolled areas.

Jimmy Doolittle, a brigadier general with a Medal of Honor, was back in Washington in the early summer of 1942, while the Air Force considered what to do with him next. One possibility was Australia: MacArthur needed someone to command the Allied air forces in the Southwest Pacific. General Arnold offered him a choice of Doolittle or Major General George Kenney ('21). MacArthur picked Kenney. Arnold decided to place Doolittle in command of a medium bomber Wing which, when trained and up to strength, would be assigned to the Eighth Air Force which was forming in Britain.

The Army Air Forces struck their first blow in the European theater on 4 July 1942, while Doolittle was still in Washington. It was a token blow: six Eighth Air Force crews in borrowed planes in a routine RAF sweep against German airfields in Holland. Despite the decision of Churchill and Roosevelt to knock Germany out of the war first, events in the Pacific had caused a temporary change of priorities; so the American offensive in Europe had gotten off to a late start. But the Eighth Air Force was destined to become the major instrument of American air power in the war against Germany; and the B-17E -- the air-

craft in which they were training in Britain -- was the most heavily armed bomber in the theater. As yet, there was no escort plane of comparable range; missions would have to be flown without escort over the target. But the B-17E, despite some trouble with gun mechanisms at very high altitudes (they tended to become stiff and occasionally inoperable in the cold), seemed equal to the task. The first real mission was flown on 17 August 1942: eighteen bombers, with RAF fighter cover, struck against the marshalling yard at Rouen. The mission proved the capabilities of American bombers; as Spaatz reported to Arnold, the B-17E far exceeded in accuracy any previous high-altitude bombing in the European theater by aircraft of either side.

Doolittle had fully expected to go to England to serve with the Eighth. But even before the mission of 17 August, something had happened to change his plans.

The Eighth Air Force still barely existed, and it would be some time before the Allies could launch a cross-channel attack from Britain into Europe. But the Russians were urging a "second front" to ease the pressure of Hitler's assault on Russia. Under the circumstances, it seemed best to open a lesser "second front" in the Mediterranean, beginning with an invasion of North Africa. Eisenhower and some of his staff were already in London in late June.

Arnold and Marshall had decided that Doolittle should lead Eisenhower's air arm. On 7 August 1942, Doolittle was in London, meeting Eisenhower and discussing the plans for TORCH, as the operation was to be called. Doolittle's air force, initially code-named "Junior," would have to be built on a nucleus drawn from the Eighth. By 23 September 1942 he was officially Commander of Twelfth Air Force and deep in plans for the first Anglo-American combined operation of the war.

While Doolittle worked to build Twelfth Air Force out of whatever he could get from the Eighth -- he "stole," among other things, the two most experienced B-17 units Eaker had -- Kenney was extremely busy in the Pacific. Midway had weakened the Japanese fleet, but it had not stopped the tide of Japanese conquest. In early July the Japanese had occupied Guadalcanal and Rekata Bay in the Solomons; on 22 July a picked force had landed on the north coast of Papua and started a furious drive toward Port Moresby. Kenney, who as commander of Fourth Air Force had been maintaining and training fighter and bomber units for the air defense of the Pacific Coast since February 1942, had been informed of his new assignment on 12 July and had spent some hectic days in Washington, absorbing data on the Southwest Pacific Area and, as he put it, "looking around for anything that was not nailed down" to bolster the force he was about to inherit. On 29 July he was in Australia, reporting to General MacArthur. Kenney went out immediately to Port Moresby, took one good look at the airfield there (under the unpropitious circumstances of a Japanese air raid), and quickly concluded, "One thing was certain. No matter what I accomplished, it would be an improvement."

The B-17 group that had been in the Philippines was now at Mareeba, in northern Australia, though the airplanes were so worn out and short of parts that Kenney doubted whether more than four of the 32 could have taken to the air if called on for immediate action. He told their commander to cancel all flying and get the airplanes into commission for a maximum effort in about a week. Then, armed with a list of bits and pieces needed to fix airplanes, Kenney set out to do something about the supply system. A phone call to Melbourne got the parts on their way to Mareeba. But that was only the beginning; for, as he told MacArthur, Kenney had one primary mission in mind: to take out the Japanese air strength "until we owned the air over New Guinea."

He had plenty of difficulties besides the Japanese. It seemed that the only item not in short supply was red tape. His air depot in the Australian bush operated mostly on ingenuity: "There were very few spare instruments, so the kids salvaged them from wrecks and repaired them. There was no aluminum sheet-stock for repair of shot-up or damaged airplanes, so they beat flat the engine cowlings of wrecked fighter planes to make ribs for a B-17 or patch up holes in the wing of a B-25. . . . In the case of small bullet holes, they said, they couldn't afford to waste their good 'sheet stock' of flattened pieces of aluminum from the wrecks, so they were patching the little holes with scraps cut from tin cans." Somehow they got eighteen B-17s off the ground on 7 August for Kenney's "maximum effort" against the Japanese airfield at Vunakanau. It was the heaviest US bomber concentration flown so far in the Pacific war.

The mission had been timed to support Marine landings at Guadalcanal and Tulagi. There was no Japanese air interference with either landing.

On 7 August Kenney had sent a wire to Washington, asking for authority to organize a numbered air force and requesting permission to call it the Fifth. He got his authorization two days later. His newly created Fifth Air Force might not "own the air" yet, but it was headed in that direction.

Kenney was uniquely qualified to run that kind of air war in that kind of theater. He had always been resourceful, an innovator, a man who tried out new ideas. Back in 1922, the year he graduated from the Engineering School, he had been the first man to install machine guns in the wings of a plane: two 30-caliber Brownings in an old De Havilland. In 1928 he had invented a parachute bomb, which enabled bombing planes to fly lower and bomb more accurately. "You've got to devise stuff like that," he commented after the war. "I'd studied all the books, and Buna" -- the campaign he was about to face -- "was not in any of them."

Buna was a place on the north coast of New Guinea where the Japanese had landed in July, pushing the Australians back up the mountain trail toward Port Moresby. The Japanese now had an airdrome there, as well as a port where they were trying to land reinforcements. Brig Gen Ennis Whitehead ('26), whom Kenney had placed in command of the air forces in New Guinea, had been pounding away at the airdrome with such effectiveness that by 7 August the Allies had not seen a Japanese airplane over New Guinea for several days. But the Allies need to retake Buna to keep the Japanese from running supplies and troops into New Guinea through the port.

Kenney's parachute bomb had finally been produced in 1936 -- about 5000 bombs, intended for a service test. When Kenney was in Washington in July 1942, he had found out that 3000 of them were still in war reserve, and had them shipped to Australia on the next boat. They had arrived in New Guinea in late August, [and] Kenney's A-20 light bombers had no racks for them. But Kenney had found out by this time that he had a "gadgeteer par excellence" working for him: the legendary Pappy Gunn (more formally, Maj Paul I. Gunn, a former naval aviator, who had been running an airline in the Philippines when the war broke out). Kenney told him he needed 16 airplanes ready to carry parachute bombs in two weeks. He got them.

The first nine were ready in early September, and Kenney was already thinking about Buna as a good place for the first test of the parachute fragmentation bomb -- or *parafrag* bomb, as he called it. The Japanese had repaired the airdrome enough to land 22 planes on it just before dark on 11 September. The next day, Kenney's bomb was demonstrated for the first time in war. Nine A-20's sneaked in over the palm trees at Buna and caught the Japanese planes on the ground. Strafing and dropping forty parafrags each, the A-20's destroyed all but five of the Japanese planes. Then Kenney sent in heavier bombers to put enough holes in the runway to keep Buna out of action for awhile.

Kenney tried a lot of other things during the Buna campaign -- skip bombing, which he and his staff had thought up on the way across the Pacific; the supply of ground troops by air; the air insertion of troops into forward positions; more modification of airplanes to do the jobs he needed done. By mid-October, as he put it, "We owned the air over New Guinea." He had also been promoted to lieutenant general.

The campaign went on through the autumn of 1942, with various Japanese attempts to reinforce or resupply Buna. The rainy season set in and slowed things down. But by the end of the year the campaign was in its last phase. Buna finally fell in the first days of 1943.

Doolittle, meanwhile, had spent most of the autumn of 1942 in England and Gibraltar, getting ready for Twelfth Air Force participation in TORCH. D-Day for the invasion of North Africa was 8 November 1942. On the afternoon of the following day, Doolittle landed at Tafouri, an airfield captured on D-Day and still a shambles, with pocked runways, smoking wreckage, and now and then the harassment of an enemy shell. His own supplies -- spare parts, fuel, ammunition, and the rest -- were still on the landing beach fifteen miles away. Out of all this, he had to get an air force operating.

But within two weeks he was able to report to Arnold that Twelfth Air Force was in place and operating. On 17 November 1942, Eisenhower recommended him for promotion to major general, commenting, "It is appropriate to announce his promotion as a result of leadership in actual battle command as well as in organization of Twelfth Air

Force." Doolittle got his second star on 15 December. By that time, the headquarters of Twelfth Air Force had moved from Tafouri to Algiers, and Doolittle was planning how best to use the Twelfth when the time came to drive the Axis out of Africa.

The situation at the end of 1942 was vastly better than the situation at the end of 1941. The war was far from over, however; and the graduates of the Engineering School had many more contributions to make toward victory. Doolittle and Kenney were only the most famous of a distinguished company. Graduates of the Engineering School served in all theaters and in many modes. Colonel Edwin Aldrin, Sr., who had organized the school and graduated in 1920, served in the Pacific as Assistant Chief of Staff for Operations, Thirteenth Air Force. Maj Gen Follett Bradley ('22) was sent on a special mission to the USSR in 1942. Col John Macready ('23) went to North Africa as Inspector for the Twelfth Air Force. Ennis Whitehead ('26) took over Fifth Air Force in June 1944 when Kenney became commander of Far East Air Forces; he had won Kenney's esteem as a great leader and aviator and "a driving operating genius, who planned every operation down to the last detail to insure success." Thomas Jeter ('27), a Navy man, commanded the aircraft carrier USS Bunker Hill. Muir Fairchild ('29) became a member of the three-man Joint Strategic Survey Committee and advised the Joint Chiefs of Staff on strategy and its relation to national policy. Many others served with distinction in every phase of the war effort.

Because of their scientific and technical training, many remained at Wright Field or at other technological posts. Here they played key roles in developing the technology that made victory possible. While the B-17 Flying Fortresses did their work in the air, the Wright Field engineers were already well along in the development of its follow-on, the B-29 Superfortress.

The development had begun in the winter of 1938, when far-sighted Air Corps officers went into closed sessions with Boeing engineers about changes to be made in the existing models of the B-17. It became clear through discussions that the modifications they wanted were not practical for the B-17: what they needed was a long-range, high-altitude, high-speed bomber with a much greater bomb capacity. In January 1940 Boeing got the specifications for a four-engined bomber design.

Boeing already had on its drafting boards a "little 29," a small airplane with four engines and a very long range. Wright Field engineers took one look at it and said no. Military observers like Kenney had already brought back the word on what the Germans had and the Americans didn't, and the Air Corps had rigid requirements in mind for its new superbomber. Specifically, they wanted a bomber that would have an unusually long operating radius with a full bomb load; that could carry at least five tons of bombs at a speed in excess of 300 miles per hour; that could climb high into the substratosphere between 30,000 and 40,000 feet; that could pack more machine guns and cannons than any bomber ever built or likely to be built during the war.

Boeing took its design for the "little 29, enlarged and improved on it, and came out with a bomber which the Air Corps immediately accepted and designated as the XB-29. A contract was signed in August 1940 for three full size XB-29s -- two for flight tests, one for structural testing. The project officer was to be Donald L. Putt (class of 1937) -- the same who, as a young lieutenant in 1937, had convinced everyone that the Air Corps should go ahead with the B-17 even though the prototype had crashed in testing.

The XB-29 went through tremendous growing pains. Wind tunnel tests led to changes: a B-17 like rudder, turrets molded almost flush with the fuselage to get more speed. The design looked so promising that the Air Corps -- sure that Boeing would produce a reliable airplane -- placed its first order for production models before the B-29 had ever flown.

A wood-and-metal mock-up of the new bomber was made, so the Wright Field experts could see and feel what the B-29 would be like. They approved of the overall design, but recommended over 900 minor changes. Two hundred more changes were incorporated before the first production model was complete.

Putt, as project officer, sweated and worried through the experimental phases of getting the first B-29 into the air. Producing the bomber was an enormous job, involving vast quantities of hard-to-get materials and the design of special tools. Parts of the plane were made while other parts were still on the drawing board. In some cases, the men who had produced one section would go into a huddle with designers and engineers to help decide what an adja-

cent section would be like.

One feature which caused particular problems was the pressurized cabin. The B-29 needed one, since it was intended as a high-altitude bomber; but the technology for pressurized cabins was still new -- Carl Greene ('26) had built the first one in 1937 -- and at times the problems seemed insurmountable. Once, when a cabin was being pressurized in a test hangar, the nose blew off the airplane and tore out the whole front end of the building. Later, during one of the early test flights, a window blew out because the pressure was too strong, and a bombardier-gunner was sucked out into the sky. Fortunately, he had on his parachute and landed safely, but the engineers had to go back and design stronger gun windows.

The first of the experimental B-29s, built at the Boeing plant in Seattle, rolled out of the factory in the early summer of 1942. Even before it flew, it was destined for mass production; the factories were already being built. On 21 September 1942 -- after three months of inspection and more minor changes -- the big silver XB-29 took to the skies, startling the residents of Seattle by its size, speed, and maneuverability. When the Boeing test pilot climbed down from the cockpit, he told an Air Corps representative, "Colonel, she's a sweet airplane. Flies better than a B-17. I think aerodynamically it is one of the cleanest designs ever built."

Putt by this time had the nickname "daddy of the Superfortress." But it was Brig Gen Kenneth B. Wolfe ('31) who became responsible for the production and procurement of the plane through Air Materiel Command. The B-29 was to be built at Boeing's Wichita, Kansas plant. Wolfe knew that the next months were going to be critical and decided to go to Kansas to help engineer the B-29 through production. He took with him some of the other outstanding officers of the Materiel Command, among them Col Edward M. Gavin ('39), Col Howard H. Couch ('30), and Col Leonard F. Harman ('32), the man who had made the B-17 fit for combat. Harman, who knew all about production through his experience as head of the Bombardment Branch, Production Engineering Section, was also a test pilot and would continue the testing program.

As Wolfe later described it,

> As our first step we moved in with the Boeing Company at its Wichita, Kansas Plant and we brought along some of the top engineers of the Materiel Command. . . . We supervised and expedited all pre-evaluation, flight tested the experimental planes, flew acceptance tests on all new production aircraft, effected modifications while prescribing changes in equipment for later models. . . . As rapidly as these tests uncovered "bugs" engineers took the problems to Wright Field's laboratories, and worked them out. Their expeditious handling of our design and mechanical problems continuously contributed to improve the performance and reliability of our new planes. . . . We were accomplishing a week's research, testing, modification and training every 24 hours.

In 1943 General Arnold authorized Wolfe to take personal responsibility for all changes to be made in the production line. This meant that the entire project was taken out of the usual channels for the rest of the year: critical decisions were handled on the spot, often verbally, and the normal paperwork followed later. This inevitably left many loose ends dangling, and valuable time had to be spent later in gathering them together. But it got the first production model into the air at Wichita in June 1943.

The Air Corps Proving Ground at Eglin Field, Florida was to do much of the testing. It was still going on when Wolfe left for the China-Burma-India theater, where he was to command the first organization to receive the new bombers. In late 1943 and early 1944 an advance echelon was preparing airfields in eastern India and western China -- a monumental task in which a handful of American engineers directed an army of Chinese coolies. The first B-29 arrived in India early in April 1944.

The first B-29 missions had to be logistical. The Hump of the Himalayas -- the highest mountains in the world -- rose between China and India. To keep other units in the theater from being short-supplied because of B-29 requirements, the unit began hauling its own gasoline and other supplies over the Hump. This supply run was expensive; but the targets in Formosa, Manchuria, and Kyushu were worth it. Meanwhile the tests went on at Eglin. In the spring of 1944, a crew prepared a B-29 for a simulated bombing mission against Puerto Rico, which happened to be the same distance from Eglin that Japan was from the bases in western China. With a full bomb load

and a full load of gasoline, the plane roared into the sky and headed out over the water. Hours later it came out of a cloud bank over Puerto Rico. The plane circled for a few minutes and made a trial run over the island. The dummy bombs were unloaded into the ocean, out of sight of land. Then the Superfortress started back for Eglin. Within hours, a long teletype clacked its way in code to Wolfe and his B-29 crews in China. It told him that the bomber had flown 3200 miles nonstop with a full load of bombs and gave further data important for flying the B-29 on a long-range mission.

A few days later, on 5 June 1944, Superfortresses took off from India and bombed railway yards in Japanese-held Bangkok. Then on 15 June a whole flight of B-29s out of western China struck the Imperial Iron and Steel Works at Yawata, the "Pittsburgh of Japan." Newspapers in the United States printed glaring headlines: B-29s BOMB JAPAN.

In July, Wolfe was ordered home to direct B-29 engineering at Wright Field. But the B-29 operations -- high-level, tight-formation daylight bombing -- were just beginning to get under way. Superfortress production was increasing rapidly. In September the first B-29s arrived in the Marianas, the primary basing area for the air offensive against the Japanese home islands. On 24 November 1944, eighty B-29s raided Tokyo.

Elsewhere, behind the scenes, other new technologies were being developed. One of the most spectacular developments rose out of something known at the time as "the Whittle engine." It was a jet-propulsion power plant.

The idea of jet propulsion had been around for a long time. In 1922, Air Service engineers at McCook Field had asked the Bureau of Standards to investigate the practicability of the jet engine (and were told it could never compete with the aircrew.) Nevertheless, despite lack of funds and high-level interest, they experimented with turbo-superchargers, sure that if they could solve the problems of hot metal and stress involved in the supercharger, they would eventually be able to build a jet engine. In the late '30s a special alloy finally made it possible to build a turbo-supercharger that would withstand high speeds and high temperatures. In the spring of 1939, near Seattle, a YB-17A equipped with superchargers (and copiloted by Col Pearl H. Robey of the Engineering School class of 1936) had reached 311 miles per hour of ground speed at an altitude of 25,000, which was 100 miles faster than any bomber had ever flown before -- faster, also, than any fighter plane had ever flown at that altitude. Robey, who was project officer for the supercharger, had afterwards rushed into the operations office and sent a coded message to his commander at Wright Field: "She climbed like a mountain goat and ran like a deer."

But both the British and the Germans were ahead of the United States in the development of jet propulsion. The original British jet engine, developed by an RAF engineering officer named Frank Whittle, powered an aircraft in flight for the first time on 15 May 1941; and the German jet flew more than a year earlier.

The Army Air Forces had already made some preliminary moves toward getting the jet engine developed by contractors. But when Gen Henry H. Arnold, Chief of the Air Forces, heard about Whittle's engine and the fact that it had powered a small airplane, he flew to England to find out all about it. The British showed him the primary drawings of Whittle's engine; and Arnold persuaded them that it would be a good idea to produce the jet engine in quantity in the United States, incorporating all the American turbocharger information to make it even better.

Back in Washington, Arnold called his foremost aeronautical engineers. Maj Gen Oliver P. Echols ('27), Assistant Chief of Air Materiel, Maintenance and Distribution, was there (his agency made policy for Wright Field). So were Brig Gen Frank O. Carroll, Chief of the Engineering Division at Wright Field, and Brig Gen Benjamin W. Chidlaw ('31), as well as Col Donald J. Keirn ('37) and Col Ralph P. Swofford, Jr. ('36). Arnold asked Chidlaw "What do you know about jet aircraft."

Chidlaw said "Very little. Does anyone?"

Arnold told him, "Get with it. You've got the project for the Army Air Corps."

The meeting went on for hours and reconvened several times in the course of the week. Chidlaw was appointed as liaison for the project, to coordinate activities with General Electric, which was to build the engine, and Bell Aircraft, which was to design and build a plane for the engine. Swofford was to be the project officer. Keirn got a special secret assignment: go to England and get the detailed blueprints of the Whittle engine.

At the final meeting, Arnold showed them the early blueprints the British had already given him. "These, gentlemen," he said, "are preliminary drawings of the Whittle engine. Your job is to build one like it and better."

When Keirn got back from England with the detailed blueprints, he found that things had moved ahead. General Electric and Bell were hard at work. NACA had brought its foremost authority on gas turbines back from retirement. And at Wright Field a special section had been established in the Engineering Division to deal with the flow of information and paperwork needed to get the jet engine into the air. Expectations were high: this might be "the biggest thing in aviation since the Wright brothers first flew."

Chidlaw, operating out of Air Force headquarters, monitored and directed the development of both engine and airplane. On 18 March 1942 the engine was finished. It worked better than the General Electric engineers had even hoped for. Bell's aircraft was also reaching completion. In the summer and early fall of 1942, it was being finished in a heavily guarded hangar at the Army Air Forces' desert test base at Muroc Lake, California.

The XP-59A, as the plane was being called, was an all-metal mid-wing monoplane powered by two of the new turbo-Jet engines. Later it would be known officially as the Bell Airacomet, but to the people at Muroc it was the Squirt. Its most striking feature was that it had no propellers whatever.

On 1 October 1942 the Bell test pilot took it up for the first time in a preliminary, low-altitude flight. Everything worked. The next day, after the Bell pilot had made it climb to altitude a couple of times, Laurence Craigie ('35) -- a general by now -- took the controls and became the first military man to fly a US jet. He said it was one of the best-flying airplanes he had ever had the pleasure of handling.

The *Airacomet* -- though it caused continuing excitement in the area, flying around without propellers and trailing a thin line of smoke behind it, so that people kept reporting it to the base as an aircraft in distress -- was only a beginning, a trainer rather than a fighter. A more powerful engine and an aircraft to go with it -- ultimately to be famous as the P-80 (later F-80) Shooting Star -- were already being designed in early 1943, with Col Ralph P. Swofford, Jr. ('36) as Air Force project officer. The first P-80 was delivered to Muroc for testing in November 1943 and flew for the first time in January 1944. Though it never got into combat in World War II, its development put the United States at the forefront of jet technology before the end of the war and led to a generation of experimental follow-ons even before the war was over.

Reopening of the Engineering School

While its graduates had been proving their worth in so many capacities, the Engineering School itself had been in abeyance. Its students had scattered after Pearl Harbor to augment the Army Air Forces' critically small number of technically trained officers. A few months later, in June 1942, the regulations pertaining to the school had been suspended pending further orders.

Even before the war, there had been a shortage of engineering officers. The shutting off of the pipeline did not help.

This was extremely obvious to the Materiel Command, which had inherited the engineering and procurement responsibilities of the old Materiel Division early in 1942. They depended heavily on people like Wolfe ('31), Putt ('36), Chidlaw ('31), and the rest to monitor programs, solve problems, and otherwise make the system work. But there seemed to be more jobs than there were qualified men to do them.

For example, there was the problem of getting the scientists in the laboratories to understand field conditions. The Alaska experience was a case in point. When the Air Force moved into Alaska and the Aleutians to fight the Japanese, planes designed for temperate conditions immediately had problems. Whole squadrons of planes, arriving from the continental United States, would be grounded as soon as their engines cooled off: oil congealed, rubber parts hardened, grease froze, hydraulic fluid leaked out through broken seals. Ignition harnesses on engines would get moisture in them, freeze, break their insulation, and develop an ignition leak that would short out the plugs. The oil in guns would congeal so that they would not operate.

Wright Field had sent some of its experts, headed by Lt Col Edward M. Gavin ('39), to Alaska to find out what to do. They flew the airplanes in all kinds of weather, worked on the engines, studied the problems that confronted the operators in cold-weather regions. Then they went back to the laboratories at Wright Field and started a priority program

for winterization of aircraft.

Gavin and a special crew went back to Alaska and carried out an intensive analysis. Problems ranged from landing gears that were reluctant to go down because the hydraulic fluid froze, to maintenance men whose task was almost impossible because they had the wrong kind of gloves. The big cumbersome gloves would not let maintenance crews get at certain parts, so they would take the gloves off and work with bare hands and try to keep their fingers from freezing to the metal. Gavin and his experts were able to solve the glove problem rather readily, through the Equipment Laboratory at Wright Field, which sent up some thin nylon and rayon gloves that could be worn under the mittens when feasible and yet keep fingers from freezing to metal when the mittenless approach was necessary. Some of the other problems were harder, like getting engines to start promptly at 65 degrees below zero. They finally solved that one, after several tries, with a portable engine heater.

But there were not enough experts like Gavin to go around. By 1943, it had become clear to people like Maj Gen Oliver P. Echols ('27) -- who was still Assistant Chief of Air Staff, Materiel, Maintenance, and Distribution -- that the pipeline must be started again, to produce a flow of younger officers to the Materiel Command in order to insure continuity of effort. Otherwise, who would do the job when one of the handful of existing engineering officers was not available?

The first attempt at a solution was a civilian institution program. In 1943, sixteen officers from General Carroll's Engineering Division were sent to the California Institute of Technology for specialized training. Other officers were sent to the Massachusetts Institute of Technology, Purdue, and similar centers. But these programs could not produce technically trained officers in the numbers the Air Force needed, nor in the specialities -- in engineering, maintenance, and procurement -- that were most critical.

Echols, considering the people he relied on most, must have pondered the fact that a large number of them were graduates of the old Air Corps Engineering School. It was clear that the pre-War one-year course was out of the question. But what else might be done? Sometime late in 1943, he hit on the idea of taking rated officers with combat experience -- and consequent knowledge of combat problems -- and giving them a short course in which they could learn enough about engineering to be able to work with the laboratories.

On 1 December 1943 -- less than two years after the closing of the school -- Echols sent a memorandum to the Chief of Air Staff:

Subject: Reactivation of the
Air Corps Engineering School.

1. Discussion

1. It is proposed to re-establish the Air Corps Engineering School with a curriculum curtailed so as to provide a course of approximately three months duration. It is proposed to run several such classes in succession initially with approximately twenty-five student officers per class. Eventually the classes may be evolved to cover a full year's work as in the past.
2. The shortened courses will cover primarily a review of basic engineering subjects, but in addition will incorporate whatever specialized subjects can be introduced to render the graduate more valuable for Materiel Command or similar duty.
3. The reactivated engineering school will not eliminate the present practice of detailing selected officers to M.I.T., Purdue and similar educational institutions.
4. Candidates must have an education equivalent to that required for a degree of Bachelor of Science, and must have a flight rating of pilot or above. They should be of the grade of major or lower. Preference will be given to those who have had active combat experience.
5. It is anticipated that the reopening of the Air Corps Engineering School on the basis outlined above will have the following advantages:
   a. Direct properly qualified officers with combat experience into a field which will employ both their qualifications and experience to the best interest of the Army Air Forces.

b. Produce a flow of younger officers to the Materiel Command, insuring continuity of effort. This is particularly important in view of the constant assignment of experienced Materiel Command officers to other duties in the course of time.

c. Provide a means for examining younger officers with a view to selecting the most promising for permanent commission in the Army after the war.

d. Improve the professional qualifications of officers with engineering training, thereby benefiting them personally whether retained or not in the Army Air Forces after the war.

6. It is planned to start the first short course of the Air Corps Engineering School as soon as the necessary arrangements can be made at the Materiel Command and as soon as a suitable student body can be assembled.

II. Action Recommended

Approval of the reopening of the Air Corps Engineering School on the basis outlined above.

Not only the Chief of the Air Staff, but the Commanding General, Army Air Forces liked the idea. On 3 January 1944, Echols was able to write to Maj Gen Charles A. Branshaw, Commanding General, Materiel Command,

> It is directed that necessary action be taken by the Materiel Command to re-establish the Air Corps Engineering School. . . .
>
> It is directed that the first short course of the Air Corps Engineering School be started as soon as the necessary arrangements can be made. . . .
>
> It is requested that a plan of operation be submitted to the Commanding General of the Army Air Forces through this office. . . .
>
> By Command of General ARNOLD.

Branshaw responded quickly. On 8 January 1944 he wrote to Echols, "Arrangements are being made to reestablish the Air Corps Engineering School at Wright Field, the initial class to start 1 April 1944." This he felt, was the earliest possible date, since there was so much to be done, from deciding the curriculum to selecting the students. Branshaw wanted ten of the twenty-five students in each class to be his own Materiel Command people. He also suggested to Echols that a limited number of non-rated officers be allowed to attend, and that selected graduates be offered a chance for postgraduate study at places like MIT.

The details of the re-opening were worked out in the next two months by Branshaw, Carroll, and Chidlaw (who by this time was Chief of the Materiel Division). Branshaw, as Commanding General, Air Materiel Command, was to serve as Commandant. The Assistant Commandant -- the real head of the School -- would be Major William R. Weems, an MIT man who had held a reserve commission and been called into active service when the war broke out. By 7 February, when Branshaw reported developments to Arnold, an application questionnaire had been prepared for selecting students; curriculum planning was almost finished; and a staff of five -- Assistant Commandant, Administrative Assistant, Chief Instructor, Administrative Clerk, and Secretary -- was largely in place. Branshaw commented,

> Although this staff is larger than that formerly used, it is considered the minimum necessary in view of the many details involved in the reactivation of the school, the larger classes, the more frequent turnover of classes, and the degree of planning and preparation required in order to accomplish the mission in the short time allowed per class. It is possible that an additional full-time instructor will be found necessary. . . .

He expected to rely on the key technical personnel of the various components of the Engineering Division for most of the instruction.

The school wanted, of course, to invite Ezra Kotcher back as Chief Instructor. But he was deeply involved in aircraft research; he had been working on problems of overloading, ways to extend the range of fighters, air-to-air refueling systems for bombers, and the like, in conjunction with Craigie, Putt, and others. Just then he was working on the development of jet fighters, and could not be spared. So Captain Vidosic, a former faculty member of Georgia Tech, was

assigned as Chief Instructor.

On 16 March 1944, a letter went out from the Chief of Air Staff, announcing,

> The AAF Engineering School is currently being reactivated at Wright Field, Dayton, Ohio, to provide for short courses in basic and specialized phases of aeronautical engineering. A uniform curriculum of approximately three months duration is being established. . . .
>
> Subject to existing requirements at the time of graduation, it is anticipated that most of the graduates of the course will be assigned to the Materiel Command or similar duty. A limited number of officers completing the course with very high standing will be considered for extended post-graduate work at leading educational institutions.
>
> Students will be officers who are excellent in general and who are academically well qualified in engineering. Younger officers who have had active combat experience will be given preference.

The following day, 17 March 1944, an Army Air Forces regulation formally re-established the school, assigning it to the Materiel Command. Apparently remembering the occasions when the old Air Corps Engineering School had been forced to suspend operations because some other priority tied up its faculty and students, the framers included a paragraph titled "Importance of School":

> The importance of the AAF Engineering School cannot be overemphasized, since the maintenance of superior quality in future AAF materiel will depend in large measure on the technological perception, foresight, and aggressiveness of responsible officers. Military superiors of individual applicants for detail to this school will bear that fact in mind in considering such requests.

On 1 April 1944, Class 44A -- twenty-four officers, ranging in grade from second lieutenant to lieutenant colonel, but more than half captains and majors -- assembled for the re-opening of the school. The site was no longer the old Army Aeronautical Museum, which had been pressed into other service. Instead, Branshaw had given them two frame barracks buildings across the road from Wright Field proper, bordering the main highway into Dayton.

They had an incredible task before them: to try to review, in three months, the basics of engineering and take specialized subjects of interest to Materiel Command. Somehow they did it; and a second class, 44B, followed close on their heels in July. But by that time it was beginning to be clear that three months was not enough.

As General Carroll put it, "During the summer it became apparent that the time allotted for the course was too short and required too much student cramming to accomplish the school's mission. Also we believed it possible to enlarge the school and provide training for more students."

About this time -- on 31 August 1944 -- the Materiel Command, which had had engineering and procurement responsibilities alone for the past two years, acquired the logistics responsibilities which had belonged to the "old" Materiel Division. With this change, it was re-christened Air Technical Service Command (ATSC). Almost simultaneously -- the organizational restructuring may have produced a climate favorable for change -- the AAF Engineering School obtained authority to double the length of its course and make provision for training fifty students continuously by running what were really two schools, with twenty-five students entering each quarter.

Class 45A -- with twenty-six officers ranging from first lieutenant to major -- entered in October 1944, with graduation scheduled for March. Class 45B -- with twenty-seven officers -- entered in January 1945, with graduation scheduled for June.

The small barracks buildings could hardly accommodate this influx of students. Even twenty-five had been considerably more than the school had ever had before the war; fifty-plus was stupendous. Someone -- apparently Carroll, but perhaps also Echols or Lieutenant General William S. Knudsen, whom Arnold had persuaded to head the unified ATSC -- was thinking on a large scale. Whoever it was had the power and the interest to find a better home for the enlarged school: the second floor of Building 14, an imposing structure with handsome metal-and-glass doorways. The next few classes had their graduation pictures taken on its steps.

Another six-month class -- 45C -- arrived at the Engineering School in April 1945. Among the students was First Lieutenant Harold C. Larsen, recently

back from service in the Aleutians as a maintenance officer. He was one of the few non-rated people in the class and one of the most junior; by now, captains and majors -- many of them flying officers with exceptional combat records -- had become the norm.

The intensive six-month course ran five-and-a half days a week -- typically eight hours' worth of classes, each two hours long. Permanent-party instructors taught general theory; adjunct faculty from the laboratories taught application. There were classes in mathematics -- from trigonometry through differential equations, a normal year's work, in three months -- physics and mechanics review, electrical engineering (centering, in those days, on the fundamentals of AC/DC circuits), radio and radar, and aircraft design and propulsion.

There was no time for laboratory work, just theory classes in the morning and seminar classes most afternoons. ATSC people came to talk to the students on procurement, supply, and other Air Force functions in the logistics area. Students regularly went over to ATSC or toured laboratories. For a class in Air Force performance in stability and control, they sometimes took flights to observe performance and stability tests; they would then take the raw data and reduce it.

The program was problem-oriented. Besides the numerous problems with "school solutions," there were "bonus problems" duplicating real problems solved by the laboratories.

Every now and then -- typically on a Saturday -- the students would take field trips. They took tours of local plants, such as the General Motors plant which made aeronautical products in Vandalia and a machine tool plant in Cincinnati, as well as Republic, Curtis-Wright, and Dodge. At Carswell Air Force Base, Texas they saw a B-36 under construction -- the first truly intercontinental bomber, around which the postwar Air Force would be built.

It was, as Larsen recalled later, a heavy grind. Classes ran from 0730 to 1700; after that, students went back to whatever quarters they had, to study. Housing was short, so they lived wherever they could, some as far away as Xenia. With classes, study, and travel back and forth, they were lucky if they got four hours of sleep a night.

Nevertheless, he remembered it as "kind of a fun period, really." There were good friends; there was a big party every Friday night at the Area B Officers Club, and another one on Saturday at the Area A club. Most students managed to attend each party at least once a month.

One daily feature of the program was a short intelligence briefing on the war situation, with a more complete briefing once a week. About a week before Victory in Europe Day, the students knew fairly well it was going to happen. Victory in Japan was almost a surprise. One of the officers had flown B-29s and knew there was a secret project; and then the atomic bomb was dropped, and the students guessed that the end of the war was near. Nevertheless, no one quite expected VJ day to come as soon as it did.

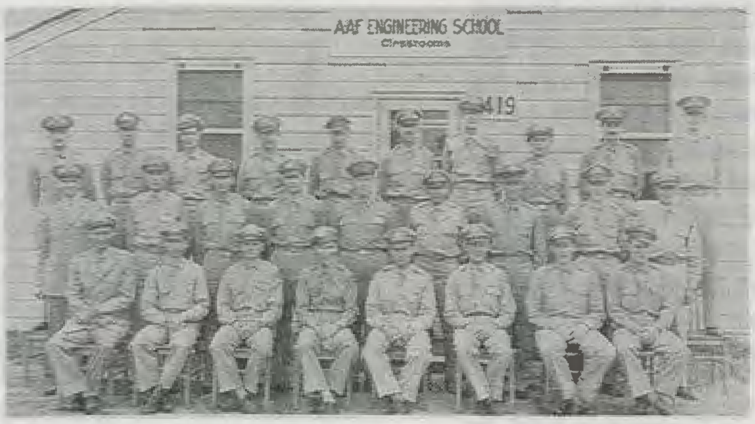
The end of the war meant a slightly more relaxed pace for Larsen's class. Saturdays were free now, and the program -- "like a Master of Science degree without a thesis" -- was drawing to close. About 60 percent of the graduates had been scheduled to go to laboratories, but now many of them were thinking of returning to civilian life. Larsen himself was one of the few selected to go on for advanced degrees at places like MIT, Cal Tech, and Harvard.

In the South Pacific, an armament sergeant works on a B-17

Lt Gen George C. Kenney ('21) in 1943.

On the USS Hornet, April 1942: Lt Col James H. Doolittle ('23), with Rear Adm Marc A. Mitscher and bomber crews.

Tokyo Raid aircraft on the deck of the Hornet.



Class 44B, AAF Engineering School.

" . . . A Source of Stimulation to the Imagination of Officers"

Meanwhile, at higher levels, planners were already outlining the future of the Army Air Forces in the postwar world. Research and development, it was clear, would have to be part of the picture. Early in 1945 Carroll had written:

> It is the opinion of this division the results of research and development during the two years immediately following

> the war are [of] the greatest importance to the future development of the Army Air Forces. During the war, sufficient funds have been made available to build up what might be called "research momentum." Through research of the Army Air Forces and the aircraft industry, new developments are cascading one after another, and at the close of war this tremendous effort will be at full tide. It is, therefore, of vital importance that the Army Air Forces take advantage of this effort, the great facilities provided for it, and the teams of scientists and engineers who are carrying on this work.
>
> Every effort should be made, and funds should be provided, to complete many of the very fine and very important projects which will be approaching production reality. **No matter what the disposition of aerial strength may be after the war, no matter how certain peace terms may seem to make future wars impossible, research, which means preparedness, must be continued. Research is our aviation insurance; we dare not let a single premium lapse.** [Emphasis supplied]

In June 1945 Maj Gen Hugh Knerr -- the same who, with Clinton W. Howard ('21), had pushed forward the development of the bomber in the 1930s -- had become commander of Air Technical Services Command. He had just come from an assignment as Deputy Commanding General, U.S. Strategic Air Forces in Europe, where he had helped plan a program for exploiting German scientific and aeronautical research -- he had in fact suggested that the key German scientists and their families be brought to Wright Field, where they could work in an atmosphere conducive to creative thought, with the aid of all the laboratory equipment available at Wright Field. Research and development were very much in his thoughts.

William R. Weems, a lieutenant colonel by now, was still assistant commandant of the AAF Engineering School. Early in July 1945, Knerr took pen in hand and drafted a memo to Weems:

> Experience gained in the current war has clearly demonstrated the desirability of expanding the activities of the AAF Engineering School to include a Department of Maintenance Engineering and a Department of Air Logistics, co-equal with the present Aeronautical Engineering activities of the school.
>
> It has been my observation during the past 25 years of the development of aeronautics that the aeronautical engineer has a tendency to seek laboratory perfection at the expense of the hard realities of field utilization. This is not the fault of the engineer. The responsibility rests upon those charged with his training.
>
> We are at the threshold of a new era in aeronautics, both military and civil. That nation will prosper most and survive the longest that has the most realistic appreciation of the time and space factors involved in its aeronautical resources. It will not be sufficient that these resources be perfection itself unless they are available in sufficient quantities at the right place at the proper time. Hence, maintenance and logistics. It is our duty to be fully prepared.
>
> Please prepare for my consideration an organization and curriculum for the AAF Engineering School that will accomplish these objectives.
>
> H.J.K.

At a meeting on 9 July, Knerr discussed the idea with Chidlaw, who had recently come back from commanding the Mediterranean Tactical Air Forces and was now Knerr's deputy commanding general for operations. Both thought that to cover the added subjects adequately, the Engineering School course would probably have to be extended to twelve months, the length it had been before the war. Furthermore, in view of anticipated size of the postwar Air Force, the number of students would have to increase -- and they were thinking in terms of two hundred graduates a year. (Chidlaw's class, in 1931, had produced sixteen.)

Chidlaw forwarded the memo to Weems, along with his own account of the discussion with Knerr. (They had envisioned among other things a continuation of the staggered system, with a class of one hun-

dred entering each January and a second hundred each July.) Chidlaw pointed out:

> It is realized that the new concept of the AAF School embraces many hitherto unconsidered factors such as:
>
> a. A broader consideration of the qualifications of the prospective student.
>
> b. Added technical instruction equipment.
>
> c. Class room facilities.
>
> d. Housing problems for the students and their families.
>
> e. Problems of transportation.
>
> f. The securing of qualified instructors on Maintenance Procurement and Supply matters.
>
> Many other factors of like nature.

He also suggested some attractive features that might be included in the program:

> Consideration might well be given to the idea of limited 'co-op' work during the school year, i.e., the students should be given an opportunity to observe or possibly participate for short periods in the work of various divisions of ATSC. Plans should be laid for the follow-up training of selected students at such schools as Harvard School of Business Administration; Cal. Tech; M.I.T., etc., following graduation from the Engineering School. Leaders of the aeronautical industry, outstanding scientists, high government officials should be considered as visiting lecturers on subjects within their respective fields. The reputation and desirability of the School should be such as to attract the attention of the AAF in order to increase the availability of students and thus provide a greater range of selection.

Colonel Weems scrawled across the bottom of his copy of the letter, "Let's not make this just a school to perpetuate the status quo, but rather let's make it a source of stimulation to the *imagination* of officers."

Thus began what came to be called "the General Knerr Committee." Knerr, as Commandant, was on it; so were Weems and several other officers. Its purpose was to put together a staff study showing how the Engineering School could be broadened into a technological institute on the scale Knerr envisioned, and to draw up the regulations to cover it.

The study and draft regulation were finished by 7 August 1945, and Knerr forwarded them to Arnold. He had already -- on 3 August -- sent Arnold a letter recommending the expansion of the Engineering School to an AAF Technological Institute.

A period of discussion and delay followed. A lot else was going on in ATSC; as Wolfe -- now Commander, Fifth Air Force -- wrote to Knerr just after the fighting ended, "While the war may be over for the combat personnel it is really just beginning for you." The VJ plan had to be put into effect, technical intelligence exploited, and large-scale planning done for the postwar Air Force. But Chidlaw and other officers interested in the project for a technological institute -- notably Craigie ('35), who was back at Wright Field as Chief of the Engineering Division -- saw to it that a proposed directive was urgently forwarded to Arnold on 26 October 1945.

It arrived at a time when Wright Field, and research and development generally, were very much in the public eye. Another of Knerr's projects had been the staging of a huge AAF Air Fair from 12 to 21 October 1945. For years a tight lid of security had covered everything at Wright Field; Knerr felt that after VJ Day the American people had a right to the full story. The fair was an astounding spectacle; all the laboratories of the Engineering Division exhibited such things as radar, radio-controlled target planes, and other equipment that had been highly classified during the war. As Knerr described it, "We have, in effect, turned our laboratories inside out to show our visitors the wonders of modern science that went into the creation of the world's greatest air force."

Top-ranking officers of the War Department and the Army Air Forces, members of Congress, state and municipal officials, leading industrialists, and press and radio people from all over the country had come to see the show. Orville Wright, who had built the first military aircraft so many years ago, called the fair "the greatest display of technical research equipment and airpower I have ever seen." Kenney -- back from Japan, where he had accompanied MacArthur for the first landing on Japanese soil and then witnessed the signing of the Japanese surrender on board

the battleship Missouri -- was guest of honor on the last day of the fair.

The whole spectacle underlined the point Knerr had made to Arnold on 3 August: "The thought is presented that our best chances for preserving a healthy, progressive Air Force lie in the area of engineering research and development and in technical education."

On 21 November the Office of the Chief of Air Staff gave ATSC the go-ahead for the project; and on 5 December, the AAF Institute of Technology was officially authorized, effective 15 December 1945. On Air Staff instructions, Gen Nathan F. Twining -- who in early December had succeeded Knerr as Commander, ATSC -- appointed a resident committee of ATSC officers to prepare an operating plan for the proposed institute. Col Donald J. Keirn ('37) was chairman.

They met on 24 January 1946 to review the existing plans and decide such questions as organization and key personnel. The plan approved on 21 November called for the continuation of the current Engineering School classes under existing policies until they graduated in April 1946. Meanwhile the Commandant -- as soon as one was appointed -- was to "assemble a faculty composed of civilian and military specialists with outstanding ability and vision and institute policies designed to assure the faculty continuity, tenure and freedom of thought and expression." The instruction offered was to "avoid routine job training and . . . stimulate constructive critical scrutiny of present and past practices and equipment." It was to consist of a basic course for all students, focusing on "the development, procurement, supply, and maintenance of AAF equipment" plus specialized courses giving each student specific instruction in one of those areas. Facilities for 200 students were to be ready by September 1946; subsequent classes would be even larger, up to 350 students.

This was a visionary plan, but a visionary plan was needed. Scientific personnel had been in critically short supply in the Engineering Division since VJ Day -- partly because the output of engineering and scientific graduates from the universities had declined seriously during the war, partly because many of those the AAF already had were getting out. And this was happening just at a time when the Engineering Division was diverting its research and development programs into new channels of technological advancement, "from the airplanes and weapons of World War II to a program designed to lead to the development of the airplanes of tomorrow." As Chidlaw had commented to Weems in October 1945, "We need people versed in engineering and the sciences to make the translation from fundamental to applied research. . . . We've spent lots of money buying our yesterdays, and now we are creating more yesterdays by not getting going now." This was the reason for the note of urgency in the correspondence ATSC sent to Headquarters AAF in the fall of 1945.

And a narrow concept of training, the planners realized, would not do. A comment of Dr. Theodore von Karman, Special Consultant to the Commanding General, AAF, had been current among them the previous fall: " . . . It is necessary to organize a broad training program for officers in scientific and engineering fields, not merely to impart information on scientific and technical matters, but to accustom them to working in cooperation with scientific institutions and a scientific world."

Dr. von Karman had served in the Austro-Hungarian Army during World War I until one of his seniors noticed his scientific ability and transferred him to Goettingen, the center of German scientific thought. He was at Aachen University when Hitler came to power and the climate in Europe ceased to be healthy for intellectuals. So Von Karman came to the United States around 1934. During the war, he was chairman of the AAF Scientific Advisory Group of distinguished civilian scientists which Arnold had brought together late in 1944. Their mission had been to assemble "ideas for new weapons, possibly of the 'Buck Rogers' variety, for use during this war or for post-war development." In 1946 he was one of the luminaries of Cal Tech, a bachelor with a liking for cigars and plum wine, generally referred to by his students as "Papa Von Karman." Now he was about to become involved in the creation of the AAF Institute of Technology.

When Keirn's committee met on 24 January 1946, Colonel Don Coupland -- the same whose class had been abruptly disbanded in December 1941 -- gave a brief resume of all the previous planning. Then the committee got down to business. They were anxious to find highly qualified instructors -- possibly outside Civil Service -- and to explore what was being done elsewhere, particularly at the Naval Postgraduate School at Annapolis.

Later in the month they learned that they could indeed contract with universities for civilian instructors. They discussed the proper level of courses and most suitable number of military and civilian instructors. The possibility of offering courses at the graduate level was raised: why not provide for both undergraduate and graduate work?

Chidlaw, it developed, wanted the Institute to conduct instruction at the graduate level from the start; undergraduate education could be provided for later. People who had no undergraduate degree could be sent to civilian institutions to get one, then come to the Institute for graduate work. A few of the most highly qualified could then go on to postgraduate work at civilian institutions.

At a meeting on 1 February 1946, Chidlaw told the committee that they were about to get some extraordinary assistance. General Curtis LeMay was sending Dr. Von Karman to aid in establishing the Institute.

Since a Commandant had not yet been named, Keirn assumed the duties of Commandant for the time being. Before the next meeting, Dr. von Karman had become part of the enterprise, directing a group of distinguished scholars who came to be known as the Von Karman Committee, or -- later -- the Markham Committee, after Dr. John Markham of MIT. The Von Karman Committee doubted whether graduate education was feasible just yet. They did point out that at whatever level the Institute began, the faculty should be administered by civilians with long educational experience and should have freedom for experimental work.

While the committees worked out detailed plans for the Institute, the AAF was being reorganized for the postwar world. The Air Technical Service Command became the Air Materiel Command (AMC) on 9 March. The Army Air Forces University was being organized at Maxwell, under the leadership of General Muir L. Fairchild ('29). The AAF itself was working slowly toward autonomy as a separate service within a unified Department of Defense.

By late March the Von Karman Committee and Keirn's Resident Committee had arrived at some definite decisions. The AAF Institute of Technology would begin classes on 1 July 1946, with 200 students. It would function as a two-year undergraduate school. And Major Ezra Kotcher -- who was about to become a civilian again -- was to be invited back as Director. On the recommendation of the Von Karman Committee, the curriculum of the school was to be divided into two courses: one for officers planning to enter Engineering Maintenance or Procurement, the other for those planning to enter Logistics. The Committee noted, however, that the two courses should "be carefully integrated so as to give each officer as broad an education as is possible within his chosen field." Graduates were to receive Bachelor of Science degrees as soon as accreditation could be arranged.

The decision in favor of undergraduate training was a matter of feasibility. As the Markham Committee (as it was called by then) pointed out in a later report, many AAF officers had had their schooling interrupted by the war; others who held degrees would need a comprehensive review. So the AAFIT would have to begin with an undergraduate curriculum. But graduate education was not ruled out: faculty could offer courses on the graduate level, and in time a graduate school would develop naturally. The Committee outlined a plan for building toward a graduate school, commenting that if its policies were followed, "the resulting graduate courses will be on a level of those offered by the best scientific institutions."

The last class to graduate under the old system left at the beginning of April 1946. Since the Institute was supposed to start classes under the new system on 1 July, much had to be done. Among other things, Keirn's Resident Committee had to hire staff and faculty and settle the Institute in new quarters, since the school area in Building 14 would hardly accommodate two hundred students.

At first they expected to move back to Building 11, the old Materiel Division building where the school had spent its first years at Wright Field. Keirn's staff had already gotten approval for the necessary alterations, including an auditorium, a drafting room, and a library. Then, at the beginning of April, they learned that the space would no longer be available; instead, they were being given the second floor of the front wing of Building 125, in the newer and more open part of the field.

They had wanted the Institute to be in that area, away from the airfield and railroad; and the building was new, completed in 1944. But now they would have to work fast, to get Building 125 ready for occupancy by 1 July, complete with the auditorium, library, drafting room, lecture halls, study rooms, and

other improvements which Keim had planned for Building 11.

Ezra Kotcher, released from active duty in the spring of 1946, came back as Director. Other faculty and staff were also being appointed, both military and civilian. One of those -- the eleventh person assigned to the Institute -- was Capt Harold Larsen, lately of Class 45C, just back from getting his masters degree at Cal Tech.

In May 1946 a Commandant arrived, Brig Gen Mervin E. Gross. Like Chidlaw, Craigie, and many of the other shapers of the AAFIT, he was a graduate of the old Engineering School ('33). During the war he had been Chief of Staff for the U.S. Forces in China and later Deputy Assistant Chief of Staff, Personnel, Headquarters AAF. In Washington, he had been one of Echols' most important assistants. He was an extremely dynamic man who liked to fly airplanes, especially the still very new F-80.

Before long however, it was clear that classes were not going to start on 1 July. It was taking too long to get faculty.

Plans called for the organization of the Institute into two Colleges -- the College of Engineering and Maintenance, and the College of Logistics and Procurement -- each of which was to have a dean. Deans, department heads, and at least half of the rest of the faculty were to be civilians, so the program would have continuity. To get good people, the planners hoped to develop within the Institute a "university atmosphere," with security of tenure, dignified surroundings, a reasonable teaching load, and opportunities for research -- not only the superb experimental facilities of Wright Field, but a non-teaching quarter each year for each faculty member, to allow time for such research. But all this was still in the future in the early summer of 1946, when the Institute was trying to recruit enough instructors to start classes.

Finally everything was ready. Eight civilians and five officers -- including at least one from the old Engineering School faculty, Albert B. Carson -- had been brought on board. Almost 250 students had been enrolled. Two of them -- Col Don Coupland and Lt Col Roy W. Gustafson -- had been members of the Class of 1942 that had scattered abruptly after Pearl Harbor.

On 3 September 1946, Lt Gen Nathan F. Twining, Commanding General of Air Materiel Command, formally dedicated the AAFIT in the Institute auditorium. General Chidlaw and General Gross were present, as well as other guests, including Colonel Donald Putt. The Institute -- still part of the Engineering Division, but one of a system of schools under the educational coordination of Air University -- was officially in operation.

However, operations did not go quite as planned. Classes had started out as usual -- with Larsen, for instance, lecturing on the aeronautics he had learned under Von Karman at Cal Tech. But by the second week it was clear that most of the students were not ready for the level of instruction that was being offered. All lectures were called off for six weeks to allow for an intensive mathematics review. Then the Institute could go back to presenting what were, essentially, Cal Tech's aeronautics and M.I.T.'s electrical engineering.

Just before that -- on 18 October 1946, less than two months after the Institute was dedicated -- General Gross was flying back from Maxwell, where he had been consulting, as he often did, with General Fairchild and other staff of Air University. In heavy weather over Kentucky, his F-80 crashed into a mountain and he was killed.

The Institute was stunned. Chidlaw took over as Acting Commandant until a new Commandant could be appointed.

As fall moved toward winter, the school began to fall into a regular pattern. Each college had a one-year program, for people who already had degrees and needed a refresher, and a two-year program which was supposed to lead eventually to a BS degree. The curricula were designed to be "broad in scope and rich in fundamentals." The College of Engineering and Maintenance stressed advanced mathematics, mechanics, electrical engineering and electronics, thermodynamics, aerodynamics, and the application of all these to problems of design. The engineering student was also expected to learn something about economics, industrial management and procurement, and supply. The College of Logistics and Procurement (later called the College of Administration) gave its students an equally broad training in accounting and finance, economics, management, production, procurement and supply, and law. They were also required to take drafting and basic courses in all the engineering fields except design.

There was also a graduate program based in civilian educational institutions. AAFIT supervised the education of graduate students in technical fields at such institutions as Stanford, Princeton, and Cal Tech. Its Military Graduate Branch also conducted surveys to determine educational requirements and handled the administration of all graduate education, technical or not, and undergraduate education purchased from over a hundred civilian universities.

The Institute also monitored the training of officers assigned to civilian industries and administered a graduate program for civilian employees conducted on base by Ohio State University.

Student life was also settling into a pattern. Housing was a problem because of the shortage of living quarters in Dayton and the surrounding areas. Some housing was available in temporary barracks on the Patterson Field side, near the base chapel; but because of the shortage, many officers were separated from their families. The situation was not greatly improved until the Page Manor quarters were built, toward the end of the decade.

The program was intensive. Most students also had flying requirements, so the Institute maintained an Operations Section to coordinate activities with base operations and provide facilities for flight planning.

The students were organized into class sections of about 25 each, with the senior officer as section leader. A student council of section leaders and elected representatives met weekly to discuss student problems such as flying, housing, and study conditions and to plan social functions, such as quarterly dances.

Somehow -- though there were no organized Institute sports -- the students found time to play softball, football, golf, and other games and attend the Officers Club parties on Friday and Saturday nights. There were air shows, summer picnics, and a big Christmas party, patterned after the parties at Cal Tech, where Papa Von Karman played Santa Claus.

Towards the end of the decade the Institute executive officer, Colonel Clarence B. Lober, composed a song which, he felt, expressed the feelings of the students:

The Institute of Technology is the damnedest place to be

Where trig and physics and calculus still remain a mystery.

They speak of Theta, Omega, Pi -- just a lot of Greek you see.

I thought a flyer would ride the sky, but the profs are riding me.

Chorus: Heigh ho for the Institute, fiddle-de diddle-de de,

Heigh ho for the Institute, brothers in misery we.

We rush to classes and hurry home to stay up till hours wee,

A-readin', studyin', frettin', just to get a B,

Then take a flight in the dead of night to maintain proficiency --

The Institute of Technology is the damnedest place to be.

Repeat Chorus.

The song was duly printed on the Institute's addressograph machine and distributed -- though (as Larsen commented years later) the students already had a few songs of their own.

Life was not much easier for the faculty in the early years. They faced the same housing problems as the students; military faculty lived either in temporary barracks in the same area as the students, or across the highway in the area known as Wood City. Because there were so few instructors, they were likely to spend twenty hours a week in front of a class, often teaching in several fields; that first quarter in 1946, for instance, Larsen taught courses in aerodynamics, mathematics, and physics (and in the next quarter, thermodynamics).

But things gradually got better. At first, for instance, the Institute had had no laboratories of its own; the base provided a wind tunnel and laboratory facilities, and people went down for scheduled experiments. But the laboratories were not always available, so the Institute gradually developed its own -- physics, electrical engineering, aerodynamics, thermodynamics. There was not much money available, so this took several years.

By the end of the decade, the Institute had acquired such a reputation for excellence that it was being given some important projects for student research. At the end of the forties, for example, the Air Force was having problems with the F-86 -- problems severe enough to ground all F-86s more than

once. Gen Malin Craig suggested that aeronautical engineering students of the Institute investigate the problem and gave Larsen -- who was to head the investigation -- and his students a "blank check" to go anywhere necessary.

Larsen and his students found out what the problem was: not only the F-86s but all Air Force jets were being sent to the squadrons before they were fully tested, so the squadrons could get flying experience with jet aircraft. The group recommended a new procurement system to keep planes from getting into service before they were properly tested. Larsen introduced into the system the concept of the "learning curve": if you introduce changes into the production line, everything slips back. It would be better, he and his students concluded, to take experimental planes and test them twenty-four hours a day, to get flying hours on them in a hurry and find out problems early enough to correct them in the experimental line. When a decent version of the plane had been evolved, then the Air Force should "freeze" it and build it. If later changes were necessary, the best solution was to set up a mass-production retrofit line.

This concept came to be known as the Cook-Craigie Procurement System, after Generals Orval R. Cook ('30) and Lawrence Craigie ('35), who backed it. Larsen and his group were invited to Washington to brief it in a meeting which contained forty-seven stars -- somebody counted -- and a large crowd of Air Staff colonels. They had wanted to brief Chidlaw first, but he was too busy to see them.

As they stepped off the plane back at Wright Field, Larsen's boss met him and told him he had to go back and brief Chidlaw the next day. It seemed the Chief of Staff had picked up the telephone and called Chidlaw: "Bennie, when are you going to get the Cook-Craigie System into operation?" Chidlaw had to admit he had never heard of it, and -- as in the case of jet aircraft -- he took action to find out fast.

After that, Larsen recalled, anytime he needed something to get the job done, all he had to do was call Chidlaw's office to get approval of almost anything.

Years of Development

By the end of the forties, several other important developments had occurred. On 26 July 1947, on board his plane, the "Sacred Cow," President Truman had signed the National Security Act of 1947, which established the Department of Defense and provided for a separate Air Force. A few months later, on 5 December 1947, the Army Air Forces Institute of Technology had become the Air Force Institute of Technology (AFIT).

At the time, the Institute had recently achieved a significant change of organization of its own. At the start, it had been under Headquarters Air Force for policies and the assignment of missions; but organizationally it had been part of the Engineering Division. Brig Gen Edgar P. Soresen ('23), who had succeeded General Gross as commandant on 3 January 1947, had felt that the Institute belonged at a higher organizational level. He sent General Twining a memorandum, pointing out that the broad scope of AAFIT curricula took in the interests of all four of AMC's major divisions, not just Engineering, and that there was no real logic in submerging AAFIT within any particular division. He urged that AAFIT be placed directly under AMC.

General Twining thought this made sense. On 1 July 1947, AAFIT was placed directly under the Commanding General, AMC and, a few weeks later, formally given the mission of conducting "educational courses primarily in the field of engineering sciences and industrial administration, at undergraduate and graduate level, for AAF officers, to improve and maintain at a high level the technical competence of the AAF."

Shortly after, on 2 September 1947, the Institute had transferred most of its civilian institution program to Air University, in compliance with instructions from Headquarters AAF, to the effect that AU assume the responsibility. The Institute was not to regain the civilian institution function for a couple of years.

Meanwhile, a major struggle over accreditation was shaping up. It had started over differences in philosophy between the Von Karman/Markham Committee and the Gerow Board.

The Gerow Board, more or less simultaneously with the actions of the Von Karman Committee, had recommended the establishment of six Air Force schools, of which AAFIT had been one. According to the Gerow Board, the AAFIT mission was "to provide instruction which will assure scientific and technological development of Army Air Forces equipment and efficient operation of procurement, supply, maintenance, and service responsibilities assigned to the

Army Air Forces." It had not said anything about accreditation, and it defined the scope of instruction in rather narrow terms.

The Von Karman/Markham Committee, on the other hand, held that "The Air Force Institute of Technology should be a school fulfilling the required objectives which are to provide the necessary technological (engineering, maintenance, procurement, and logistical) educational needs of the Air Forces as brought out by the last war and as anticipated in the future." They wanted broad, fundamental courses "to cover the variation of technological and supply problems that would confront officers in the future" and held that selected graduates should be sent on to civilian educational institutions for advanced or specialized study -- which, of course, implied accreditation.

The difference in philosophy first surfaced on 8 May 1946, when General Gross pointed out to the Commanding General, AAF, that there were different points of view about what AAFIT was supposed to be. Air University's concept of AAFIT was considerably broader in scope than the original, rather limited Headquarters AAF concept. Gross proposed a regulation which took a middle ground corresponding to the Gerow concept -- he needed some kind of a regulation approved before classes started -- but pointed out that it would soon have to be revised.

On 2 July 1947 the Markham Committee also pointed out, in a letter to General LeMay, that divergences of opinion existed between the committee and the hierarchy. The committee held that the awarding of undergraduate degrees was important. Despite this, the First Board of Visitors (16 July 1947) took the Gerow view: undergraduate work at Wright Field should be highly specialized -- limited to courses of study not normally available in civilian institutions.

The man who first came to the rescue of the Markham Concept was General Ira Eaker, Deputy Commander, Army Air Forces. In a letter to General Twining on 19 July 1947, he wrote:

> I have the greatest interest in this undertaking [the AAFIT], realizing that it undoubtedly will be the most effective single agency for insuring the Army Air Forces' having properly qualified technical officers in the years to come. . . .
>
> As you are aware, the Army Air Forces Institute of Technology was studied and discussed fully in Headquarters, AAF before the Markham Board was convened. . . . Just how the school was to fit into the AAF educational program was determined very carefully, the resulting decisions being provided the Markham Board as a guiding policy. . . .

Eaker indicated that the courses should be brought into line with the policies embodied in the Markham Report: that the AAFIT was to be "a technical school comparable to the best in the United States," teaching fundamental subject matter primarily, and carefully avoiding "any tendency to become a trade school, or a training school for the Air Material Command"; that, though primarily an undergraduate school, it should establish a graduate school as soon as it reasonably could; and that it should award degrees.

General Twining replied that this was exactly what he wanted to do, and that his command would "do everything within our power to make the AAF Institute of Technology a technical school comparable to the best in the United States." The problem, it seemed, was at the intermediate level: the AU Board of Visitors was much concerned over an AAFIT which operated in the undergraduate field currently covered by civilian institutions. As for the granting of degrees, the Institute would first have to get accreditation; and it could not do that till it was actually in operation.

Muir Fairchild, ('29) at Air University, was deeply concerned by these differences in philosophy between his Board of Visitors -- distinguished scholars all -- and Headquarters AAF, which seemed to want "an undergraduate engineering school similar to M.I.T. or Cal Tech." He went so far as to write to Headquarters AAF, suggesting that "it might be desirable to revise Army Regulations removing the responsibility of the Air University for broad supervision of the curricula of the Air Institute of Technology."

What bothered Fairchild was the idea that the kind of AAFIT envisioned by the Markham Committee would prove to be a duplication of civilian schools and that -- as a result -- sooner or later the Air Force would lose it. Eaker wrote to reassure him:

> [AAFIT's] curriculum, although composed of courses similar to those offered at M.I.T., is especially designed to provide a greater coverage of subjects of particular interest to the Army Air Forces

than any civilian school has found practical to date. It is our confident expectation that the AAFIT will prove to be a better technical school for our purpose than any civilian institution.

He pointed out the unique advantages of the Wright Field location, which provided the students with "a standard and variety of laboratory equipment unmatched in the United States."

The debate went on along these lines. The Institute urgently needed it solved: graduates who had not previously possessed college degrees needed the BS to get into graduate schools. The Institute sought an interim solution: some officers got into graduate school by persuading their original, pre-war colleges to give them degrees through the transfer of AAFIT credits; others got in through the Graduate Record Examination. The Institute noted in 1948 that out of 32 graduates accepted by civilian graduate schools, 21 had gotten in without bachelors degrees.

The issue of accreditation hung fire for awhile. Meanwhile, on 16 July 1948, Headquarters AMC changed the Institute's name to USAF Institute of Technology (USAFIT).

During this period the faculty and staff had expanded. Deans had been found for the College of Industrial Administration and the College of Engineering Sciences (as they were now called); and the faculty was beginning to have time for research, consultation, and the presentation of papers. The frenetic days of teaching twenty hours a week across a whole spectrum of subjects were over, though adjunct professors still regularly came from AMC offices and laboratories and nearby universities and industries.

In October 1947 the Institute had received approval for a twelve-week Air Installations School, designed to prepare selected officers to solve specialized administrative problems pertaining to the maintenance of base air installations. It began operations in March 1948, as a department of the College of Industrial Administration, and graduated its first class in May.

The Institute Class of 1948 -- both Engineering Sciences and Industrial Administration -- the first major postwar group to be graduated, received diplomas on 16 August 1948. Chidlaw was the graduation speaker. He told them,

It is always an eminently worthwhile thing for an adult to undertake a new phase of mental growth. And it is to enable Air Force officers to accomplish this cultural and educational development that the courses of the Air Institute of Technology have been planned. The value, of course, rebounds directly back to the Air Force.

Your curricula have been based on foundations of the broad fundamentals of military requirements. In the College of Engineering Sciences you have been given the opportunity to tackle mathematics, physics, chemistry, electrical and mechanical engineering, electronics, aerodynamics and other basic engineering subjects. You have studied them from the point of view not of specialists, but of the general student, who if the service requires will be able to speak the general language of science, or if his choice directs or the occasion requires, can make it his specialty for further study later on.

In the College of Industrial Administration you have followed the same trend of fundamentals. You have learned management and organization. The handling of laboratories, the formation of depots, the assumption of procurement or staff positions, all lie within this field. You have learned something of the conduct of business, personnel management and production. This is a new type of instruction in this school and one that should prove of inestimable value, particularly to the more seasoned officer, this value also rebounding to [the] good of the Air Force.

These courses in the colleges are conducted primarily on the advanced undergraduate level and serve two particular purposes: they prepare the students for work in any one of the many specialized fields or they prepare him to assume important positions in the general field, enabling him to analyze the problems, to discuss them with scientists or industrialists in their own language, to see the Air

Force picture as a whole rather than in part.

He spoke with nostalgia of his own graduation in 1931 and then reminded the graduates of the Cold War which had, in this summer of the Berlin Airlift, become a part of their lives:

> We who have chosen the Air Force as our careers realize the seriousness of those responsibilities. Never in the contested history of this modern world has one nation given more generously of its substance, its wealth, and strength -- first to defeat aggression, and thereafter to arrest its regrowth. . . . Had we at this time failed to rouse our strength in reply to threats and intimidation, we might have drifted helplessly through crisis after crisis into catastrophe without power to change our course. This we elected not to do. Instead we have gathered our powers to avert war -- not to fight it. We are personally aware of the horror of war and we know that a future war will prove more disastrous than any history has known in the past. And so it is with no sense of security or ease that we dedicate ourselves to a service by which we hope the nation and our way of life may be saved.
>
> Hence, with my hearty congratulations goes the solemn acknowledgement that never before, perhaps, has each member of a graduation class gone forth from Wright Field with a greater reason for giving the very best of himself to his Service.

They, and others before and after them, did go forth and do just that. It was a time of great technological growth -- the development of newer and better jet aircraft, guided missiles, nuclear weapons. Practically all World War II aircraft were obsolete -- though records were set with them after the war, as when Colonel Clarence Irvine ('33) flew a B-29 nonstop for 8,198 miles, more than a thousand miles farther than any previous record. At the end of the war the AAF had decided to increase its emphasis on jet propulsion and guided missiles.

Some of the groundwork had been laid before and during the war. Wright Field engineers had been working on various guided vehicles since the 1930s; the first radio-controlled target drone had been tested at Wright Field in 1936, and George Holloman ('35) had made the first completely automatic landing, with radio compass and automatic pilot, in 1937. By the end of the war, this technology had gone so far that in August 1946 two Wright Field Flying Fortresses, without crews, flew nonstop from Hawaii to the United States under radio control from a mother ship.

Guided missiles were another facet of the same basic technology. Ever since 1940, Wright Field had had part of its budget allocated for guided bomb research. Glide bombs, "aerial torpedoes," and controlled wing bombs had been quietly tested at Muroc in the 1940s. (Some of them were actually remote-controlled aircraft carrying bombs.) German use of the V-1 jet propelled pilotless bomb, beginning in June 1944, had spurred AAF efforts to develop a useful guided missile. The initial plan was to build an American version of the V-1; to that end Ezra Kotcher and other Wright Field engineers reconstructed a V-1 propulsion unit out of parts salvaged in England and tested it in August 1944, less than three weeks after they got the first parts. By 8 September 1944 they had built the first JB-2, an all-steel jet-powered monoplane version of the V-1; the Air Force ordered it but the end of the war came before it was ever used.

The glide bomb project -- of which Holloman ('35) was in charge -- brought advances in radio control. Holloman's goal was to develop a radio device that would guide a bomb to a predetermined point up to thirty miles away, or -- alternatively -- to develop a seeking device through which the bomb could be made to home on the target. This latter alternative was never used in World War II, but seeking and homing devices continued to be tested. At the end of the war, the AAF guided missile program included air-to-surface, surface-to-surface, surface-to-air, and air-to-air missiles.

Most of the research money at the end of the war, however, was intended for experimental and developmental aircraft. The AAF was thinking in terms of a jet-propelled stratosphere fighter, a transonic experimental plane, a supersonic experimental plane -- both fighter types -- an experimental medium jet bomber, and even a supersonic jet bomber.

During the war years, the AAF had nothing whatever to do with atomic energy except that it car-

ried the bombs. Only Arnold and a few others knew anything about the atomic-energy project until almost the end. But in August 1945, one Air Staff agency quietly asked another what would be the effect of atomic energy development on the guided missile program. Before the end of 1945, the first steps had been taken to include atomic energy applications in the AAF research and development program.

After the war, the exploitation of German technical intelligence made further advances possible. Col Donald Putt ('37), as AMC assistant chief of staff for intelligence, set up the nucleus for the Air Intelligence organization just after victory in Europe, when he went overseas and took command of the captured Nazi research center at Adlershof. Adlershof, the German equivalent of Wright Field, was the place where basic research had become physical experiment; Putt's technical intelligence officers combed it and similar places for every scrap of information on German scientific developments. Tons of documents, microfilm, prototypes, and the like were sent to the United States for study. And -- as Hugh Knerr had urged -- the most important German scientists were brought to Wright Field, where Putt once again presided over the continuation of their work.

Wernher von Braun was one of them. In connection with Putt's project, he wrote a brief description of the development of liquid rockets in Germany, in which he included his own prediction of the rocket's future. His estimate was visionary: he foresaw crew-carrying winged rockets with ranges of over 3,000 miles; rocket aircraft used as commercial planes or bombers, so fast they could travel from Europe to America in forty minutes; even multi-stage piloted rockets which would reach a maximum of more than four miles a second outside the earth's atmosphere.

"At such speeds," Von Braun wrote,

> the rocket would not return to earth, as gravity and centrifugal force would balance each other out, in which case the rocket would fly around the earth the same way as the moon. The whole of the earth's surface could be continually observed from such a rocket. The crew could be equipped with a very powerful telescope and would be able to observe even small objects such as ships, icebergs, troop movements, construction work. Finally, it can land like an ordinary airplane by means of wings and auxiliary gear.

He also envisioned the construction of observation stations in space -- "the work would be done by men who would float in space, wearing some form of diver's suit" -- and a solar power station in space, which could provide heat and light to earth's cities, influence the weather, and even serve as a weapon by focusing extreme heat at certain spots on the earth's surface.

Putt became Deputy Chief of the Engineering Division in December 1946, about the time that the postwar research and development effort was getting firmly established. Earlier in the year, Col Donald Keirn ('37) had been assigned as liaison officer for the Manhattan Engineering District and had gone out to Bikini to participate in an atomic bomb test. Lt Col Bernard A. Schriever ('41) was Chief of the Scientific Liaison Branch at Headquarters AAF. Gen George Kenney ('21) was commanding general of the newly formed Strategic Air Command (SAC). Craigie, as Chief of the Engineering Division at AMC, was monitoring a whole collection of projects, including several types of jet aircraft and guided missiles. Swept-wing technology was just coming into being; in a report late in 1947, Craigie made special mention of an experimental jet bomber, the Boeing XB-47, "having a radically swept back wing which helps to defeat compressibility problems and permits speeds of nearly 600 miles per hour," and the XP-86 jet fighter, which embodied "the latest theory of sweepback, which reduces the drag and enables us to get more speed for the same horsepower." He spoke of plans for the fighters of the future: penetration fighters to escort bombers "out as far as we can design jet fighters to go," all-weather fighters "able to fight at night and in bad weather and still take care of themselves as fighters," interceptors which could climb 15,000 feet a minute from sea level and fly "well beyond the speed of sound." All these types, he noted, were already being developed, though the supersonic interceptor was only in the design stage. Guided missiles were also becoming important; Craigie mentioned a rocket-powered air-to-air, with a radar seeker in its nose -- it was intended for use against enemy bomber formations -- and a ground-to-ground missile still in the concept stage which would "be able to go out 5000 miles and more."

The "compressibility" Craigie referred to was the one remaining obstacle to the development of supersonic aircraft. During the war, pilots had found that when the fastest fighter aircraft dived at top speed, they would start to shudder violently -- sometimes so violently that tails or wings came off. Aerodynamicists found out why: as the airflow over the wings approached the speed of sound, shock waves were created. The swept-wing technology made it possible to attain higher speeds before trouble started, but the "sound barrier" remained.

Ezra Kotcher had been working with this problem since 1944, when he had first discussed the possibility of a man-carrying rocket-powered aircraft with the Bell Company. In subsequent months an experimental aircraft -- known as the X-1 -- was built. The end of the war made a B-29 available for air launching, and the X-1 was successfully glide-tested in early 1946.

Ridley worked closely with Yeager through the early tests. At Muroc, on several successive test flights, a converted Superfortress carried the X-1 up to 30,000 feet in the bomb bay and then let it go. Each time, Yeager flew it a little closer to the speed of sound.

Then on 14 October 1947, they felt the time had come. On board the B-29, Ridley sealed Yeager into the X-1 and asked him if he was ready. Yeager said he was. The X-1 dropped away from the Superfortress, and Yeager ignited the rocket engine. The X-1 began to buffet, but he knew it was too late to turn back now. Then suddenly the buffeting stopped: he had passed through the "sound barrier" in level flight, proving what Craigie and Kotcher and so many others had counted on -- that the speed of sound was no real barrier for a carefully designed aircraft.

Later on, Ridley also checked out in the X-1 and flew some tests at transonic speeds. But his most important work with the X-1, like Kotcher's, had been his part in making the historic flight possible.

Another development was taking place quietly about this time. Wernher von Braun and his group of scientists had moved to White Sands, New Mexico, to work with the V-2, an advanced rocket which Germany had put into operation, toward the end of the war. The V-2's at White Sands, however, were research rockets, not weapons. Von Braun's group was using them to send research instruments into the upper atmosphere.

This was the state of technology on that August day when Chidlaw addressed the Class of 1948. Their year was in several ways a watershed year. The 1947 class had been in some ways the last of the old, a continuation of the old Engineering School in that it was a one-year program for people who already had degrees; the presence in it of Coupland and Gustafson had been fitting. The 1948 class was the beginning of something new: a new concept of education, a new type of student adding formal academic knowledge to wartime experience. The prewar graduates were now reaching the upper levels of the Air Force; these postwar graduates were for the most part a younger generation, facing different challenges. That morning in the first months of the Berlin blockade, the outlines of a new era were beginning to be faintly visible: the era of the advances in technology which would, in just over twenty years, place men on the moon.

The Institute itself, in that year and the following, was beginning to assume the shape it would keep for a number of years. Schools of engineering, logistics and civil engineering were already present under different names. The Civilian Institutions Program was transferred from Headquarters Air University to USAFIT late in 1948, so that all college level Air Force education was logically combined in one organization. The graduate program was beginning to become a reality -- partly through Civilian Institutions, partly through the one-year programs in the two resident schools. In the summer of 1949, USAFIT also acquired the responsibility of supervising the education of Air Force medical personnel, including senior dental students and medical interns.

During this period too, for the first time the Institute had to fight the kind of battle Muir Fairchild had foreseen as an inevitable consequence of the Markham concept. Several Air Force agencies questioned the type of training being offered in the resident programs, under the premise that the training could be obtained at civilian institutions. The Institute had to explain patiently, as Eaker had once explained to Fairchild, that, no, this was different: even if the names of courses sounded like what was being offered in civilian schools, the course content was considerably different, specially tailored to the needs of the Air Force. An Institute document noted,

> It is stimulating for the student officer to combine, as he can in the 'inresident' program of the institute, the academic knowledge which he is acquiring with his

which he is acquiring with his military experience and professional interest. It is in this typical manner that the Air Force officer having a technical career objective receives the vital training which will enable him to contribute to the achievement of superiority of Air Force weapons. It is the type of training which is not available at a civilian college.

Early in 1949 the Institute acquired the last major element of its postwar structure: a Plans Division. The Plans Division that began on 15 March 1949 was small, staffed by a colonel with four officer assistants; but it had large projects in its jurisdiction, ranging from the development of a functional organization for the Institute to a study of the feasibility of establishing a program in nuclear engineering. One objective was to develop a long-range program to raise the general educational level of the Air Force.

The Institute staff was there too, under the general heading of Academic Administration Section: the registrar function, the admissions board, the personnel people, the library, audiovisual and graphics staff, supply, and the rest.

In September 1948 General Craigie came to the Institute as Commandant, the first of several commandants who were graduates of the old Engineering School or the later Institute. There had also been a change at Air University: Fairchild had gotten a fourth star -- he was one of the first Engineering School graduates to do so -- and gone to Washington as Vice Chief of Staff of the Air Force. His successor was Maj Gen Robert W. Harper, who held the post for only a few months before getting a third star and leaving to take over Air Training Command. The new commander of Air University was the dynamic General George Kenney ('21).

It must have seemed to Craigie like a good time to settle the question of what the USAFIT mission actually was. On 24 February 1949, he suggested that an exploratory discussion should be held to determine a policy for USAFIT.

A document drawn up for Craigie about this time summarized the situation as it appeared in 1949, when the Markham concept of a degree-granting program had already become firmly established in people's minds:

> That USAFIT is in need of a clear mission directive is . . . an obvious fact. What the USAFIT mission should be, however, has apparently been a much opinionated matter. The various opinions expressed in the past can be synopsized into three (3) general schools of thought.
>
> a. The Gerow idea.
>
> b. The Markham idea.
>
> c. USAFIT's recommendation that the Institute be the responsible agency for postgraduate ("after Air Academy" or equivalent) education of Air Force officers in the technological field.
>
> The main point of similarity between these three ideas is that they all propose a college type training program to further the technological needs of the USAF. The Gerow idea, however, foresaw an added mission for AFIT, namely, that it should provide instruction which will assure "efficient operation of procurement, supply, maintenance, and service responsibility assigned to the USAF." This is the main point of dissimilarity between the Gerow idea and the other two ideas shown above. The Gerow idea is the only plan which appears to appreciate the fact that a strong relation exists between USAFIT and the school systems and that USAFIT truly complements the Air University System. . . .
>
> Decision as to what the USAFIT mission should be therefore requires settlement of two basic questions:
>
> a. Should USAFIT teach only college type courses, or should it also include necessary military staff training for certain type officers to complement the Air University system and "assure operation of procurement, maintenance and service responsibility assigned to the USAF"?
>
> b. To the fulfillment of what requirements, aims and objectives should the college type program be geared?

On the first question the USAFIT position had favored "college type courses" only. That position had grown out of the struggle to gain acceptance for the idea of USAFIT as a degree granting institution.

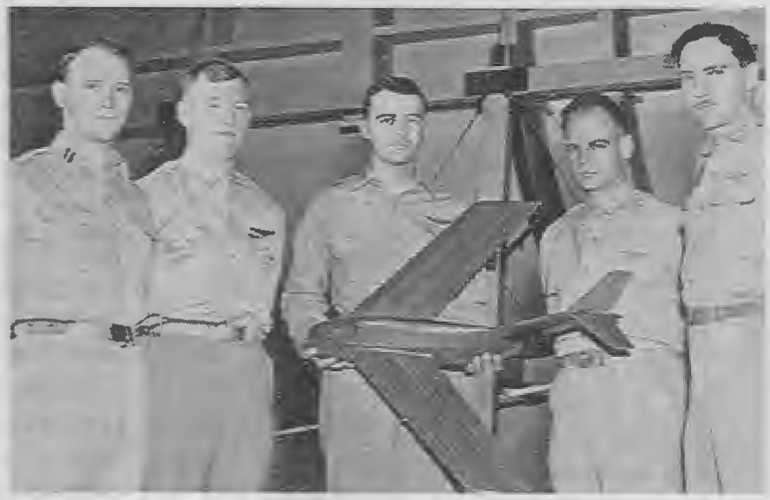
Engineering School students study an electric model of a reciprocating engine.

The first B-29 to arrive in China.

B-29s: The main assembly line.

Maj Gen Laurence C. Craigie ('35).

Members of the Class of 1947 examine an early swept-wing research model.



That point had been more or less settled on 19 March 1948, when a conference at AMC concluded that the Air Force should take action "to secure legislation . . . which permits the granting of degrees." But the thinking in 1949 was that USAFIT could go beyond that -- could accept what was now viewed as "an added mission," to fill the gap in the Air Force school

system. The gap, as the summarizing document pointed out, was causing real problems:

> In practical everyday thinking it creates a dilemma in the Training Division each time a request is made by the staff for establishment of new courses in the Air Materiel Command or materiel field, such as Advanced Logistics Course for Staff Officers, Advanced Maintenance and Supply Courses, Advanced Transportation Staff Officers Course, etc.

The second question was broader: just what role was USAFIT to play in the future? As Craigie's document put it:

> In 1946 we embarked on an undergraduate program to raise the level of education in the technological field of a substantial number of officers. . . . Inasmuch as a need existed for upgrading at both the baccalaureate and graduate levels, the Markham Committee also recommended a graduate school be established as soon as feasible. What is important to note at this point of the discussion is that all the Markham recommendations relative to either the undergraduate or postgraduate education were aimed at the solution of a strictly temporary problem. . . . It was also recognized that in time the conditions then existing would change completely through the output of USAFIT graduates and stabilizing, in general, of recruitment programs, at which time the need for the present program would completely disappear.
>
> Then what? Reiterating the thought expressed above, no study has yet been completed to determine the exact long-range role of USAFIT with reference to college type training. It has been suggested by USAFIT and also the Board of Visitors that the Institute could fulfill a role of preparing officers for graduate work in civilian institutions. USAFIT also recommends in its *First Annual Report* that the Institute be the responsible agency for postgraduate ("after Air Academy") education.
>
> All summed up, these suggestions seem to point to the establishment of a standardized graduate school to which General Fairchild as Commanding General of Air University and his Air Staff continually objected in the past.

Craigie's exploratory discussion brought about the publication, in May 1949, of a regulation considerably broadening the USAFIT mission: USAFIT was now to "provide such education and training as will meet the technical, professional, and scientific training requirements of the Air Force."

Another achievement of that year was the inauguration of USAFIT's first real graduate-level program.

In September 1949 the College of Engineering Sciences set up a special one year graduate program, with options in aeronautical engineering and electronics. The College of Industrial Administration was also planning a graduate program, to begin in September 1950.

This was in line with developments that had been going on since the spring of 1949. On 11 April 1949, Kenney, as commander of Air University, had written to the Chief of Staff of the Air Force, calling attention to a trend he considered fundamentally unsound: the gradual evolution of the Air Force educational system toward division of educational responsibility among several major commands. His point, of course, was that Air University should be given responsibility for the conduct and administration of all USAF educational institutions and programs.

USAFIT was not among the institutions he hoped to acquire responsibility for. His staff had told him USAFIT had already fulfilled the short-range mission of undergraduate technical education planned for it; therefore, they said, it no longer had a mission and should be discontinued.

Craigie, of course, knew what the Air University staff had recommended. On 19 May 1949, he also wrote to the Chief of Staff, pointing out that USAFIT did have a mission and was doing it: "[The] requirements still exist and are being met by the program of courses at USAFIT. The curricula of both colleges of USAFIT have been developed to take full advantage of the technical environment of Wright-Patterson Air Force Base and the unique Air Force facilities and material available only at that base." He

agreed with a proposal made by Kenney, that a board of general officers should convene to determine Air Force educational requirements -- and, he added, the USAFIT commandant should be a member of that board.

The Air Staff studied the issues Kenney and Craigie had raised -- as well as one they had not raised: what command USAFIT should belong to, if continued. They strongly disagreed with the verdict of Kenney's staff: "The dissolution of USAFIT, or a part of it, on the basis of the incomplete evidence presented . . . would be premature and is unworthy of consideration until exhaustive study establishes conclusively that a requirement no longer exists. Too much time, money and effort have been expended in the development of this school to lightly cast it aside at this time." Their study was broader in scope than the one Kenney's staff had done for him: they set out to review the overall educational needs of the Air Force. These, they found, were "distinctly bilateral in character. The components of this bilateral pattern are readily identified as EDUCATION and TRAINING. It may be said that the former is primarily concerned with 'teaching the head' and the latter with 'teaching the hands.' The indispensability of each is self-evident." The responsibility for these had been given, respectively, to Air University and Air Training Command.

USAFIT was one of the exceptions to this policy. The May 1949 regulation which broadened its mission had also removed it from Air Materiel Command (except for logistical support and services), since there seemed to be no valid reason to keep it under AMC. This left USAFIT isolated, without proper integration into the functional plan of Air Force organization. Obviously, the Air Staff felt, it should belong to one of the two school commands. They recommended USAFIT should be a part of Air University.

Meanwhile a different problem had come to light at a meeting of the Air Force's Scientific Advisory Board on 7 April 1949. The question had come up: What should the Air Force do to maintain technical superiority in the precarious international situation of the cold war? Somehow, more emphasis must be given to research and development.

A small group of Scientific Advisory Board consultants, headed by Dr. Louis N. Ridenour, was formed in June 1949 to study the research and development situation. Their report, published on 21 September 1949, included a strong recommendation on USAFIT:

> The Committee has given some thought to the place of the Air Institute of Technology in connection with fundamental research. . . .
>
> The Committee feels that the Air Force could do something that would be unique in the Department of Defense, and also of the greatest benefit to the Air Force, by gradually turning the Air Institute of Technology into a graduate school of engineering which would rank with the best civilian institutions of this kind. The expense of doing this would not differ substantially from the expense of running the Institute on the present basis; yet the returns, in terms of competent technical men trained in or attracted to the Air Force would be incalculable.
>
> The question may be asked: Why need the Air Force have its own graduate school of engineering? Why not depend upon civilian institutions, already in existence, for the advanced study and research of interest to the personnel of the Air Force? These questions have two ready and compelling answers. First of all, the Air Force is concerned with the engineering of weapons which often have no civil counterpart. Thus, the study of terminal ballistics, of radiological warfare, and of many other matters, is not the proper business of a civilian institution. Such topics can be best handled in a service establishment. Second, the Air Force has at Wright-Patterson Field. . . . facilities for specialized research which are unmatched in civilian institutions, and which cannot be duplicated without large and unjustifiable expense. These facilities should be used for research, and the proposed development of the Air Institute of Technology is the most direct and immediate way of ensuring that they are so used.
>
> *The Air Institute of Technology should be made into a graduate school of engineer-*

ing ranking with the best civilian schools in this category, and having specific objectives derived from the needs of the Air Force.

Jimmy Doolittle ('23) -- now back in Reserve status and serving as Vice President of Shell Oil -- had been a member of the Ridenour Committee. Maj Gen Donald Putt ('37) and Brig Gen Ralph Swofford ('36) were both members of another committee formed at the direction of the Chief of Staff to review the whole structure of Air Force research and development. The committee's findings coincided with those of the Ridenour Committee: that the Air Force had better do something promptly, to insure the long-term development and superiority of American air power; and that high-caliber graduate-level instruction at USAFIT was part of the solution.

Kenney was fully convinced that they were right. On 19 November 1949 he wrote to the Chief of Staff, "I believe that their findings . . . should be implemented as soon as practicable, to put the Air Force on the road of a Research and Development program which will better insure our position in the technical field for the future. As long as we remain ahead of any possible opponent technically, we could not lose a war; but if we once fall behind technically, it is difficult to see how we could win a war of the future."

On 24-25 January 1950 the board of general officers Kenney had asked for the previous April met at Air University. Fairchild, as Vice Chief of Staff, headed it. They surveyed the whole USAF educational system, beginning with USAFIT.

The first question asked of the Board was: "Does a valid present or future need for the USAFIT justify its continuance within the educational structure of the Air Force?"

Discussion of the question centered around the value of the uniqueness of Air Force "emphasis" or "slant" that could be given to specific Air Force engineering problems in a service school. The Ridenour Report had highlighted the point that USAFIT had access to tools and research facilities not readily available to civilian universities, and that research work or graduate work might be done at USAFIT in fields which could not be pursued at civilian colleges. The fact that the curriculum offered by USAFIT could be duplicated in civilian universities, as far as course title was concerned, was irrelevant: while titles were similar, the course content was considerably different, since the Institute placed its emphasis on Air Force application and pointed its instruction toward the solution of Air Force problems. The Board accepted the fact that there was a need for this unique education and that the continuance of the resident program at the Institute was justified. However, they also agreed that in view of the high educational level of officers now being commissioned in the Regular Air Force, the undergraduate program should not continue beyond the next five years. During that period the level of instruction should be raised to that of a graduate school.

Discussion then centered around the possibility of changing the emphasis, over a five year period, to graduate level instruction, to provide the Air Force with a means of obtaining education not available in civilian institutions. The Air Force, the Board noted, was concerned with the engineering of weapons which often had no civilian counterpart -- the study of terminal ballistics, radiological weapons, and similar matters were not normally the business of civilian institutions. And the Air Force did have at Wright-Patterson unique facilities for specialized research which were ideally suited for graduate study.

There was another aspect: the creation of an Air Research and Development Command, to be active at the beginning of February. The Research and Development Command placed great emphasis on the desirability to the Air Force of assembling leading men in scientific fields to carry out research. The fact that top-flight scientists could be attracted to the Air Force by an opportunity to teach part of the time, as well as engage in research, was a persuasive point in USAFIT's favor.

The Board also recognized that assured continuity and stability were necessary to the successful development of an education institution. Outstanding educators were not attracted to schools whose permanence was questioned; and the attraction of such people was the greatest problem the Commandant of the Institute would face in the development of a top-level graduate engineering school. The Board concluded that assurance should be given to everyone concerned that USAFIT was to continue as an integral part of the Air Force education system and that future Air Force policy should recognize how essential this continuity and stability were to the operation of the school.

Finally, the Board agreed with the point Kenney had originally made, that Air Force education belonged in one command. USAFIT would become part of Air University, as of 1 April 1950.

While all this was being debated, USAFIT went on with its business of conducting its resident programs and expanding its civilian institutions program into areas like reactor technology, medicine, and the design and production of guided missiles. The Air Installations School, now separate from the College of Industrial Administration, had expanded to a twenty-week course.

The Class of 1950 left its own view of USAFIT on record in its yearbook, the *Integrator*. Its cover featured the new coat-of-arms approved the preceding year: a predominantly gold and blue emblem, featuring the atomic symbol for oxygen imposed on a gear wheel. Inside the book, the class commented on academics:

> Many of the officer students had not been inside a university for a number of years, and to get everyone back into the swing of studying, students of both courses were subjected to a one-month intensive mathematics review. Engineers then proceeded on their technical way to learn to solve problems in aircraft design or electronics, as they elected; the 'Admins' studied to learn something of business and commerce, to enable them to decide whether it would be practical to purchase what the Engineers had dreamed up.
>
> The Engineers seem justified in their feeling that they had to work harder than anyone else for their education, while the 'Admins' are positive that if anyone learned more than they were expected to, he would have needed two heads. The versatility of the Institute in helping students with their work load was exemplified by the solution of the problem posed by the voracious reading in the Technical Library that was required of the 'Admin' students. Some schools might cut down on assignments rather than have the students suffer ill health from lack of sleep. Not so AFIT! A course in accelerated reading was introduced so that everyone could learn to read twice or three times as fast as before.
>
> In the Summer Program the students of both Courses were familiarized with the activities of all divisions of the Air Materiel Command and were conducted through a large number of industrial manufacturing plants. By this means, the Engineer, by noting the practicalities he had seen in Industry, learned to design items which he knows will reach the beachhead without involving the problems of change; and the Admin, who may later be purchasing for the Government, learned to evaluate production potential of a new design, and also was prepared to enter future dealings with civilian firms with a more adequate understanding of their problems as well as some familiarity with their facilities.
>
> No matter which course each man completed at AFIT, he worked hard while he was here to increase his potential value to the Air Force.

Each college produced an acrostic on the word "Integrator." There were some pithy comments and some playful ones:

> In the pages to follow -- who are these men of letters and science, whose faces and characters are exposed to your scrutiny?
>
> Never in the history of education has so much been expected by so many of these few -- if a plagiarism be permitted.
>
> The receding hair lines, silvered temples, and deepening character lines are mute evidence of those endless hours spent cloistered with text and drafting board.
>
> Endless differentiation, integration, interpretation of results, series expansions, term papers, lab reports are the hurdles placed in the paths to more useful conclusions.
>
> Game are these veterans of foreign wars, military academies, and civilian universities, who had the temerity to apply for schooling by the Air Force.

> Relatively simple to the profs, maybe, some of the subject matter will never come easily to many of these men -- but it had been interesting to do one's best -- their ability to produce the answers will never be in doubt.
>
> All they could hope to accomplish was to learn enough to better understand and correlate and use the findings of research scientists working with the Air Force to produce the best tools to accomplish the work safely and economically.
>
> That there was a grading system seemed unfortunate, except to a select few. One hopes people at the next assignment don't look closely at those grades, and feels sure St. Peter won't care.
>
> Our paths will be divergent after graduation -- wouldn't do to have too much knowledge concentrated outside the Pentagon, y'know!
>
> Returning to the Air Force, so to speak, these men will contribute not only their prolific technical knowledge, but an added fledgling in almost every family.

The class also paid tribute to the student wives, who, while husbands were busy "chasing the electron, the elusive dollar or the air particle," somehow kept the household in operation and quiet enough so that husbands could study. Someone even composed a poem in their honor, with the refrain, "It's the students' wives who deserve degrees."

They offered farewells to Craigie, whom they thought of as "their" commandant since he had arrived almost when they did and would leave almost when they did:

> In another more personal sense General Craigie is "Our" Commandant. He is the kind of leader who imparts his confidence and enthusiasm to those in his command. And to us who have been privileged to serve under him for the past two years he has become a true and trusted friend. His interest in us and our work, his understanding of our problems, and his unfailing loyalty to us have cemented our devotion to him.
>
> He has treated us always as gentlemen and officers. He had dealt kindly yet fairly with our shortcomings and he has praised us all too generously. His sterling leadership and fine example have set for us a goal which we can hope only to approach in our future years of service.

The Class of 1950 represented the Institute at the end of the first phase of its postwar development: an undergraduate school still, on the threshold of becoming a graduate school, with the outlines of its future development already faintly perceptible.

Craigie was justly proud of his Institute and wanted to tell the world about it. On 27 April 1950 he addressed the graduating class of the Air Tactical School at Tyndall AFB, Florida, emphasizing the importance of education, and technical education in particular:

> All of us in the Air Force today, as well as many outsiders looking in, are impressed by the technical progress of military airpower in the brief time that has elapsed since the close of the war. We have watched jet propulsion come into its own and alter the entire tempo of air warfare in many ways. The lethal power of armament has been increased, to say nothing of the destructive force of bombs. Entire new systems of radio navigation are being perfected to accommodate the faster, higher-flying aircraft. Improvements and refinements in landing systems have been achieved and the sensitive fingers of radar are now more skillfully directed in many ways.
>
> What does all of this mean to you, the young officers of the Air Force? For one thing -- and a quite obvious thing -- it tells you that the managers and administrators of airpower must today be more competently trained than ever before. Many of you have no doubt reasoned that the increasingly complicated air weapon, and the technically advanced related equipment that goes with it, will require an officer corps rich in technical background and geared to high administrative competence, if it is to be properly employed.

> Scientific advances will not stop and wait for men to catch up with them before going on. We cannot afford to let them stop, and if we could afford it, we could rest assured that others elsewhere could and would burn the midnight oil in continued progress. This incessant march of science will surely continue to alter and advance military airpower. Technological progress bids fair to remain a keynote as the future unfolds itself. It follows logically that officers of the Air Force must prepare themselves to match the pace of scientific advancement. This will call for placing a heavy accent on self-improvement and the development of an individual and collective intelligence geared to move in step with the march of science. Tomorrow's leaders will surely be those who today are actively and vigorously interested in the building of such intelligence.

Craigie's speech attracted interest throughout the Air Force. He gave it again to a group of West Pointers who visited the Institute, and addressed a conference of Ohio newspaper people on the same subject. He saw to it that USAFIT had a very prominent exhibit at the Armed Forces Day celebration: a 50-foot graphic and pictorial display of its various educational activities for Air Force officers, housed in a hangar on the Wright Field flight line. Some 185,000 people got a chance to look at it: it was one more way to get the word out about what USAFIT was and what it did.

But his tenure as commandant was ending; he was about to go to Far East Air Forces as Chief of Staff. On 19 June 1950, Maj Gen Grandison Gardner ('27) assumed command of USAFIT.

Gardner was a veteran of the old aviation section of the Signal Corps, which he had joined in 1917. He was no stranger to the school. Not only had he graduated from it; he had been assistant commandant of the old small-scale Engineering School in 1930. Since then he had held a series of positions mostly related to engineering or research; he had been one of the principal figures in the early development of radar in the US. Most recently he had been president of the Air Force Base Development Board.

Less than a week after he arrived, war broke out in Korea.

Project DAWG: Dr Charles Stark Draper and Br Gen Leighton I. Davis examine the analog con puter used in an early attempt at simulation strategic air war.

Lt Gen Benjamin W. Chidlaw ('31

The Electronics Lab, 1950.

"PRESIDENT SIGNS DEGREE GRANTING BILL. . . ."

This time there was no abrupt scattering, as there had been after Pearl Harbor. The USAFIT Class of 1951 left as planned on 8 July for a 12-day tour of West Coast industrial plants and air materiel installations, designed to provide on-the-spot education in engineering and industrial administration problems related to air power. Grandison Gardner and Ezra Kotcher headed the group.

However, some rapid re-planning was going on behind the scenes. On 22 July the Chief of Staff, General Hoyt S. Vandenberg, announced that Air Force higher education was to be cut back, so that additional officers would be available to meet "present operational requirements" -- meaning the Korean emergency, which was particularly grave at that time. Training programs with civilian universities were to be cut back, and the number of officers attending the Colleges of Engineering Sciences and Industrial Administration would be reduced to "a minimum consistent with Air Force requirements in critical technical fields."

Colonel Ernest L. Clough, the assistant commandant, had remained at Wright-Patterson while Gardner took the students to the West Coast. It became his task to announce, on 23 July 1950, the first details of the cut: "Present tentative plans call for a gradual curtailment of student strength to approximately 50 percent of the present level over the next six months."

Gardner's deputy commandant -- recently assigned to USAFIT, to become Gardner's successor when he retired -- was Colonel Leighton I. Davis, a man of long experience in Air Materiel Command, typically in engineering or laboratory assignments. In 1946 he had won the Thurman H. Bane award for his work in developing fire control equipment which, by the time of the Korean war, was standard on jet fighters.

Davis assured the Air Force community that the cutback was only temporary -- that, war or no war, the pace of modern weapons development and technological advancement in all fields bearing on air materiel would not allow the Air Force to slash its educational programs in technical areas. "On the contrary," he said, "we know that transitions and change overs to new advanced equipment will demand that we be ready with a greater number of officers who have had specialized engineering and scientific training."

By early August the decision had already been made to reduce the Class of 1952, which was to enter in September, so that young rated personnel could be channeled into operational duties. But the 50 percent reduction -- it had been further decided at Air University -- would affect only undergraduate and nontechnical groups. The College of Industrial Administration -- or "the business school," as it was informally called, since it had been developing in that direction -- seemed the most feasible place to cut back, since AMC and Air University had other schools where logistics education was provided. Its undergraduate program was reduced almost two-thirds: 22 officers entered in September, while 58 had graduated in August. The graduate program in Industrial Administration planned for September was postponed.

The Engineering Sciences programs were also drastically cut. In August, 80 officers graduated from the undergraduate program and 20 more from the first graduate program. The following month, 26 officers entered the two-year undergraduate course, and 16 enrolled in the graduate program.

Part of the reduction was the planned phase-out of the undergraduate programs. But the cutback in Engineering Sciences was, as Davis had said, temporary; the cutback in Industrial Administration was different. There were no more entries to its undergraduate program.

The College of Engineering Sciences made a comeback in October, when 51 officers enrolled in a special stepped-up program in Electronics. Augmenting the September enrollment, it was a nine-month course at the upper undergraduate level. In it was the son of one of the old Engineering School's most famous graduates: Capt James H. Doolittle, Jr.

USAFIT was reorganized that fall. Instead of two colleges, there was now a single Resident College, mostly Engineering Sciences, though Industrial Administration formed a department. Civilian Institutions became a division of USAFIT; it had some new programs, such as bioradiology and the management of research and development. The Air Installations School became the Installations Engineering School. All this was in preparation for the coming year, when USAFIT was to begin a period of active transition from undergraduate to graduate education.

Gardner left at the beginning of 1951, but not for retirement as he had originally planned. He had written to the Chief of Staff in mid-January, asking Vandenberg's opinion as to whether it would be proper for him to retire during a national emergency. He pointed out that though he was not really needed at USAFIT -- Colonel Davis had been brought in specifically to succeed him -- he still had experience valuable to the Air Force:

> I could save the Air Force many millions of dollars and greatly expedite our construction program by being assigned to supervise construction projects let to the Army Engineers. As you will perhaps remember, I spent a year and a half studying our base development problems during which time I visited all our major bases excepting Iceland. I think perhaps I am the only officer in the Air Force who has seen all our bases. I also prepared a long range construction program but was not in a position to do anything toward its activation. . . .
>
> You may also remember that I originated the existing program for family housing and had the few projects that have since been finished well underway before I left the Directorate of Air Installations almost two years ago.

Within days he had been given a new assignment, rather different from what he expected: command of Tenth Air Force, with headquarters at Selfridge Air Force Base, Michigan.

Colonel Davis took over as commandant on 22 January 1951. The transition period was just getting under way. The pilot graduate program in engineering which had been taught the previous year was now a definitely established program in Advanced Engineering Management, and six more graduate curricula were planned for fall.

Civilian Institutions was also changing. Through it, the Institute was beginning to have more influence on the content and character of courses taught in civilian schools, helping civilian educators build tailored curricula to meet Air Force requirements. Its education-with-industry program was developing along similar lines; it was just completing plans for training officers in guided missiles at the plants of several leading missile producers.

Davis pinned on a star in April. A few weeks later, Ezra Kotcher was recalled to active duty after five years as academic head of the resident programs. He was assigned as Technical Executive at the Aeronautics Division, Wright Air Development Center, with good reason: not only was he a systematic problem solver with extraordinary insight in aerodynamics; he also had so much experience in the management of engineering research that he could get things done which nobody else could.

The Wright Air Development Center was a community of laboratories and test facilities belonging to the Air Research and Development Command (ARDC), which had been created that year out of research, development, and engineering functions which had formerly belonged to AMC. As such, ARDC was the successor of the old Air Service Technical Division at McCook Field and all the intervening organizations, with which the old Engineering School, and later the Institute, had always been closely associated.

From the first, the Institute had a close relationship with ARDC. Graduates of the old Engineering School were scattered through its structure, many in key positions -- Putt, for example was to become deputy commander of ARDC at the beginning of 1952, and subsequently commander -- and they were familiar with the kinds of things the Institute did. The Institute was more than willing to help ARDC. In April 1951 it set up a series of six-week ARDC Indoctrination Courses to bring officers newly assigned to ARDC up-to-date on Air Force engineering research and development. From 1951 onward, a large proportion of USAFIT graduates -- sometimes well over half -- went to ARDC.

This was particularly true of graduate students. Of the eight who graduated in December 1951 from the Advanced Engineering Management Course, six went to ARDC.

This group of eight, in the course of their program, had done something which was a sign of things to come. They had made extensive use of an analog computer which General Davis had developed, to conduct a Dynamic Air War Game (Project DAWG). Throughout the course, they had conducted test games in order to determine DAWG's usefulness in solving strategic air problems.

The age of rapid developments in electrical engineering had already begun. The Institute had

been interested in computer technology at least as early as 1950, when a seminar on large-scale automatic calculating machines was held at USAFIT, to acquaint Wright-Patterson engineers with the principles and uses of the "Mechanical Brain," of which ENIAC was the best-known example. DAWG was based on vacuum tubes, but by 1951 the vacuum tube was beginning to give way to the transistor. The application of computer technology to weapon systems had already begun; General Davis, in fact, had developed the automatic computing gunsights then being used on high-speed jet fighters in Korea.

Davis was behind a reorganization that took place in USAFIT that summer. Manpower was scarce because of the war; two unfilled positions, Director and Educational Advisor, were combined to create the position of Academic Director. This was partly a move to get the accreditation effort under way once more: the position of Academic Director, who would exercise top-level policy control over the entire academic structure of the Institute, was to be filled by an educator of recognized national stature, whose reputation would both attract good faculty and help secure accreditation of the Resident College. Other structural changes went along with this -- most notably, the creation of the position of Assistant for Plans and Programs, to study the long-range aspects of USAFIT's mission and provide better coordination and control for USAFIT's diverse elements.

Five new graduate programs started in September 1951, most of them filling the needs of ARDC -- industrial administration (mostly for AMC), electronics, armament, automatic control, and aeronautical engineering.

The Wright-Patterson Professional Graduate Office -- a program which USAFIT ran through Ohio State University to bring graduate education on an after-hours basis to AMC and ARDC engineers and specialists -- had been going on quietly all this time. That fall it awarded the first doctorate ever granted through a USAFIT program: a Ph.D. in Chemical Engineering, given to Captain James Bierlein of the Wright Air Development Center.

Davis had accomplished a good deal in his few months as Commandant. But he was reassigned that fall -- appropriately, as Director of Armament at Headquarters ARDC. On 1 October 1951, Brig Gen Ralph P. Swofford, Jr. ('36) -- the man who had been the Air Force's first project officer on the F-80, and most recently Chief of Staff, ARDC -- became commandant of USAFIT.

By that time the effort toward accreditation was definitely under way once more. In early September Institute representatives had talked to Dr. Norman Burns, Secretary of the North Central Association of Colleges and Secondary Schools, about getting the Resident College accredited by his organization. In line with Burns' suggestions, on 12 October 1951 Swofford sent the North Central Board of Review a description of the resident programs, for consideration at the Board's October meeting.

The Board pointed out that the USAFIT resident programs lacked an essential element: the inclusion of general education courses in the cur[riculum] study to find out whether, perhaps, its students had taken care of their general education requirements before they came to the Resident College. Yes, it turned out: on the average, they came in with as much general education as was usually required by engineering schools. The Institute sent this information to the Board of Review in December, to be considered when the Board met in March.

This time the ball was really rolling, though not too rapidly yet. What drove it -- besides Swofford's evident determination that USAFIT was going to get accredited and soon -- was a critical shortage of Air Force engineers.

Part of the reason for the shortage was an overall shortage in the number of college-age people. During the depression of the 1930s, the birthrate had declined sharply, so that in the early fifties there were fewer young adults than usual. Another reason was a Bureau of Labor Statistics report, issued a few years earlier, stating that the engineering field was overcrowded; this report had kept many young men from entering engineering studies. Because of the war in Korea, the Armed Forces were getting the bulk of the young graduate engineers coming out of the schools; but even so, the overall engineer shortage was estimated at between 30,000 and 50,000.

To Swofford, it was clear that part of the solution was to send more people through USAFIT, both in residence and in civilian institutions. One way of doing this was to publicize USAFIT and make entry easier for qualified officers. Another way was to make USAFIT itself more attractive by getting it accredited and authorized to grant degrees.

In 1952, therefore, he embarked on a series of initiatives along these lines. A series of articles began to appear in the *Air Force Times* and other publications read widely within the Air Force, publicizing educational slots available at USAFIT and administrative changes designed to draw more officers into the program. The articles also advertised, "USAFIT training -- mostly scientific and technical -- is especially important to the AF at this time because: (1) AF requirements for these specialties are increasing while (2) the supply of new technical personnel is dwindling. (The latter is a nationwide ailment.)"

By early 1953 Swofford was already working to inform past graduates of USAFIT plans and progress, and to publicize alumni accomplishments in order to make USAFIT programs better known both inside and outside the Air Force. The 50th anniversary of powered flight was being celebrated that year; in connection with the Resident College graduation in September 1953, a special Graduation Announcement and Report to Alumni was prepared and distributed to former graduates as well as members of the graduating class. It publicized the achievements of USAFIT alumni, starting with the Class of 1920, in an effort to interest the alumni in USAFIT activities so that they would provide support for the attainment of USAFIT educational objectives.

But the main effort was to do everything possible to get accreditation and degree-granting authority. On 1 March 1952 Dr. Harry P. Hammond, dean emeritus of engineering at Pennsylvania State College, came out of retirement to accept appointment as special consultant to the Commandant. Hammond had 42 years of experience in engineering education, and two years earlier he had headed a panel of civilian technical educators who had done a study for the Department of Defense on science and engineering instruction at the service academies. His role at USAFIT was to study the educational programs of the Institute and recommend desirable changes.

Hammond's report was completed in May 1952. He took note of the critical shortage of engineers and scientists and urged that USAFIT get authority to grant degrees as soon as possible. Accreditation -- normally dependent on authority to grant degrees -- would be the next step. "Lack of such recognition is a serious handicap to the Institute and its graduates," he noted. He called for several improvements: higher salaries for civilian faculty; longer tours of duty for military faculty; new courses and equipment in fields like chemistry, metallurgy, and nuclear engineering; a full-scale curriculum in Industrial Engineering; larger facilities; systematic cooperation in research with the Wright Air Development Center; and -- almost above all -- more students. He recommended a rapid increase in the authorized number of fulltime students, to bring the Resident College a student body of approximately 600, with the expectation of producing 350 graduates a year.

Meanwhile the dialogue with the North Central Association still remained inconclusive. Still concerned about the shortage of general education in the curriculum -- the Association was used to dealing with liberal arts colleges -- the Board of Review had advised against USAFIT's seeking accreditation. The Institute discussed the situation with George Washington University, which had representatives on the National Commission on Accrediting. George Washington's President, Dr. Floyd M. Marvin, expressed a willingness to help; and on 27 June 1952, at a meeting of all national regional accrediting officers, the George Washington representative urged the national associations to include technical institutions like USAFIT in their accreditation sphere.

While this was being worked out, Swofford urged the Commander, Air University to renew action on legislation to allow USAFIT to grant degrees. The Institute had been trying to arrange such legislation since 1946, but to avoid confusion the action had been held up while the proposed Air Force Academy was being considered in Congress. By this time, however, it was clear that the Academy was to be an undergraduate school, while USAFIT was to function primarily at the graduate level: there was no conflict of mission. It was time to get moving again. On 30 June 1952, Swofford sent a draft of proposed legislation to Air University.

A few days earlier, the North Central Association had reconsidered its earlier decision and agreed to send an evaluation committee to USAFIT. The committee had been selected by mid-September, and USAFIT forwarded preliminary information to the committee in late fall. The committee's formal survey of the Institute took place on 11-12 December 1952. Their report came back informally in March 1953, recommending that USAFIT concentrate its efforts on the graduate program rather than seeking authority to grant undergraduate degrees.

The Institute wanted, however, to keep a small undergraduate program to meet the long-range needs of the Air Force. The previous summer, its request for legislation had gone to Headquarters Air Force; legislation had been drafted and approved, and was being coordinated before submission to Congress. The US Office of Education had decided that USAFIT's request was part of a larger problem -- whether government-supported schools should grant degrees -- and so the proposed legislation was still under study in the summer of 1953.

The North Central Association never had officially told the Institute whether the Resident College should make formal application for membership. At its annual meeting in late March, the Association had decided to do what George Washington University had recommended: include colleges whose courses were primarily technical or scientific. In the light of this decision, it was studying the Institute once more; and informal contact between Association and Institute continued, with the Institute keeping them informed of its progress.

USAFIT had been going ahead with as many of Hammond's recommendations as possible. The Institute Faculty Council, which had existed informally since 1946, had been formalized late in 1952, to advise the Dean of the Resident College on matters of educational policy and practice. The joint research program involving USAFIT and the Wright Air Development Center had been put into operation, with faculty and students working on Air Force problems of special interest to the Center. USAFIT's graduate program was increasingly predominant; new programs were being added, and the first large class of graduate-level engineers -- 41 in all -- had received diplomas in August 1952. Responsibility for the Wright-Patterson Graduate Program had been transferred to WADC, after it had produced 81 masters degrees and one doctorate as a USAFIT activity; but USAFIT had set up a special program for doctoral students, through which they would complete course and resident requirements at certain civilian universities and then conduct their research at USAFIT. Moves had even been made toward getting more space, since Building 125 was getting overcrowded. What USAFIT really wanted was a new building.

The Civilian Institutions Program and the Installations Engineering School (as the former Air Installations School was now being called) were making their own quiet progress, unaffected by the struggle for accreditation. Civilian Institutions had developed a far-flung set of programs, ranging from Business Administration at Harvard to large-scale study of languages both familiar and exotic. The Installations Engineering School now included students from other nations, such as Italy, Belgium, Nationalist China, Yugoslavia, and the Philippines. It gave only short courses, but it gave more of them than before. As one of its graduation speakers pointed out, it faced a big job: "Our World War II B-29 bases simply will not accommodate the B-47 and B-52."

The war in Korea settled into an uneasy ceasefire in the summer of 1953. (Craigie, as Vice Commander, FEAF, had been the Air Force representative in some of the early peace talks in Panmunjon, but had long since gone on to Headquarters USAF to be Deputy Chief for the Development of the Air Force.)

The Institute was completing its transition to predominantly graduate-level education in terms of curricula. In September 1953 USAFIT enrolled students in three new graduate programs -- nuclear engineering, air ordnance, and servomechanisms and computers -- in addition to the earlier engineering graduate programs in aeronautical engineering, electronics, automatic control and armament engineering, and the two logistics-oriented graduate programs, industrial administration and engineering administration.

Swofford -- a major general now -- was still pushing for accreditation and degree-granting authority. The accreditation effort, at last, was taking on a hopeful tone: the North Central Association was going ahead with its program of developing criteria for the accreditation of technical and scientific institutions. The draft legislation for degree-granting authority, however, was still under study by what was now the Department of Health, Education, and Welfare (HEW).

On 30 October 1953, HEW called a meeting to discuss the USAFIT legislation in the context of the whole question of federal participation in education and the special problems faced by the Services in offering high-quality graduate work. USAFIT and Air University representatives outlined the Institute's programs and described the status of the accreditation effort and the need for degree-granting authority. HEW decided to form an Ad Hoc Committee of educators to study the whole situation and act as an advisory body to the Commissioner of Education.

The first meeting of the committee was scheduled for mid-December. Early in December its chairman, Dr. Henry A. Armsby, Chief of Engineering for HEW, visited the Institute to get a first-hand look at its operation. He was thoroughly briefed on the Institute's programs and shown its facilities and the Wright Air Development Center laboratories. At his request, USAFIT sent a letter on 10 December to the US Office of Education, outlining the need for degree-granting authority:

> . . . The present Institute of Technology has evolved from the efforts, which began as early as 1919, to supply professional and engineering training so necessary to the development of military aviation. During its 34-year history, the Institute has been in continuous operation with the exception of a brief period in 1927 when the activity was moved, and again during World War II when it was diverted temporarily from its long range mission by the exigencies of war. . . .
>
> The scope and content of engineering education provided for Air Force officers must keep pace with the ever increasing technological complexities of weapons and the mounting importance of science in aerial warfare. The situation is never static and at the present time deficiencies continue to exist in the Air Force scientific and technical personnel categories. The effectiveness of tomorrow's Air Force will be even more dependent upon the professional and technical competence of its personnel.
>
> The USAF Institute of Technology conducts a program of professional education for Air Force officer personnel in the various fields of engineering and related areas of studies in order to meet these urgent requirements. Some of those requirements are met by detailing officers for study at civilian colleges and universities; however, others can be more effectively fulfilled at the Institute's Resident College.
>
> Officers detailed to civilian colleges and universities for advanced study normally receive an appropriate degree upon completion of their program. Similarly, officers detailed to the Institute of Technology deserve and should receive this universally accepted recognition of academic achievement. . . .
>
> In the final analysis, degree granting authority is requested in order that the Air Force may more adequately meet its urgent need for officers professionally trained to a high degree of competence in the fundamentals of science and engineering, and their application on specific Air Force problems.

At the Ad Hoc Committee meeting in Washington on 14-15 December 1953, General Swofford outlined the Institute's reasons and requirements for the degree-granting privilege. He told the Committee,

> Over relatively recent years there has been a significant increase in graduate education. You are familiar with the reasons for this growth and fully appreciate the importance to the services of keeping up with the expanding knowledge in science, engineering, and related fields. It was inevitable that the military services become increasingly involved in graduate education for their officers and natural that they should participate in this education whenever there is a contribution to be made by them. . . .
>
> The combination of the best that can be gained from civilian institutions with the best that can be produced internally is more effective than any single or exclusive educational pattern.
>
> The development of the Institute of Technology over the past thirty-four years, and our future plans for the Air Academy and for the Institute are founded upon a solid background of precedent and are in accord with the policies which have evolved through long experience.

At the end of the conference, the committee submitted its recommendations to HEW. As 1954 opened, the Institute waited anxiously for some sort of news. Informal reports indicated that though the Office of Education felt that degree-granting was primarily a function of civilian institutions, they would not close the door on outstanding federally-supported

schools which had specific and unique education responsibilities. The Institute hoped to see a degree-granting Bill presented to the 83d Congress before it adjourned in midsummer 1954.

When things finally started happening, they moved fast. On 7 July 1954, a New Jersey senator introduced Senate Bill 3712:

> To authorize the Commander, Air University, to confer appropriate degrees upon persons who meet all requirements for those degrees in the Resident College of the United States Air Force Institute of Technology.
>
> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that under regulations prescribed by the Secretary of the Air Force, the Commander, Air University, may, upon accreditation of the United States Air Force Institute of Technology by a nationally recognized accreditation association or authority, confer appropriate degrees upon persons who meet all requirements for those degrees in the Resident College of the United States Air Force Institute of Technology.

It passed both houses and reached President Eisenhower by 31 August 1954. He signed it.

The news flashed immediately to the Institute. "The right to grant degrees will give our graduates the recognition they deserve and help in building the school to make its contribution to scientific and technological development in the Air Force," Swofford told local papers that night. The next day, a handbill given to all the students proclaimed the news in bold headlines: "PRESIDENT SIGNS DEGREE GRANTING BILL FOR USAF INSTITUTE OF TECHNOLOGY."

Only one obstacle remained: accreditation. After the passage of the bill as Public Law 733, the Institute contacted the Engineers Council for Professional Development (ECPD) -- which gave accreditation only to degree-granting schools -- and arranged a meeting with their representatives in November. ECPD told USAFIT that now that the law had been passed, the Institute could move forward to accreditation by them.

Meanwhile, at the suggestion of Dr. Floyd H. Marvin, Secretary-Treasurer of the National Commission on Accreditation -- the George Washington University president who had helped USAFIT before -- a Commission representative visited the Institute from 19-22 October 1954. From this visit emerged an objective study of the status of USAFIT, as recommended by the North Central Association. It recommended that the Resident College make formal inquiry to both ECPD and the North Central Association as to whether they were willing and ready to grant accreditation.

Meanwhile, the Institute invited Trevor Gardner, Assistant Secretary of the Air Force for Research and Development, to speak at its 15 March 1955 graduation. Secretary Gardner alluded to the increased importance of guided missile technology in the national strategy:

> The future of the Air Force and perhaps the survival of this nation rest on the ability of men like yourselves to develop and produce weapon systems of such superior quality that no aggressor nation will dare risk the consequences of our retaliatory striking power. . . .
>
> One of the areas of research and development having the highest priority in Air Force planning is that concerned with the development of guided missiles. This is not to say that the era of the manned airplane in warfare is over. It is to say that the era of the unmanned missile in warfare is very much at hand.

The man whose name was almost synonymous with the development of the ballistic missile program had been a first lieutenant in the six-man class of 1941. His name was Bernard Schriever.

In 1953, while USAFIT was fighting for accreditation in order to provide the Air Force with more technically qualified officers, a few high-level officials in Washington had been contemplating the significance of a great advance in atomic development: the thermonuclear breakthrough. What it meant was that high-yield hydrogen bombs could soon be built small enough to become the warheads of missiles. A new era in warfare was imminent.

Trevor Gardner had been one of the few who knew. He had established the Teapot Committee, composed of ten leading scientists whose task was to

evaluate the feasibility and practicality of developing an intercontinental ballistic missile (ICBM) weapon system. They said it could be done.

Gardner decided to set up a project to develop an ICBM. Logically, it would come under the Air Research and Development Command, of which Lt Gen Donald L. Putt was commander in early 1954. Putt knew the right man for the job: a colonel who had worked for him a few years earlier and who, even then, had urged the development of an ICBM and other advanced weapon systems, and who was eminently qualified to serve as what Gardner termed "vice-president in charge of getting things done."

Thus, in June 1954, Bernard Schriever was appointed a brigadier general and Assistant to the Commander, Air Research and Development Command. Two months later he also assumed command of ARDC's Western Development Division, with responsibility for the highest-priority project the Air Force had.

The Western Development Division -- later renamed the Air Force Ballistic Missile Division -- was in Inglewood, California. In the months that followed, Schriever and a hand-picked staff toiled around the clock there, in the closest secrecy -- they wore only civilian clothes, they met in a small building which had formerly been a chapel.

But the project itself, as it developed, was the greatest concentration of men, money, and material ever assembled. Ballistic Missile Division expenditures for the first five years quadrupled the money spent on the Manhattan Project that developed the atomic bomb.

The original plan was to develop one intercontinental ballistic missile (ICBM), the Atlas. Then Schriever discovered that for 10 percent more in overall cost, a second missile could be put together out of the "backup" subsystems -- the alternate technical approaches to each system which were being developed by separate contractors in case a primary system failed to meet the schedule. Schriever had these backup systems realigned as a second ICBM, the Titan; the extra 10 percent was for the Titan airframe.

This second ICBM was possible because of the "concept of concurrency," for which Schriever was mainly responsible: the concept of developing all phases of the program on parallel tracks and simultaneous time schedules. This meant that airframe, propulsion system, guidance system, and the rest -- not to mention the backups -- were being built by different corporations all over the country. The task of coordinating it all was enormous. As Colonel Otto Glasser ('47), project officer for the Atlas, explained it, all the systems had to be compatible with each other: "Compromise of each element is the answer. But this compromise or adjustment would not be feasible should the program be segmented and fragmented through a series of offices. This is only possible when you have an integrated systems-engineering technical-direction group which has all the pieces under its control."

This concept was, in fact, a modification of the Cook-Craigie System developed by Larsen's students somewhat earlier. Six students from that Special Management class had been assigned to Schriever's project and took the concept with them. (The original concept was used in the procurement of the F-102, F-106, and B-58.)

Schriever's contribution to the program was managerial above all. Somehow he made the whole complex system work. Flight tests for the Atlas began in 1957, and the first full-range flight of over 6,000 miles took place on 28 November 1958. The Titan first flew on 6 February 1959. By September 1959 the Atlas was fully operational.

All this was still under wraps on that spring day in 1955 when Trevor Gardner addressed the graduating class. He told them only that the Atlas and other ICBMs were under accelerated development. It was still the era of the small missile, like the air-to-air Falcon whose existence he announced to them that day.

The battle for accreditation was about to be won at last. On 18-19 April 1955 an ECPD Inspection Committee visited the Institute to make a careful study of the undergraduate curricula in electrical engineering and aeronautical engineering. On 14 October 1955, the ECPD granted accreditation for both these curricula.

Swofford was able to announce on 26 October, "Since the ECPD is the only nationally recognized accrediting authority in engineering, this accreditation of the Resident College curricula by them fully meets the requirement of Public Law 733, 83d Congress for conferral of appropriate graduate and undergraduate degrees in engineering to graduates of the resident programs. . . ."

In the years since he had become commandant, the Institute had seen other changes. The position of Academic Director, vacant since its creation, had been filled by an eminent educator, Dr. Roy A. Seaton, Dean Emeritus of the School of Engineering and Architecture of Kansas State College. The Institute now had detachments at Yale, Syracuse University, Indiana University, and the Army Language School. Civilian Institutions had picked up yet another role: preparing instructors for the new Air Force Academy headed by Lt Gen Hubert R. Harmon ('25). Civilians from AMC had taken courses in the Resident College for the first time. Plans had been approved (but not funded yet) for new buildings for the Institute. A USAFIT Alumni Association had been formed.

Another name change had also occurred. On 1 September 1955 USAFIT had been redesignated Institute of Technology, USAF (ITUSAF).

Names, at this period of the Institute's history, came and went rather rapidly. ITUSAF lasted less than a year. The Institute became Air Force Institute of Technology (AFIT) for the first time on 16 April 1956, and kept this name for just over three years.

A more significant development, started by Swofford but continued by others, involved logistics education within the Institute. The Department of Industrial Administration had moved more and more in the direction of a business school -- so much so that in October 1955 the Institute began efforts to get its graduate programs in industrial administration accredited by the American Association of Collegiate Schools of Business.

Meanwhile other developments had been taking place at Air Materiel Command. Chidlaw ('31) had been commander of AMC for not quite two years, as a lieutenant general; but in August 1951 he had acquired a fourth star and gone to take over Air Defense Command from Ennis Whitehead ('26). Gen Edwin W. Rawlings now headed Air Materiel Command.

In 1954, after a series of conversations with his principal deputies and other Air Force officials about the improvement of logistics support, General Rawlings had concluded that he needed some form of graduate-level education dedicated to logistics -- not just business -- for the AMC people who were making logistics decisions and forming logistics policy. He asked Lt Gen Laurence S. Kuter, the Air University commander, what could be done.

Kuter and Swofford were quite prepared to take the project on. USAFIT worked with the staff at Headquarters AMC to develop a proposal for a program in high-level Air Force logistics. The program, at graduate level, was to combine a study of industrial management with study and research of current and proposed Air Force logistics problems. It would be offered to senior officers assigned to high-level logistics positions.

In February 1955 the Institute was authorized to establish an experimental six-month Advanced Logistics course that would include research in logistics problem areas and instruction in logistical concepts. The Institute negotiated a contract with the Ohio State University Research Foundation to develop the course and provide academic support for it. The course, known as the Logistics Education and Research Project (LERP), was launched with 24 students on 10 October 1955.

Swofford left almost immediately afterward -- on 1 November 1955 -- to become Director, Research and Development at Headquarters Air Force. His successor was Maj Gen Julius K. Lacey, recently back from an assignment as Deputy Chief of Staff for Plans, FEAF. Lacey had been in meteorology for much of his early career; his MIT thesis on "Icing of Aircraft" had been hailed as the first successful attempt to tie together theory and fact in that field. He had, at various times, surveyed possible locations for air bases in Greenland, commanded a Flying Fortress group in England, and served as Senior Member, United Nations Military Armistice Commission in Korea.

Lacey was so enthusiastic about the LERP that most people thought he had established it. The program itself was a tremendous success. It started as a six-month course for lieutenant colonels, majors and high-level AMC civilians, taught by outstanding professors from nearby colleges and universities and guest lecturers from business and industry. This first class, just 24 people, graduated on 27 April 1956. For the second class the curriculum was expanded to nine months, and a short-course program got under way about the same time. AFIT launched a program to get maximum publicity for the LERP within the Air Force logistics structure -- letters, an article in *Armed Forces Management* magazine, a brochure on the mission and objectives of the course, briefings on logistics theory at various major commands.

That same spring, AFIT gave its first degrees at last: twenty-two master of science degrees, to electrical engineering and nuclear engineering students, on 13 March 1956.

Building a "Space Age Campus"

The same month, the Board of Visitors set a major change in motion. They recommended that AFIT establish separate schools for engineering and business -- a plan the Institute had been considering for some time. Lacey went ahead with it and, in July 1956, reorganized the Resident Instruction Division (as the Resident College had come to be called) into the School of Engineering and the School of Business, each headed by a dean.

The problem of buildings was becoming critical, especially since the Installations Engineering School was about to extend its 21-week course to nine months to provide more time for management subjects. At the first annual conference of the USAFIT Alumni Association on 23 June, Lacey stressed the Institute's need for a new building and laboratory facilities and urged alumni to support the building program. He had been urging the same thing at Headquarters USAF. But there were still people in the Office of the Secretary of Defense who did not feel that the Air Force should be conducting 'schools of higher education' in the first place (despite the fact that civilian institutions were already full to overflowing, especially in their limited facilities for scientific and technical education); and they deleted the new building from the list of projects being considered. It was too late anyway to prevent the physical separation of part of the Institute from the rest of it. The Installations Engineering School had started months earlier to transfer its faculty and staff to Building 288, Area A -- on the other side of the sprawling base.

Lacey went on trying to get his building. By the spring of 1957 he had at least convinced the Air Force. On 11 May the Air Force's Deputy Director for Personnel Procurement and Training, Brig Gen Cecil E. Combs, told Congress that AFIT needed "adequate and modern facilities" and they ought to be funded.

Combs explained how the Air Force had arrived at this conclusion. The Chief of Staff, Gen Nathan F. Twining, had established a special board, headed by General Rawlings of AMC, to study aspects of Air Force educational programs. One of its recommendations had been better facilities for AFIT.

Combs stressed the importance of the board's findings because of the shortage of engineers in the United States and the progress of scientific training in the Soviet Union.

The same serious note was sounded a few weeks later, when Maj Gen Mark E. Bradley, Jr. ('38), Assistant Deputy Chief of Staff for Material, addressed graduates of the Advanced Logistics Course and the Advanced Installations Engineering Course. Bradley reminded the graduates how much had happened since his own days as a student at the Engineering School: at that time, the Army had considered the Air Corps little more than a tool for aerial observation -- not even a complete substitute for cavalry reconnaissance; now air power was the first line of defense for the free world. He mentioned the introduction of the B-52 into active units, the development of whole families of missiles, the growing sophistication of electronic devices and controls. "But we must still push the state-of-the-art across the board," he told them, "toward the development and production of still higher performing air vehicles. Directly associated with this is the concurrent demand for accurate programming of both installations and logistics support."

He also made a curiously prophetic comment: "I do not truly believe we are any farther, in a relative way, from space travel today than the world was from world-wide travel in 1457 when Columbus was a boy."

No one guessed that day how soon it would start to happen. None of the group sitting in front of Bradley was to travel in space. But the previous year, a young officer named Virgil ("Gus") Grissom had gotten a diploma in aero-mechanics from the School of Engineering.

Lacey, however, was not going to be at AFIT to see the startling verification of Bradley's prophecy. He was retiring. Early in September 1957 his successor arrived to take command: Brig Gen Cecil E. Combs, the same who had urged Congress to fund new facilities for the Institute.

Combs was a Texas man and a West Pointer. He had won his wings in 1937 and flown some of the first operational B-17s. In 1941 he had been given command of the 93d Bomb Squadron -- B-17s -- and

had taken it to the Philippines in late October, just weeks before the outbreak of the war. On 8 December 1941 he had led his squadron in the first US bombing mission of the war, against the Japanese landings at Vigan, north of Clark Field. Later, he had commanded his squadron and later the 19th Bomb Group from bases in the Philippines, Australia, and Java. In the course of the war he had served in such diverse places as India, Egypt, and the Marianas, where he was deputy commander of a B-29 group in August 1945.

Afterward he had had various assignments in the US and Caribbean; for awhile he had been Deputy Chief of Plans Division at Headquarters USAF. In 1953 he had been selected to organize and command the USAF Officer Military Schools at Lackland Air Force Base, Texas. He had been in education and training ever since.

He arrived at AFIT at a crucial time. As early as the beginning of 1956, there had been concern at the Institute and elsewhere that US educational facilities were unable -- or at least indisposed -- to provide the right kind of education, on the right scale, to equip the nation for the protracted, global competition that seemed likely to engage the national energies for years to come. A particularly critical aspect of this was the shortage of students and facilities for the scientific, engineering and related fields. The Civilian Institutions Division had been having trouble finding qualified students for engineering and science programs, particularly at the undergraduate level; even so, the schools were having difficulty in finding room for all the qualified students who did apply. Combs himself had pointed out the shortage of US engineers and the progress of scientific education in the USSR when he spoke to the Congress. But no one had taken any major action as yet.

Then, on 4 October 1957 -- less than a month after Combs had taken command of AFIT -- the world learned that Russian scientists had just orbited a small satellite. Sputnik I -- a metal sphere with four aerials and a radio transmitter -- was swinging around the earth every 96 minutes, its bleeps advertising the fact that, somehow, a country most people considered technologically backward had launched into the space age ahead of the United States.

The same day, Brig Gen John W. Carpenter III, assistant vice commander of ARDC, wrote to General Combs, "The Air Research and Development Command is presently in the process of developing a long-range plan. . . . One of [our] committees, the Guided Missiles and Space Vehicle Long Range Planning Committee, recognized that a separation exists in the technological fields pertaining to flight in the atmosphere as opposed to flight outside the atmosphere. They concluded that there was a need for a new 'breed' of scientists equipped to cope with the problems of advanced flight in this new medium. He asked Combs whether he was interested in helping to explore the problem.

Combs wrote back, "As I see the mission of the Institute, we should have a very keen interest in this problem and from here on out I would like very much to be kept in touch with it, in order that we might participate and contribute in every way possible."

Lt Gen Dean C. Strother, commander of Air University, also knew about the problem. AU representatives attended a conference on the educational requirements for advanced flight technology at Headquarters ARDC on 20 December 1957. Afterwards he wrote to Putt, who was Deputy Chief of Staff, Development, at Headquarters USAF, requesting a meeting of senior people concerned with technical and scientific education programs, at which Strother and Combs could present the highlights of what AFIT could do.

The conference took place at AFIT on 24 January 1958. Putt could not come, but sent Swofford -- now a major general -- as one of the Headquarters Air Force representatives. ARDC and AMC were also represented.

Combs and other key AFIT people made their presentations, to show what AFIT could provide in residence and in civilian institutions. Carpenter and other ARDC representatives explained that they were still trying to determine what was needed: this was a matter of projecting ten or fifteen years into the future.

Swofford told them not to worry about that just now. For psychological and moral reasons the Air Force needed to get started on such a program immediately, on a fundamentally sound basis even if the numbers were small. He felt that Air University was the place to start -- and the astronautics program which AFIT was proposing looked as if it might be the right thing.

AFIT wanted to start immediately: establish individual courses in astronautics at once, for students

presently enrolled, and get full-fledged astronautics programs going both at the School of Engineering and in civilian institutions.

Headquarters Air Force gave them the go-ahead. The Institute embarked on a period of frenzied activity aimed at achieving US space power. A masters-level astronautics program was developed, with courses scheduled to begin in July at MIT and in September at the School of Engineering; its aim was to provide officers with a basic knowledge essential for the analysis and synthesis of vehicles functioning in the extreme limits of the earth's atmosphere and levels of space beyond. Courses in scientific Russian were introduced. The Civilian Institutions Division arranged for training-with-industry courses in Management of Air Force Aeronautics and Space Vehicles. Maj Alexander P. de Seversky, nationally known authority on airpower, came to the Institute to deliver a lecture titled "Air Power is Space Power." Maj Gen Bernard A. Schriever, commander of the Air Force Ballistic Missile Division, came to speak at the Institute's graduation of 18 March 1958. "The military must take the lead in developing the space age," Schriever told them. "We must have qualitative superiority. . . . Our response has been too slow to the state-of-the art advances." In an interview afterward, he told the press that the Air Force had had a military satellite program in progress for some time and that he knew when the first Air Force satellite was to be launched. He had to know: the space program was very closely integrated with the ballistic missile program.

The first American satellite, Explorer I, had already gone up, on 31 January 1958. The Soviets still dominated the space scene, but Schriever did not expect that to continue. He alluded to a recent statement of the Secretary of Defense, suggesting that the Air Force might be given the job of putting a man into space.

Some of his listeners thought he was referring to the X-15 research plane as the space vehicle. The X-15, a winged aircraft used for extremely high-speed experimentation, was designed to provide data on material and human factors involved in space exploration. It was not yet ready to fly, but people were already being picked to attend the test pilot school -- among them Capt Robert A. Rushworth ('54), who was selected that year.

Schriever's missile program was going full-steam in 1958. The intermediate-range Thor was being delivered to bases in England. The Atlas program was ahead of schedule; the Titan was too; and yet another missile, the solid-fueled Minuteman, was under accelerated development.

All this affected not just engineering research and development, but management, logistics, and installations engineering. AMC had pointed out its special needs at the conference in January, and AFIT had not been neglecting those other phases of its mission. The School of Business finally got its accreditation from the American Association of Collegiate Schools of Business that spring, so that the Institute could now grant the degree of Master of Business Administration. The Logistics Education and Research Project (LERP) -- comprising an Advanced Logistics Course and a Logistics Research Program -- was in the process of becoming a centralized and integrated logistics education program. In August 1958 it was redesignated the School of Logistics, to be located in Building 288, Area A.

AFIT was still having no luck with its construction program. In the fall of 1958 the School of Business was also moving away from the headquarters and School of Engineering -- also to Area A, Building 1455, a "blockhouse" building just vacated by an Air Defense Command division.

But the astronautics program started on schedule -- in July at MIT, in September at the School of Engineering. One of the students who entered in September was Capt Donn F. Eisele, who ten years later would take part in the first Apollo test flight. He and his classmates graduated on 31 August 1960, with some of the first Master of Science degrees in astronautics ever awarded to anybody.

On 23 October 1958, the Air Force's vice chief of staff, Gen Curtis LeMay, sent a letter to all major commanders encouraging maximum support for AFIT. He asked commanders to interview all officers who qualified for AFIT programs and encourage them to apply. LeMay's letter was given wide publicity; the Air Force hoped to get at least 5000 applications, from which about 1500 officers would be selected for AFIT programs. The letter was effective; applications went up.

An Air Force Educational Requirements Board was also established in late 1958, to become active the following year. Its purpose was to identify and

describe current and future educational requirements for Air Force officers.

In December 1958 the first moves were made toward establishing an Airman Education and Commissioning Program (AECP) for career-minded airmen who had already done some college work. They were to complete degrees in fields like meteorology, geodesy, nuclear physics, and engineering through AFIT programs, then go to Lackland for officer training school.

The first year after Sputnik I had thus seen some dramatic changes at AFIT and a lessening of the financial austerity the Institute had been subject to. AFIT -- or IT, as it was redesignated as of 1 July 1959, in an Air University effort to streamline school names -- now had five major elements: the School of Engineering, the School of Logistics, the School of Business, the Civil Engineering Center (as the Installations Engineering School had come to be called), and Civilian Institution Programs. It was no longer all-male: it had "gone co-ed," as the local papers termed it, in September 1958, with the enrollment of Lt Col Mary J. Strong in the School of Business (though actually there had been women in the civilian institution programs for years). But the Institute was still trying to get more students: the goal of 1500 entries had not been realized. And it was scattered all over a large base, in buildings that were grossly inadequate. The Congress's latest reaction to the Institute's appeal for new buildings had been to suggest that maybe it should move to some installation where there was more room, like Moffet Field, California. The Institute had gone through a lengthy study of alternative sites and had been left with the old conclusion: the research facilities it had to have were at Wright-Patterson.

Combs wanted his new buildings. Even the last Board of Visitors had taken exception to the dispersal of buildings, which in some cases were miles apart, and called for the construction of permanent quarters. So in 1959 he launched another attempt to get adequate facilities for the Institute.

This time the Institute tried a different approach: an effort to mobilize popular opinion. On 8 February 1959 the *Dayton Daily News* carried a full-page display headed "Space Age Campus," publicizing the Institute's mission and accomplishments. The stories also dramatized the Institute's need for facilities, in both pictures and words: "It's like Studying in a Factory -- Noisy, Crowded, Too Hot or Cold"; "Library Overflows into Hallway"; "Small Offices Make Private Counseling Difficult." One article also gave recognition to the efforts of Representative Paul Schenck, of Dayton, who for years had been trying to help the Institute get funding for modernization, and who planned to try again.

The publicity effort continued all year; the Institute even got approval for the production of a thirty-minute color film. But again the Institute's request for construction funds was turned down.

Worse was about to happen. On 23 December 1959, Headquarters Air Force prepared a letter to Lt Gen Walter E. Todd, the AU commander, telling him that a House Appropriations Committee investigation of the Institute's program in May 1959 and subsequent hearings had led the committee to a conclusion: the School of Business was not necessary. Civilian institutions were able and willing to conduct business education programs for the Air Force, for less money. Considering this information and the Air Force's critical manpower situation, the headquarters had decided to phase out the School of Business and transfer its programs to civilian institutions. No more enrollments into the School of Business were to take place.

This letter was delayed in the holiday mail. The Institute found out what had happened when the dean of the School of Business saw an article, "AFIT Business Courses Shift to Civilian Schools," in the *Air Force Times* on 6 January 1960.

Todd requested [that] Headquarters Air Force reconsider its decision, but told Combs to go ahead with planning for the phase-out. Combs himself talked to the Secretary of the Air Force and other high officials, pointing out that the School of Business was a fully accredited school which trained students in specific Air Force operations not covered in civilian schools. But on 10 February Todd had to notify Combs that the final decision had been made. The resident School of Business was doomed.

Twenty-five students were supposed to enter the School of Business in February 1960; some of them were already en-route. The Civilian Institutions Division stepped in to contact and divert them and find other schools for them to go to. Because of the unusually fine working relationship the Division had with the universities, a series of phone calls resulted in the placement of all 25 students. The next entries were scheduled for fall, so the Division had time to

arrange the rest of the phase-out with less disruption.

The trouble was not over, however. The Institute was still working to get its color film produced. On 20 June 1960, Headquarters USAF told the Institute to defer the film project until yet another question had been resolved. An ad hoc committee at the Headquarters was determining whether it was feasible and desirable to transfer the School of Engineering to the Air Force Academy and dispose of the remaining elements of the Institute.

This announcement caused less immediate consternation than the news of the closure of the School of Business. Rumors of possible dismemberment of the Institute had been current for years, and nothing had happened. The ad hoc committee had even inspected the Institute's buildings at the end of May and then gone out to the Academy to compare facilities. Everyone had assumed this was just one more exercise, like the earlier proposal to move the Institute to a base with more room. It took a little time for them to realize that this time the people at Headquarters were serious.

Combs had been named a member of the committee. He and the Air University representatives were strongly against the dismemberment of the Institute; the other four members of the committee were for it.

On 18 August 1960 the committee met at Headquarters Air Force to present both positions to the Air Force Council for a final decision.

A Headquarters representative spoke first, presenting the majority position. He reminded the Council that the Institute's facilities were inadequate; the funds had been dropped from the budget again, and the Air Force was apparently never going to be able to get money for new Institute buildings. The Academy, on the other hand, had excellent new facilities and a qualified military faculty. Why not simply establish a graduate engineering program at the Academy, close the present School of Engineering, and conduct its programs at civilian institutions, as had been done with the School of Business? The School of Logistics could be assigned to AMC, and the Civil Engineering Center to Air Training Command; the Civilian Institutions Division could remain part of Air University.

Combs then presented the minority position. The facilities were serviceable at least: the Institute did operate in them and did turn out competent graduates. And to meet the rapidly changing and unforeseeable needs of the Air Force, only a resident School of Engineering could guarantee the necessary flexibility and responsiveness. There was no reason why the Academy could not develop a graduate program if it wanted to; but its educational mission and environment were completely unsuited to the Institute's operation. And the ARDC laboratories were at Wright-Patterson. The Institute should be there too -- the School of Engineering in particular.

He cited evidence: the limited capacity of civilian engineering schools; the fact that the Institute currently produced over two percent of the nation's engineers, and over fifty percent of the nation's graduates in certain special fields; the close collaboration between the Institute and ARDC. The results of years of arduous development should not be thrown away. Air Force support of the Institute -- now and in the future -- would buy flexibility, the means of rapid response to Air Force educational needs, and continuing educational productivity.

So forceful and convincing were Combs' remarks, and so conclusive the evidence he presented, that the Air Force Council decided in favor of the Institute. In summing up the situation, General LeMay stated that it was his conviction that "the Air Force could not do without the kind of specialized engineering graduates that the Institute produces, and that this capacity will probably be of increasing importance in the future."

They decided not only to keep the Institute at Wright-Patterson, but to support it strongly in its need for funds for new construction and all other resources it required to do a first-rate job.

An important victory had been won. It proved to be the beginning of a general upturn in the fortunes of the Institute.

Already, some significant developments had taken place. On 1 April 1960 the Institute's long effort to gain accreditation from the regional association had paid off: the North Central Association sent the Institute official notice of accreditation for the School of Engineering -- a step on which the renewal of ECPD accreditation largely depended. The Institute's Civil Engineering Center was growing in importance; Air Force civil engineers now had responsibility for the research, design, and development of facilities for advanced weapon systems. A recent Board of Visitors had commented that though

the Center's instruction was not offered for college credit, much of the classroom work would have done credit to any engineering school.

In October 1960 the Air Force began to talk about doubling the number of officers taking scientific and engineering courses. Combs told the Air Force Educational Requirements Board he thought it could be done; most of it would have to be handled through civilian colleges, but room could be found for about 30 more students in the resident programs, which currently had 367 enrolled.

Rumors of major expansion -- which would have to mean better facilities -- continued into the spring of 1961, when Secretary of the Air Force Eugene M. Zuckert explained a recent Air Force reorganization to a Dayton-area congressional delegation. The Air Material Command had been renamed Air Force Logistics Command (AFLC) and had lost some procurement functions to ARDC, which in turn had been renamed Air Force Systems Command (AFSC); however, Zuckert had said, activities at the base would remain at a high level. He had commented, "The Air Force is keenly aware of the excellent in-house research capability which is part of the Dayton complex. While this is not its only in-house capability, it is the largest and most varied. The Air Force has no intention of losing it, moving it, or allowing it to go unused."

To his hearers -- including Ohio Senator Frank J. Lausche -- this sounded as if the Air Force intended a major build-up of the Institute of Technology.

The major development that year, however, centered on the School of Logistics. In May the Institute announced plans to extend the Advanced Logistics Courses from nine to twelve months to allow the addition of quantitative courses. Research data processing and simulation were becoming more important to the effectiveness of Air Force logistics. The Institute now ran all phases of the Logistics school, though some of the teaching was still done under contract by Ohio State University faculty. In July the School was given responsibility for all Department of Defense training in contract administration.

That summer the effort to get new buildings began once more. The Institute explored the possibility of relocating into better existing facilities at Wright-Patterson, but concluded that remodeling would be difficult and expensive. It was a fallback position at best; the main effort should go into getting new construction.

Gen Bernard A. Schriever, now Commander, Air Force Systems Command, visited Dayton in September. Calling the Institute "the key to the future of the Air Force," he made a strong pitch for community support of the Institute's effort to get modern buildings. Air Force representatives had already met with Dayton community leaders to discuss the possibility of private financing. "I haven't given up on Congress entirely," Schriever said; "but I feel every possible avenue must be explored."

He mentioned a large figure: $15 million, which would cover not only a proposed classroom building for the School of Engineering, but a full-scale campus complex suitable for 1500 students, with library, auditorium, administration building, and the like. "We feel that AFIT should continue to be located here in Dayton," he said. He pointed out that the need for competent technical officers was many times greater than when he had graduated in 1941, and called AFIT "a major factor in national survival."

Dayton was in no position to raise $15 million just then: it was in the middle of a fund-raising drive for its local universities. But Daytonians were willing to support the program by trying to convince Congress of the urgent need for the expansion of the Institute. The Ohio congressional delegation, for example, could play a more active role than in the past.

The Air Force had not even asked for AFIT funds at the last session, and in December 1961 the Institute learned that its request had again been deleted from the fiscal year 1963 military construction program. But after Schriever's speech the Ohio delegation became interested in the problem. Representative Paul Schenck had been presenting the Institute's case for years and expressed hopes of finally getting the funds. Senator Lausche visited the Institute in October and toured the rickety main building, which had been intended as a temporary structure almost twenty years earlier. During the tour, a sign caught his eye: "Danger! Roof work here. No loitering." On inquiry, he learned that a few days earlier, a workman on the flimsy original roof had fallen halfway through into the room below. The roof was now being replaced, but falling plaster and similar debris were a daily hazard. Laboratories and classrooms were extremely crowded; the library was jammed and small; the electronic data-processing room lacked the

stability and air control essential to best operation. Lausche promised to do what he could to help.

Early in January 1962 he announced that he would seek an amendment to the general military authorization bill, to provide $4 million for new facilities for the Institute, even though the Office of the Secretary of Defense had not included the item in its budget request. On 26 February he took the problem to the floor of the Senate, at the start of a long climb to get the expenditure authorized -- the old authorization had expired -- and the money appropriated. He read to the Senate portions of an article just written by retired Air Force Maj Gen Edward P. Mechling, which alluded to the "rundown, barnlike building" which served as the main facility for the school which provided "the background of the Air Force technical manpower program."

It was going to be an uphill fight. The Department of Defense did not have to spend the money even if it was appropriated; they had killed the project that way once before. In March Congressman Schenck added his efforts to Lausche's by urging the House Armed Services Committee to include AFIT funds in the budget. On 15 March the House Armed Services Committee approved almost $4.5 million for the modernization of the Institute.

The next step was the Senate. On 30 March the Senate Armed Services Committee heard testimony from Maj Gen Augustus M. Minton, director of Air Force Civil Engineering, in support of the new building. On 2 April Senator Lausche and General Combs both appeared before the Committee. Lausche made an urgent plea for the inclusion of the funds in the 1963 military construction bill. Combs described Institute programs, telling the Committee that AFIT was helping to close the scientific and engineering gap in the Air Force.

There was a bottleneck at the moment: the Kennedy administration was making an overall study of in-service educational facilities, and nothing could really be done until it was completed. That was why the Department of Defense had not asked for the money earlier. But on 18 May 1962, Pentagon officials publicly announced that the study had ended in AFIT's favor. The Department of Defense had asked Congress to consider AFIT construction plans just as if they had been included in the military construction bill.

This meant that if Congress appropriated the money, AFIT would get its building.

By this time the House had passed the bill authorizing funds for military construction, with the AFIT amendment in it; Schenck and his Ohio colleague, Representative Clarence J. Brown, had succeeded there. They were now working to get a similar amendment to the military construction appropriations bill, which would actually provide the money. This bill was before the House Appropriations Committee; this was the committee which, on 9 May, had been asked by the Department of Defense to consider the AFIT construction.

On 14 June 1962 the Senate Armed Services Committee included a $4 million authorization for AFIT construction in the authorization bill -- less than Lausche wanted and the House had allowed, but a sum that could still build a suitable building. On 21 June, in a voice vote, the Senate passed the authorization bill. After it had been reviewed by both houses, President John F. Kennedy signed it on 28 July 1962.

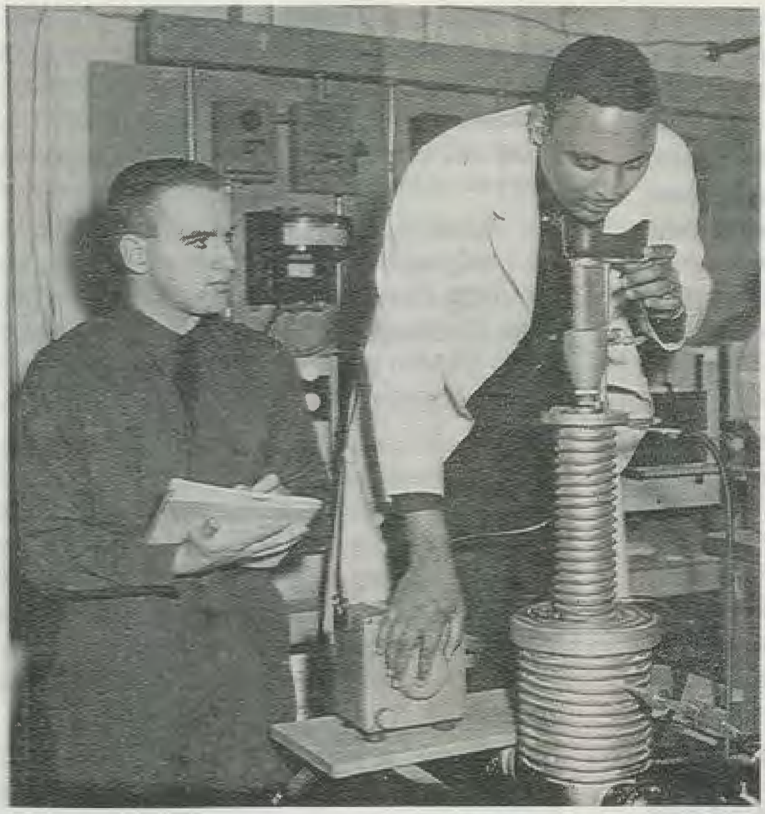
The appropriations bill still hung in the balance. General Combs and other friends of AFIT appeared before the Appropriations Committee. The Bill passed the House on 14 August, with $4 million for AFIT construction included. The Senate passed it on 25 September, and President Kennedy signed it before the end of the month.

AFIT lost no time in getting under way. Bids were opened in early November and a contract awarded at the end of the month. On 18 December 1962 ground was broken for the new school of Engineering building, with General Curtis LeMay, Chief of Staff, as guest of honor. Some eighty distinguished guests, including Congressman Schenck, were present; Schenck himself took shovel in hand for the actual groundbreaking, as did Combs and LeMay.

LeMay addressed the gathering. He reviewed the history of the Institute from its days as the Air Force School of Application, forty-three years earlier; described what it was that day and would be; and ended on a note of hope for the future: "As we break ground for this new school, all of us hope that from its graduates will come much of the sage counsel and many of the technological advances which will keep our nation strong. This will go far to maintain the canopy under which free men may continue to seek the way to a true and just peace."

Groundbreaking, 18 December 1962.

Gen Bernard A. Schriever ('41).



Thermodynamics experiment, 1964.

Astronaut L. Gordon Cooper, Jr. ('56), with Mercury spacecraft model.

The Air Force Enters Space

While Combs was fighting to save the Institute and get a decent roof over its head, some of its earlier graduates had been closely involved with US efforts in space. The X-15 research plane, which had been under development at the time of Schriever's graduation address in 1958, had made its first powered flight in September 1959. In all tests, the X-15 was carried aloft by a B-52 and released at about 45,000 feet. Its rocket engine fired for two minutes or less; the remaining ten minutes or so of flight were powerless, ending in a glide landing on a dry lake bed.

Maj Robert A. Rushworth ('54), the man who flew the X-15 on more flights than anyone else, flew it for the first time on 4 November 1960. In the course of his 34 X-15 flights, he achieved several "firsts" and set several records. On 27 June 1963 he piloted the aircraft to a peak altitude of 285,000 feet, thereby qualifying as an astronaut. On 5 December 1973 he set the unofficial speed record for the unmodified X-15 -- 6.06 Mach.

"The only sensation you get flying at that speed and altitude is the strangeness of g-forces or the lack of g-forces," he noted later. "During launch the g-forces build up to four times g [gravity] on your chest, forcing you into the seat at the end of propellant burn out. . . . Then you go into zero gravity trajectory." Through test flights like those Rushworth flew, US scientists learned much about how conditions like weightlessness would affect human beings and materials; the X-15 program contributed significantly to the Mercury, Gemini, and Apollo projects.

The program went on through most of the sixties. Another alumnus of AFIT, Maj William J. Knight ('58), flew the X-15 to an unofficial world speed record of 4,520 miles per hour in August 1966. He too earned an astronaut rating in the X-15 by attaining altitudes above 50 miles.

But the eyes of the world were not on test flights at Edwards, but on what was happening elsewhere in the space program. As early as March 1958, Jimmy Doolittle ('23) had confidently predicted that a whole sequence of events in space would occur before the end of the century: a rocket would go to the moon; scientific instruments would be landed on the moon; a manned satellite would go around the earth and return; men would make a trip around the moon and return; a man would be landed on the moon and brought back; a space platform would be established; instruments would be landed on Mars or Venus; and a man or men would be landed on Mars or Venus and return. He had commented, "The eight or ten things I have enumerated can be done. I am satisfied that before the end of the century -- and maybe long before the end of the century -- they will be done."

When Doolittle made his prediction, the US had just sent up its first satellite, Explorer 1. But that year the United States reorganized its whole space program. The National Aeronautics and Space Administration (NASA) came into being, taking over the research centers of the old NACA. The space race was on.

Manned spaceflight was already in the plans. On 9 April 1959 the government announced the names of what came to be called the Original Seven: the first Americans selected to attempt space flight. Three were Air Force pilots; of these, two -- Capt Leroy G. ("Gordon") Cooper ('56) and Capt Virgil I. ("Gus") Grissom ('56) -- were graduates of the Institute.

There was much local excitement, especially over Grissom, who was a fighter test pilot at the Wright Air Development Center (WADC). A native of Mitchell, Indiana, he had begun flying as a World War II air cadet, but the war ended before he could complete the program. He had flown 100 F-86 combat missions in Korea. After studying aeronautical engineering at AFIT, he had begun his test pilot career.

The Original Seven went off to Langley Air Force Base, Virginia to start training. The space gap was beginning to close. By the spring of 1961, three of the Original Seven -- Grissom was one -- had been chosen to complete the rigorous final phases of training for Project Mercury's first space shot.

The Soviets were still ahead -- though not so far, any more. On 12 April 1961 Maj Yuri Gagarin, of the Soviet Air Force, became the first human being to travel in space, making a single orbit of the earth. Less than a month later, on 5 May 1961, US astronaut Alan Shepard made a suborbital flight in a small Mercury capsule called "Freedom 7."

The US could not yet manage orbital flight; the Redstone rockets it was using at Cape Canaveral were just not powerful enough. But the nation planned to change all that -- and more. On 5 May 1961, before a Joint session of Congress, President Kennedy announced "I believe this nation should commit itself

to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to Earth. No single space project will be more impressive to mankind, or more important for the long-range exploration of space, and none will be so difficult or so expensive to accomplish."

Much yet needed to be learned through the one-man Project Mercury flights. Virgil Grissom made the next one; on 21 July 1961 he became the second American in space, making a suborbital flight in the capsule "Liberty Bell."

The next requirement, however, had to be more powerful rockets. The research rockets developed by Wernher von Braun and his team at Redstone Arsenal were set aside in favor of Schriever's big ICBM rockets. US scientists modified an Atlas ICBM and, on 20 February 1962, used it to put the Mercury capsule "Friendship 7" into orbit. The first American in orbit, Maj John Glenn of the Marine Corps, circled the earth three times in just under five hours.

Three more Mercury flights followed within little more than a year. In the last of the series, on 15-16 May 1963, astronaut Gordon Cooper made the longest American orbital flight so far, lasting over 34 hours.

Already, in September 1962, NASA had released the names of a second group of astronauts, nine this time, for the Gemini program. Three of the four Air Force members had studied in AFIT civilian institution programs: Frank Borman ('57), James ("Jim") McDivitt ('59), and Edward White ('59).

Neil Armstrong, one of the two civilians among the nine, was coming from another advanced project in which AFIT was represented: *Dyna-Soar*. In September 1961, Schriever had described the Dyna-Soar program as the most advanced manned aerospace research system the Air Force had: a manned space glider intended to re-enter the earth's atmosphere under control of a pilot who would land it at a conventional air base. "The Dyna-Soar will look and act like an airplane," Schriever had told a Dayton group, "in contrast to the ballistic reentry of the Discoverer and Mercury capsules. Furthermore, it will be reusable after normal servicing." It would be boosted into orbital flight by a Titan rocket.

Boeing was the system contractor for the manned orbital space glider. But Ezra Kotcher was working on the solution of Dyna-Soar problems at Wright-Patterson; and two former AFIT students -- Capt William J. Knight ('58) and Maj James W. Wood ('56) -- were assigned to the program as pilot-engineer consultants. Wood was chief of the Manned Spacecraft Center at Edwards Air Force Base, where much of the Dyna-Soar work was being done.

Project Gemini -- a series of flights by two-man spacecraft launched by Schriever's Titan II -- got off to a good start on 23 March 1965. Maj Virgil Grissom ('56) had been named as pilot of Gemini 3, with Navy Lt Cmdr John Young as co-pilot. Grissom thus became the first American to make two flights into space -- though this one was to be something very different from his fifteen-minute suborbital flight in 1961. For months before his selection was announced, he had had the task of coordinating all Gemini developments with members of the space team; he had been delighted to learn that he had been chosen for the first crew.

Grissom and Young lifted off as scheduled aboard their spacecraft, nicknamed the "Molly Brown" in the expectation that it would prove "unsinkable," unlike Grissom's "Liberty Bell" which had sunk to the bottom of the Atlantic and left him to swim for his life during recovery operations. This was a cautious test flight of the new system, with only three orbits and a five-hour flight plan.

But Grissom had time to change orbits three times by firing the thrusters -- an important test, essential for the rendezvous flights planned for later in the program.

The Gemini 4 crew, Jim McDivitt and Ed White, were both AFIT graduates -- the first, but not the last, all-AFIT team. On 3 June 1965 they lifted off for a four-day flight. Four hours after lift-off, Ed White became the first American to walk in space. He found the experience so enthralling that McDivitt and Mission Control had to urge him to get back into the spacecraft on schedule.

Gordon Cooper ('56) teamed up with Navy Lt Cmdr Pete Conrad for Gemini 5, 21-29 August 1965. This was the longest flight yet attempted -- eight days in a tiny cockpit, mostly devoted to medical and technical experiments. At the end of it, Cooper had more space time than any other man -- over 226 hours.

This flight paved the way for Gemini 6 and Gemini 7, which were to rendezvous with each other in space. Gemini 7 actually took off first, on 4 December 1965, with Frank Borman ('57) and Jim

Lovell as crew. It was to be a fourteen-day flight, with two main purposes: to prove that weightlessness was endurable for the length of a lunar voyage (eight days) and to conduct the rendezvous.

On 15 December, eight days after the Gemini 7 takeoff, Gemini 6 was launched with Wally Schirra and Tom Stafford as crew. After a four-orbit chase, they pulled up alongside Gemini 7 and flew in formation with it for five hours. Then Gemini 6 pulled away, returning to earth on 16 December. Borman and Lovell stayed up for two more days.

No docking had taken place during this rendezvous flight. That was scheduled for Gemini 8.

NASA had meanwhile selected yet another group of astronauts, fourteen this time. Seven were Air Force. Of these, six were graduates of AFIT programs, either in residence or in civilian institutions: Capt William A. Anders ('62), Capt Charles A. Bassett ('60), Capt Michael Collins ('64), Capt Donn F. Eisele ('60), Capt David R. Scott ('62), and Maj Edwin E. ("Buzz") Aldrin, Jr. ('63). This younger Aldrin, in fact, was the son of the then-1st Lt Edwin Aldrin, Sr., who had organized the Air School of Application back in 1919 and graduated in its first class. Besides the Air Force group, there was Navy Lt Roger E. Chaffee, who was working on a masters degree in Reliability Engineering at AFIT's School of Engineering when he was notified of his selection. He had had to leave in January 1964 for the astronaut training center in Houston and continue his studies correspondence-style.

Dave Scott ('62) was the first of the fourteen to fly, with Neil Armstrong on Gemini 8. Their main task was to dock in orbit with an unmanned Agena target satellite. They launched on 16 March 1966, found the Agena, and docked. But half an hour after the two spacecraft had come together, the crew noticed unplanned yaw and roll movements developing. Something was wrong. Armstrong undocked from the Agena, and suddenly the Gemini began to spin and then tumble: apparently a thruster was stuck open. They shut down the maneuvering system; but they were already drifting, much too near the Agena. The only thing to do was return to earth. They came down safely, though in the Pacific rather than the Atlantic area they had planned on.

Gemini 9 flew 3-6 June 1966, crewed by Tom Stafford and Navy Lt Eugene A. Cernan. It featured rendezvous with the Agena -- no docking, because of an Agena malfunction -- and a space walk by Cernan.

Recovery of Gemini 4, with astronauts James A. McDivitt ('59) and Edward White ('59) on board.

Mike Collins ('64) and John Young flew Gemini 10 on 18-21 July 1966. On this flight they docked smoothly with their Agena and used, for the first time, the extra power the Agena was intended to provide. They also rendezvoused with the Gemini 8 Agena; and Mike Collins, in a space walk, went over to the older Agena and retrieved an experimental package.

Gemini 11 and 12 -- on 12-15 September and 11-15 November 1966 -- also involved rendezvous, docking, and space walk. Lovell piloted the final Gemini, with Aldrin ('63) as co-pilot. During this flight, Aldrin spent five and a half hours outside the spacecraft, testing various devices designed to make space walking easier.

Projects Mercury and Gemini had been a vast success. The credit for it belonged, of course, not only to the astronauts themselves, but to vast numbers of people on the ground -- people like Lt Col Charles J. Gandy, Jr. ('62), who was launch vehicle operations officer for Mercury; Capt Robert M. Silva ('62), who pioneered the development of a manual space guidance device; and Capt Ernest P. Hanavan, Jr. ('64), who, in the Aerospace Medical Research Laboratories at Wright-Patterson, worked to develop space maneuvering units and other devices for weightless flight. Because of the work of people like these, NASA was already preparing for Project Apollo, in which the objective was the moon.

Years of Expansion

Meanwhile, the Institute was moving steadily ahead. On 1 January 1962 it had become AFIT once more -- apparently because people had steadily refused to call it IT, except with humorous intent. (A favorite journalistic ploy of the IT era had been to play games with the acronym; as one *Air Force Times* journalist put it, "It -- IT, that is -- made for some weird reading in regs.")

On 21 February 1962, addressing the National Rocket Club while astronaut John Glenn was making his second orbit around the earth, General Schriever stated that AFIT should be expanded to include a systems management school. The Air Force could no longer afford, he said, to let its officers and civil servants learn advanced management techniques through trial and error. AFIT already had a good logistics school; management courses would be a logical extension.

"I am going to push very hard for this management school," Schriever said. "It will probably take a year to set up."

It took less than that. The idea of providing managerial as well as technical education at AFIT found immediate favor; as a Dayton newspaper put it, "Imagine a merger of MIT and the Harvard Business School, and you can get an inkling of the strength a beefed-up AFIT could build into the Air Force." In September 1962 AFIT began a 12-week System Program Office Management course, designed to provide advanced management training for AFSC's System Program Office (SPO) personnel. Half of this experimental program was provided by Ohio State, the other half by military and civilian members of AFSC, including general officers in charge of systems vital to the AFSC mission. Among them was Schriever, who addressed the first management class on "The Man in Systems Management." At the close of 1962, Air University redesignated the logistics school as the School of Systems and Logistics, effective February 1963, giving formal recognition to the expanded mission of the school.

Another major AFIT program got underway in 1962 -- the Minuteman On-Site Program. Late in 1961 the Strategic Air Command (SAC) had been considering ways to maintain the morale of the Minuteman ICBM missile crews who would soon be sitting at control consoles forty feet underground in the wilderness of central Montana, where the first Minuteman complex was nearing completion. How could SAC get alert, responsible officers to stand by in the Minuteman control stations, with nothing to do but wait for the firing signal everyone hoped would never come? One answer was to offer them an incentive: the chance to study for a graduate degree. This solution would also help the Air Force increase its educational level without taking people away from active duty.

SAC approached AFIT about the idea. General Combs, a former SAC officer himself, was enthusiastic. By April 1962 the idea had become a decision:

Astronaut Ed White ('59) in the first American space walk

In search of knowledge: With book in hand, a student approaches Building 125.

AFIT would start the first program, leading to a masters degree in aerospace engineering, at Malmstrom Air Force Base near Great Falls, Montana. On 30 July 1962, AFIT's Detachment No. 5 came into existence at Malmstrom. Minuteman education programs at Whiteman Air Force Base, Missouri; Minot Air Force Base, North Dakota; Ellsworth Air Force Base, South Dakota; and Frances E. Warren Air Force Base, Wyoming soon followed.

The School of Engineering was given initial responsibility for monitoring the Malmstrom program. It had other new programs too, some of them directly related to what was going on in NASA. The Graduate Space Facilities program had grown out of Civil Engineering Center research on the engineering problems of sustained operations in free space and on the lunar surface. The researchers concluded that AFIT needed a graduate program aimed at these problems. AFSC and NASA agreed, and the curriculum in Space Facilities Engineering began in September 1962. Simultaneously, a Graduate Space Physics program got underway, designed to develop competence in dealing with engineering physics problems peculiar to space.

Since the School of Systems and Logistics was still seeking accreditation, the School of Engineering also took responsibility in early 1963 for developing and implementing a full-scale Graduate Systems Management program. Designed to provide a broad background in management, economics, and allied disciplines for technically-oriented officers, the program got underway in September 1963.

A few months earlier, on 16 March 1963, the North Central Association had voted to grant accreditation to the graduate logistics program of the School of Systems and Logistics. On 3 June 1963, AFIT granted its first Master of Science in Logistics Management degrees to the students whose curriculum had been accredited. The first official Graduate Logistics class began a few days later with 19 students -- a diversified group, as was typical of the School: mostly Air Force, but with two Army officers, one Naval officer, and one Department of the Air Force civilian.

At the beginning of 1964, Combs must have considered AFIT's situation very promising. The new School of Engineering building was almost completed. The School of Systems and Logistics was accredited. A study begun the preceding year, on the feasibility of extending the resident academic program through the doctoral level, had led to the conclusion that a doctoral program in aerospace engineering was not only possible but highly desirable; a faculty committee was already preparing a plan for such a program, and the new Air University commander -- Lt Gen Ralph P. Swofford, Jr. ('36), as of 1 January 1964 -- seemed likely to approve it. AFIT was about to acquire a major new research facility: the Air Force Nuclear Engineering Test Facility -- nearing completion, but without a mission since the cancellation of a research program centering on nuclear-powered aircraft -- was to be assigned to AFIT as soon as all tests were complete, for use in education and research. Research, as a whole, was becoming a major part of AFIT's mission; on 9 February 1964 Dr. William L. Lehmann, longtime head of the physics department, assumed the role of Assistant Dean for Research within the School of Engineering. This deanship had been created for two reasons: to provide a focal point for the exchange of information among Air Force agencies regarding their research needs and AFIT's capabilities for research, and to encourage faculty members to carry on productive research that would further the Air Force mission.

Then came news that Combs had been selected for extended temporary duty with the United Nations Command in Korea, as Senior Member of the Military Armistice Commission at Panmunjon.

The duty of Senior Member of the Military Armistice Commission had been rotated among the services ever since the Korean armistice. The selection of the AFIT commandant was of course an honor both for Combs and for the Institute; but it also meant that he would be away for six months, while several important projects were in suspense, including the completion and dedication of his longtime goal, the new Engineering building.

Fortunately he had someone reliable to leave in charge: AFIT's recently appointed deputy commandant, Col John A. McCann. McCann had served in a series of intelligence and air transport operations assignments in India, Burma, and China during World War II; after the war he had re-entered civilian life. Recalled to duty at the outbreak of the Korean War, he had served as a group commander and then as executive officer of a troop carrier wing. He had stayed on active duty ever since. After service in the War Plans Office, United States Air Forces Europe (USAFE), and as Chief of Intelligence Plans, US

European Command, he had joined the faculty of the Air War College. He had been deputy commandant at the Air War College for two years before coming to AFIT in September 1963. He was the man responsible for the development of the Air War College seminar program.

On 21 April 1964 Colonel McCann assumed command of the Institute, while Combs headed for the Pacific. Combs arrived in Korea on 26 April and took over as Senior Member of the Military Armistice Commission on 1 May.

He had never been in North Asia before or dealt directly with the Communists. A major problem confronted him at once: negotiating the release of two American captains who had strayed across the demarcation line in a helicopter a year before.

Since that time, his predecessors had tried almost every conceivable approach to get the two helicopter pilots back, most recently an exchange of letters between the commander-in-chief, United Nations Command, and the supreme commander of the other side. Following up on the letters, Combs requested and got a private meeting with the Senior Member on the other side, who promised to restudy the question of the two pilots. A week later, the North Korean Senior Member requested another private meeting, and, after much haranguing, announced that the North Koreans had decided to return the pilots. Twenty-four hours later, the helicopter pilots were back on the UN side of the border.

Combs did not credit his own persuasiveness for the return of the two pilots; he felt that the North Koreans had realized that they had gotten all the mileage they could out of the helicopter incident. But securing the release of the pilots -- who, despite North Korean charges of spying, had been flying an unarmed aircraft without even a camera -- was one of the high points in a bizarre summer of trading polite insults with his North Korean opposite number.

Meanwhile, under McCann's guidance, things were going smoothly at AFIT. In mid-August things were even going smoothly in Korea, so that Combs was able to break away long enough to come back for the dedication of the Engineering building.

On the afternoon of 28 August 1964 a distinguished company gathered at the new Building 640. The Secretary of the Air Force, Eugene M. Zuckert, was speaker for the occasion; there were some 200 other distinguished guests, including congressional representatives, educational leaders, senior military officers, and local dignitaries.

Zuckert began by reading a congratulatory letter from President Lyndon B. Johnson. In it Johnson alluded to the doctoral program, which had been approved at Headquarters USAF on 13 August: "The establishment of a doctoral level program in the aerospace sciences, announced today by Secretary Zuckert, will expand and strengthen the important role of the Air Force Institute of Technology in our nation's defense program."

Zuckert then spoke of the significance of this new building: "It is a symbol of the coming of age of the Air Force Institute of Technology, as the first permanent structure that the Institute has had since its beginning as the Air School of Application in 1919. It can also be regarded as a vote of confidence in the mission and future of the Air Force Institute of Technology, and it certainly embodies in a very real sense the spirit of mutual esteem and cooperation that has always existed between the Air Force and the people of Dayton . . . the birthplace of man's wings. . . . Finally, this building is a tangible recognition of the place of education in the defense of our country, and the significance of the Air Force Institute of Technology to the future of the Air Force and to the nation." He spoke briefly of AFIT's mission "to provide selected Air Force officers with the scientific, technological, managerial, or engineering skills that are necessary to the acquisition, management, and operation of the extraordinarily complex aerospace weapon systems that are in the inventory today, or that we plan for the future" -- "a very difficult and a very complex mission when contrasted with the mission of only twenty years ago, when air power existed in a tight little conceptual world, with its outermost limits set at the speed of sound. . . . The AFIT mission is of fundamental importance to the Air Force, and we should recognize that the money that goes to support it is not in any valid sense an expense, but an investment."

Combs took his distinguished guests on a tour of the new building. Its split-level design was impressively modern, with outside walls of pre-cast stone panels and large areas of glass. The east wing contained laboratories; the center wing held the technical reference area, where modern information retrieval devices supplemented the bookshelves; the three-story west wing, on the slope of the hill, contained offices, classrooms, and the Institute's subcritical

nuclear reactor. The building had already begun to be used; students and faculty had been moving in since spring, while the final construction was being done.

Combs could not stay long to contemplate this impressive result of his efforts. He already knew that he had to return immediately to Korea: the North Koreans were claiming a violation of their airspace. Within a few days of the dedication, he was back in Panmunjon, arguing with his opposite number over questions like the return of South Korean fishermen who had been blown to North Korean shores by a late summer typhoon.

He returned on 25 November to resume command of AFIT, while Colonel McCann became Vice Commandant once more. Considerable progress had been made since Combs' departure in April, in addition to the new building and the approval of the doctoral program. AFIT had acquired a new element: the Defense Weapon System Management Center (DWSMC), created at Headquarters USAF on 10 March 1964 and transferred to AFIT in early July. The mission of the DWSMC was to provide education for managers of major weapon programs and to perform research and development of weapon systems management concepts, doctrines, and techniques. Since the DWSMC had to share a computer with the School of Systems and Logistics, a musical-chairs rearrangement had taken place. The School of Engineering had moved into Building 640; the Civil Engineering Center had moved into the vacated space in Building 125; and the DWSMC had moved into Civil Engineering's old space in Building 288, Area A, alongside the School of Systems and Logistics. The DWSMC began its first twelve-week Senior Managers Course in late September.

Looking back over the last years, Combs must have felt justifiable pride in the accomplishments of the Institute. Other people certainly thought AFIT had done an outstanding job. In early March 1965 AFIT received the Air Force Outstanding Unit award for 1963-64. The Air Force was recognizing the Institute, as the citation put it, for its "dynamic programs of the highest quality," noting that AFIT had "achieved stature unprecedented in Air Force education by establishing and maintaining standards which have been clearly recognized by military agencies using its graduates and by civilian agencies accrediting its programs." The citation also alluded to AFIT's "singular and pioneering contributions to the Air Force and to the nation in scientific research, and in special studies and projects related to the fields of logistics, management, and career development."

The award was a fitting conclusion to Combs' long tenure as commandant. He was about to retire -- at least from the Air Force, though not from the education business. The University of Rochester was awaiting his arrival as Associate Provost. But he found time to make one more addition to AFIT: the establishment of a Programs Division in February 1965. Several AFIT Plans elements had gone in and out of business over the years; but this one was to stay on, through several name changes and expansions of mission, to become the Educational Plans and Operations Directorate still forging ahead in the late seventies.

Two final milestones marked the closing months of Combs' tenure: the AFIT Nuclear Engineering Test Facility, the Air Force's only research reactor, achieved its first nuclear chain reaction on 5 April 1965; and AFIT's doctoral program was granted preliminary accreditation by the North Central Association on 5 August.

On 31 August 1965, after eight years of leadership, Combs stepped down as commandant. Maj Gen Victor R. Haugen assumed command.

Haugen, a native of British Columbia, had joined the Army Air Corps as a flying cadet in 1934. During the late thirties and for most of World War II, he had worked in aircraft development, from early flight testing of rotary wing aircraft to monitoring the development of light and medium bombers. Late in the war he had flown B-24s in the New Guinea-Borneo-Philippines area. Later he had returned to research and development, with a series of assignments at Headquarters USAF and in ARDC. But he came to AFIT directly from Germany, where he had spent three years as chief of the Military Assistance Advisory Group in Bonn. There, he had helped develop US-German cooperative programs to build up the recently reconstituted German Armed Forces and make both US and German forces more effective. Common concepts [like] tactics, joint logistics supply systems, and standardization of equipment had been among his recent concerns.

His arrival coincided closely with an entirely different and rapidly growing requirement for a whole new kind of logistics. The situation in Southeast Asia was heating up. A year earlier, on 2 August 1964, an American destroyer patrolling in the Tonkin Gulf had

been attacked by three North Vietnamese torpedo boats. The destroyer had driven them off, but President Johnson had ordered retaliatory strikes against gunboats and certain supporting facilities in North Vietnam. In an atmosphere of urgency, Congress had passed a resolution to promote the maintenance of international peace and security in Southeast Asia.

No one, at the time, had expected anything more than a continuation of the guerrilla warfare that had been going on in Southeast Asia for decades. The US had military advisors in Vietnam in some numbers, but Johnson did not intend to commit American troops there.

In 1965 Johnson came to the painful conclusion that he had to, that there was no other way for an independent South Vietnam to survive. After Communist attacks on an American stronghold in South Vietnam that spring, he had invoked a policy of sustained reprisal against North Vietnam. Air strikes by US planes rose to levels comparable to those of World War II. By the end of 1965, the US had 184,000 troops in Vietnam; and another 200,000 went in 1966.

These events had an enormous impact on the whole concept of logistics. As an AFIT historian put in mid-1966:

> The waging of widespread counterguerrilla warfare in Southeast Asia under the most difficult circumstances has made for a host of logistical problems that do not lend themselves to conventional solutions. Response to this current challenge has resulted in the development of unusual procedures for the determination of logistical requirements, the replenishment of fighting forces in remote areas, and the maintenance of complex weapon systems far removed from supporting depots. Climate, terrain, and the nature of the conflict have compounded these problems. The human need is not only for competence in the ordinary sense, but also for a corps of logisticians who are imaginative and creative in devising new procedures, who are practical in their approach to emergencies, and who are able to apply scientific methods in the practice of their profession.

The School of Systems and Logistics responded with an ongoing adjustment of its curricula to meet the demands of change. The other schools responded similarly. But the war was affecting the Institute in wider ways: suddenly there were far more people who needed to be educated, not only beginners but experienced people whose earlier education had been outpaced by the rate of change. At the same time, AFIT operations expanded to an international scale.

Foreign students had been coming to AFIT for decades, and every now and then an AFIT course had been presented somewhere else. The first major overseas expedition had taken place in the spring of 1965, when three members of the Logistics faculty had presented five weeks' worth of logistics courses in Korea to key members of the Republic of Korea Air Force (ROKAF). The trip had been extremely successful -- the AFIT team was credited with greatly improving the entire ROKAF logistical system -- and inaugurated a series of similar ventures, known as the School of Systems and Logistics International Program.

Faced with a wartime workload, the Logistics school reorganized itself to improve operational efficiency: a directorate for graduate education, another for continuing education, and a third for curriculum review. Continuing education was the fastest-growing area: the increasing complexity of logistics and the growing sophistication of logistical methods had led to greater demands from the field for job-oriented short courses. The School taught some of these courses in residence, but the size of the resident program was limited by available living quarters and teaching space. And there were literally thousands of military logisticians who, for one reason or another, were unable to attend a resident course anyway. In early 1965 the Logistics school had created a Department of Nonresident Studies to provide courses of two types: on-site courses in the continental US and at American bases overseas; and job-oriented presentations and seminars offered at foreign installations as part of the Military Assistance Program. By mid-1966 the School had greatly expanded its overseas operations; Logistics faculty had taken courses to Hawaii, Japan, France, Germany, Taiwan, the Philippines, Turkey, and Australia.

The Civil Engineering Center was also dramatically affected by wartime demands. The RED HORSE squadrons -- Rapid Engineer Deployment, Heavy Operational Repair Squadrons, Engineering --

had been created to meet operational civil engineering needs in the combat zone. At the request of Headquarters, Tactical Air Command (TAC), the Center devised special courses to familiarize RED HORSE squadron members with such things as the kinds of soils they were likely to encounter during construction in Southeast Asia. Civil Engineering faculty were also caught up in the need to carry instruction to civil engineers overseas. In 1964, at the request of US Air Forces, Europe (USAFE), they had offered the Center's first overseas course in Europe. The following year they expanded the program, offering courses in Germany, England, Turkey, Crete, Hawaii, and Thailand.

The School of Engineering was not immediately drawn into this rapid expansion. Since it was primarily a graduate school, its operations were less ruffled by what was happening in the field. Its major concerns revolved around the new doctoral program and new research facilities, especially the Nuclear Engineering Test Facility, which had a domed white building of its own, down the western slope of the Area B hill. All the preliminary testing of the nuclear facility was complete; AFIT had accepted operational control and safety responsibility in November 1965, and a two-year development program was under way. Not only AFIT, but the entire Department of Defense research and development community was making use of the facility for research in everything from biomedical studies to solid-state electronics.

But the School of Engineering too was soon drawn into the business of continuing education. A faculty committee was formed in August 1966 to design a short course for the purpose of updating Air Force scientists and engineers. The course was first offered in April 1967 to participants from five Wright-Patterson laboratories and the Los Angeles-based Space Systems Division; it was a great success and the beginning of a regular continuing education program.

The resident programs in all schools were still going strong, despite the war. The Air Force needed people with advanced degrees, especially in engineering, so badly that instead of cutting back on AFIT programs, it was making a concerted effort to keep the classrooms full. Even people who had not asked for AFIT education but seemed eligible were being offered the chance to study at AFIT and urged to accept.

Haugen's tenure as commandant was running out, as he approached retirement after 33 years of service. On 1 November 1967 Maj Gen Ernest A. Pinson assumed command of the Institute.

Pinson was no stranger to Wright-Patterson. He had started his career as a civilian scientist in the Aeromedical Laboratory at Wright Field in 1939. In November 1942, he had received a direct commission as a first lieutenant. For five more years he had stayed on at Wright Field, where he was instrumental in the development of oxygen equipment, electrically heated flight clothing, cold weather survival gear, and several other items of flight equipment.

His entire career had been spent in research and development. He had become well known for his personal participation in research projects that involved risks to the experimenter; as a military scientist, he operated on the principle that the proper person to test a hypothesis that might prove fatal was the person who had originated the hypothesis. He had, for example, been the first to demonstrate that it was feasible to fly through nuclear clouds within minutes after detonation -- this in 1955-56, when the Air Force was not even sure what dangers lurked in nuclear clouds for aircraft passing through them. He came to AFIT from the Office of Aerospace Research in Washington, where he had been commander.

By the time of Pinson's arrival, the Institute was ever more heavily committed to support of the US effort in Southeast Asia. In the summer of 1966, the School of Systems and Logistics had extended its overseas operations to Vietnam, offering Military Assistance Program courses at Ton Son Nhut, Bien Hoa, Nha Trang, and Da Nang -- the first courses of their kind ever presented by the Air Force under combat conditions. In early 1967, one of its faculty had made a two-week survey of South Vietnam to find out what Vietnamese Air Force supply and maintenance procedures were and to develop a program for further logistics education courses. The Civil Engineering Center was busy preparing young officers, mostly second lieutenants, for assignment to RED HORSE units in Southeast Asia; it had started taking such classes on a field trip to Eglin Air Force Base, Florida, where RED HORSE enlisted personnel were being trained. Members of the Civil Engineering faculty served temporary duty tours in Southeast Asia, solving problems in areas like construction and the modification of electrical distribution systems. Both schools were involved in Project CORONA HAR-

VEST, an Air Force project designed to evaluate the effectiveness of airpower in Southeast Asia; the Logistics school's role was to identify logistics lessons learned in Vietnam, while the Civil Engineering Center documented the role of civil engineering in the logistics support of airpower in Southeast Asia.

Many of the Institute's past graduates had now been to Southeast Asia, seen combat service, and returned to research and development assignments. Capt James L. Klaus, for instance, had earned a masters degree at AFIT, then gone to Southeast Asia as a forward air controller; after earning a Silver Star, a Distinguished Flying Cross, and numerous other decorations, he had returned to Wright-Patterson for an assignment in the Aeronautical Systems Division (ASD). Maj John M. Clark had had a similar experience: after earning a masters degree at AFIT and serving in two research and development assignments, he had gone to Southeast Asia as an A-1E pilot with the First Air Commando Squadron, then come back for an assignment in ASD. Klaus and Clark were among the first representatives of a new generation which combined scientific and technical education with combat experience.

By this time, much of AFIT's resident population consisted of officers recently returned from Southeast Asia. It was not unusual for the commandant to present well over a hundred military decorations to faculty and students at a single awards ceremony -- Distinguished Flying Crosses, Bronze Stars, Air Medals, and the like.

Those who had not been to Southeast Asia yet were likely to go soon. About a third of the Engineering class that graduated in June 1968 was scheduled for duty in Southeast Asia. Their graduation speaker, Lt Gen John W. Carpenter III, commander of Air University, reminded them that this was not unfitting: a combat assignment would add to their understanding of how technology could be applied to improve their country's ability to fight.

The School of Engineering, as a matter of fact, was much more deeply committed to support of the war effort than it might have seemed to a casual observer. Carpenter's point had been well made. Additionally, there was its research mission. Dr. Lehmann was no longer Assistant Dean for Research -- he had left for a higher-level assignment -- but his place had been taken by Dr. Janusz S. Przemieniecki, well known in research and development circles for his theoretical and design work on the supersonic transport Concorde. Since April 1966 he had been managing the school's research across a broad spectrum. There was of course the Nuclear Engineering Center (as the test facility had been called since April 1968), but there was also a lot more. Some of it was futuristic, like laser research and studies related to the exploration of space; but some of it had immediate applicability, like a design for a counterinsurgency aircraft.

The Civilian Institutions Division had not been uninvolved either. In addition to its usual programs in everything from engineering to medicine, it was developing a new program for foreign area specialists -- essential to the intelligence field, among others -- and unraveling administrative problems like how to arrange area clearances for students planning field studies in South Vietnam and Thailand.

Meanwhile, because of the pace of development in all scientific fields, the number of people to be educated seemed to be getting larger instead of smaller. To keep up with the demands for both graduate and continuing education, AFIT was turning more and more to advanced educational techniques. The School of Systems and Logistics had been exploring the use of simulation since 1966, to teach its students what was in the automated logistics management systems and allow them, in the safety of the classroom, to see what would happen if certain policy changes were made. The School had also developed extensive plans for the use of computer assisted instruction and other management science techniques in the classroom. The Defense Weapon Systems Management Center (DWSMC) was also using computer-supported exercises in its curricula, including a simulation of the entire life-cycle of a fictitious weapon system, from concept through deployment. All the schools were involved in Project INNOVATE, an advanced development program concerned with new educational methods and techniques, and Project CREATE, a joint AFIT/AFLC effort to obtain, install, operate, and manage state-of-the-art computer support for educational use.

Gen Mark E. Bradley ('38).

The Aldrins, father and son, with General and Mrs. Haugen at the 47th Anniversary celebration.

The School of Engineering.

To the Moon

Meanwhile, the space program had been going ahead. Project Apollo, which aimed at placing a man on the moon before the end of the sixties, had been scheduled to make its first test flight in February 1967. Three former AFIT students -- Virgil Grissom, Ed White, and Roger Chaffee -- had been selected to make an earth-orbital journey of fourteen days, a shakedown test of the Apollo moon ship.

Instead, there was tragedy. On 27 January 1967, just weeks before the scheduled launch, a flash fire swept through the command module where the three astronauts were making a final systems test. All three were killed.

The whole nation, particularly Dayton and the Cape Kennedy community where the three had been well known, mourned the passing of the three astronauts. But Project Apollo was to go on -- though not yet, since everything possible had to be done to prevent the recurrence of anything like the tragedy of Apollo 1.

It took twenty extremely busy months of investigation and redesign. All combustible material in the command modules had to be replaced with nonflammables -- even personal gear like pressure suits and food bags. The side hatch was redesigned to allow swift egress. Numerous other changes were made. But finally, on 11 October 1968, Apollo 7 was ready for the first test flight of the new system.

Even the launch vehicle was new: the vast three-stage Saturn developed by Wernher von Braun and his team. The whole system was longer than a football field and involved over nine million parts. But everything worked, and the three astronauts -- Wally Schirra, Donn Eisele ('60), and Walt Cunningham -- piloted Apollo 7 into a perfect earth orbit.

They stayed up eleven days, giving all the new space hardware a thorough test. The splashdown on 22 October occurred within a mile of the predicted landing point.

Two months later the second manned flight, Apollo 8, was ready to go. This one was a major undertaking, for NASA and for the crew, Frank Borman ('57), William A. Anders ('62), and Jim Lovell. Not only was it the first mission for the biggest Saturn of them all, Saturn V -- it was to be the first time men ventured beyond earth's gravity. They were going to circle the moon.

On 21 December 1968 Apollo 8 lifted off. After orbiting the earth for almost three hours while the crew made one final check of vital equipment, the astronauts reignited the third-stage Saturn V engine for translunar injection: the burst of power that would propel them beyond the earth's gravitational field. Mike Collins ('64), as capsule communicator -- the astronauts' spokesman within Mission Control -- was waiting for that moment. He wrote later, "As we counted down to . . . ignition . . . a hush fell over Mission Control. . . . For the first time in history, man was going to propel himself past escape velocity. . . . This the people in Mission Control knew; yet

there were no immortal words on the wall proclaiming the fact, only a thin green line, representing Apollo 8 climbing, speeding, vanishing -- leaving us stranded behind on this planet, awed by the fact that we humans had finally had an option to stay or to leave -- and had chosen to leave."

On the fourth day, Christmas Eve, Apollo 8 entered lunar orbit. The crew took hundreds of photographs, made scientific observations -- and celebrated Christmas, while a hushed world listened, by reading from *Genesis* the first verses of the story of creation.

After ten revolutions of the moon they started for home. They had seen the most incredible sights mankind had ever looked on: the black sky; the grey, crater-scarred lunar surface; and the fragile-looking blue sphere that was earth, rising over the horizon of the moon. Borman was later to say, "When we first were able to look toward home across the moon's horizon from Apollo 8 on Christmas Eve, the good earth appeared very small and very beautiful -- an oasis of life in the desolate loneliness of space."

Apollo 8 splashed down safely on 27 December. Apollo 9, a second earth-orbital mission, flew 3-13 March 1969, with Jim McDivitt ('59), Dave Scott ('62), and Rusty Schweikart as crew. Its mission was to test all the equipment for the manned lunar landing, including the spider-like lunar module never before tested in flight.

Apollo 10 -- 18-26 May 1969 -- was the final dress rehearsal for the lunar landing. Its crew -- Tom Stafford, John Young, and Gene Cernan -- went to lunar orbit and maneuvered the lunar module down to 50,000 feet above the moon's surface for final checkout before returning to earth.

The crew of Apollo 11 -- Neil Armstrong, Buzz Aldrin ('63), and Mike Collins ('64) -- were now down to the final preparations for their mission, in which they hoped to actually land on the lunar surface.

On the morning of 16 July 1969, a Saturn V rocket lifted Apollo 11 into earth orbit. An orbit and a half later, the crew reignited the third-stage engine for translunar injection. Soon afterwards, the command and service modules, called Columbia, separated from the Saturn third stage, turned around, and connected nose-to-nose with the lunar module, Eagle, which had nestled in a protective container of its own behind the Columbia.

(Mike Collins, who maneuvered the Columbia's probe to connect the two modules, later said it was rather like aerial refueling of aircraft.) With the Eagle attached, the Columbia drew away from the third stage and began the flight to the moon.

The earth grew noticeably smaller behind them -- white clouds, blue water, four times brighter than the moon against a sky of absolute black. Within a few hours it was so far behind that it hardly filled a single window of the command module.

On 19 July they approached the moon -- a huge, cratered sphere, haloed by the sun's corona, partly dark, partly lit by white earthshine. They entered lunar orbit and studied the surface below.

The next morning -- 20 July 1969 -- Neil Armstrong and Buzz Aldrin entered the lunar module. Mike Collins threw the switch which released the Eagle from the Columbia. Armstrong and Aldrin began their descent to the lunar surface.

They approached a landing site on the Sea of Tranquility: a crater the size of a football field, covered with large boulders. Armstrong took over manual control to avoid the rocks, while Aldrin gave him altitude readings. When the probes beneath the Eagle's footpads touched the surface, Armstrong shut down the engine. The Eagle settled to the surface like a jet landing on a runway. Armstrong radioed back to Mission Control: "Tranquility Base here -- the Eagle has landed."

Later Armstrong opened the hatch and climbed down the ladder, then halted on the last step. With a sense of the importance of the moment, he placed one foot on the surface of the moon. "That's one small step for a man," he mused, "one giant leap for mankind."

Aldrin joined him on the lunar surface, and they tried walking in the light gravity. They took out an American flag, its top edge braced by a wire to keep it extended, and erected it on a staff pressed into the lunar surface.

Mike Collins, orbiting in the Columbia, kept track of their situation by radio. The public had expected him to feel lonely; instead, he felt very much a part of what was happening on the surface. "This venture had been structured for three men," he reflected; "and I consider my third to be as necessary as either of the other two."

The Eagle spent that night on the surface of the moon. The next day the ascent stage of the Eagle maneuvered up to the Columbia and docked with it. The three astronauts began their return to earth. The command module splashed down in the Pacific Ocean on 24 July 1969, concluding what President Nixon later described as "the greatest week in the history of the world since the Creation."

Years of Austerity

Buzz Aldrin and his father, the senior Edwin Aldrin, were invited back to AFIT that fall for the celebration of the fiftieth anniversary of the Institute. Colonel Lawrence McIntosh, the only other living member of the Class of 1920, was also invited back, as well as Craigie and almost 300 other graduates.

The celebration took place on 18 October, the anniversary of the first, unofficial assembly of the Class of 1920. It began with a ceremonial observance in late morning. General Pinson welcomed the guests; a professor from the Department of Humanities spoke on AFIT's early years, and Craigie added his reminiscences. Then General Pinson addressed the gathering on "The Air Force Institute of Technology Today." The afternoon was devoted to tours of AFIT facilities, and the evening to a banquet at which the Assistant Secretary of the Air Force for Manpower and Reserve Affairs, Curtis W. Tarr, was the principal speaker.

It was a pleasant celebration. Pinson gave the senior Aldrin and Colonel McIntosh gold commemorative medallions. William A. "Bill" Anders ('62) of Apollo 8, now executive secretary of NASA, appeared to represent the AFIT astronauts, since the younger Aldrin had been unable to come. (The two Aldrins had, however, appeared together at AFIT's forty-seventh anniversary celebration.) Anders presented the Institute with a picture of the earth taken from moon orbit, signed by himself, Frank Borman ('57), and Jim Lovell, and inscribed, "To AFIT, with many thanks for all your help in making this possible."

Gen Mark E. Bradley, Jr. ('38) was there to represent more than 250 officers of general rank who were graduates of Institute programs. Bradley also represented the achievements of graduates who had made careers in logistics; he had begun in the thirties as project officer for the P-47, worked in such areas as developing in-flight refueling of B-29s, and retired as commander of AFLC.

Besides Craigie, three other former commandants were on hand: Haugen, Swofford ('36), who had retired as commander of Air University a few years earlier, and McCann.

The Fiftieth Anniversary Celebration marked the end of an era of unprecedented activity, expansion, and achievement. AFIT had not only its resident schools and Civilian Institutions Directorate; it also had the Defense Weapon Systems Management Center and the Air Force's only research reactor. Its quota of students for officer programs for fiscal year 1969 had been 1,720 -- 1,473 of these spaces being for graduate education -- and the quota for fiscal year 1970 was for 1,843 officer students, with 1,510 in graduate programs. Additionally there were the Airman Education and Commissioning Program, which involved over 400 students, mostly in technical areas; and the Minuteman Education Program, funded by SAC but managed by AFIT through six detachments at SAC missile bases. The Institute's prestige was high, and its graduates had been doing spectacular things like going to the moon.

But already a change in the flow of the tide was beginning to set in. Part of it could be traced, perhaps, to the nation's growing disenchantment with the situation in Southeast Asia: there was campus unrest, the military services were in disfavor with the public, the peace talks in Paris were frustratingly unproductive. The mood of the nation was changing, turning inward, away from the outward reach of the sixties.

An era of austerity was setting in, for the Air Force and for AFIT. An economy-minded Congress cut the Institute's quota of officer students for fiscal year 1970 from 1,843 to 1,645; then, early in 1970, the USAF Military Personnel Center (MPC) told AFIT that the airman education quota for 1970 was to drop from 436 to 360. That was not all. In May 1970, Air University asked AFIT to develop a list of potential candidates for reduction, enough to approximate 10 percent of the Institute's funding outlay and 5 percent of its manpower.

AFIT developed a "protect list" based on the difficulty of reconstituting a given program once it had been eliminated. The Defense Weapon Systems Management Program was given first priority, because it was a Department of Defense program and

AFIT was obliged to continue supporting it. Next came the resident degree programs; AFIT knew from arduous experience how hard it would be to reconstitute those. The resident short course programs, other than DWSMC, came third; then the civilian institution degree programs. The civilian institution short course program had lower priority. The Air Staff Training (ASTRA) Program, a year-long non-degree program analogous to Education with Industry but centered on Air Staff positions, could be dropped. The Nuclear Engineering Center came at the bottom of the list, because it was going to be decommissioned anyway.

The decision to close the Nuclear Engineering Center had come in April. As recently as November 1967, the Secretary of the Air Force had approved the Center as a permanent educational tool of Air University, to be used for a minimum of 130 experiments a year. But in the spring of 1970, when the number of major Air Force projects was being reduced on all sides, the Air Force had decided to close the Center, ending its brief operational history and its contribution to nuclear technology. On 12 June 1970, the nuclear reactor was operated for the last time; then, shortly after noon, the fission process in the core of the reactor was terminated and the last experiment was withdrawn from the experimentation cavity. This final experiment was the end of a long series of experiments in such areas as activation analysis, radiochemistry, neutron radiography, radiation effects studies, and bio-medicine. Now that capability was gone. Nothing remained but to transfer the usable equipment to other agencies and dispose safely of the rest. Over the following year this was done. By May 1971 the Air Force's only research reactor -- what was left of it -- was permanently entombed in reinforced concrete.

The Defense Weapon Systems Management Center had been undergoing Department of Defense review since the summer of 1969. In July 1970 the review group rendered its report: replace the existing 10-week course for senior project management personnel with a longer graduate-level course for people less senior, and move the entire DWSMC program to the Washington area. This meant, of course, that AFIT would no longer be responsible for it. On 14 January 1971, the Department of Defense announced that the DWSMC would be disestablished at Wright-Patterson on 30 June 1971 and reopen the following day at Fort Belvoir, Virginia as the Defense Systems Management School.

Thus, within little more than a year, AFIT had lost two major elements. It was left with its core, however: the three resident schools and the Civilian Institutions Directorate. After a flurry of reorganizing, the Institute got down to the business of strengthening that core and trying to do more with less -- since the need for education was still there.

One way of strengthening the core Institute was to take a close look at its programs to see whether they really served Air Force needs. One of the factors involved in the recent cuts had been a General Accounting Office's report which suggested that the services spent money educating officers they did not really need to educate; the Air Force -- and AFIT in particular -- wanted to show the world that the Air Force did need graduate education and that it made good use of its officers with advanced degrees.

The Air Force's Educational Requirements Board, which had been out of business for several years, had been reconstituted in the summer of 1969 to determine the number and kind of advanced degrees the Air Force needed. Meanwhile Pinson and his staff had conceived the idea of conducting formal reviews of the existing programs, to see whether the programs specifically supported Air Force needs. They discussed the plan with Air University in the spring of 1970 and got approval to go ahead. A pilot review of the graduate Guidance and Control Program took place in October 1970, through discussions between AFIT and using organizations; in subsequent months, the other programs were similarly reviewed.

Another way to strengthen the Institute was to consolidate. One thing Pinson wanted was a new building for the School of Systems and Logistics, which was off by itself in Area A. In the spring of 1970, the Air Force had announced tentative plans for a major building program to replace aging facilities. The plans included two new buildings for AFIT: one for the School of Systems and Logistics, one for the headquarters and Civil Engineering School. Both would be on the Area B hill, alongside the School of Engineering.

Another means of consolidation was to phase out the contract program with Ohio State University, which still provided faculty support to the continuing education division of the Logistics School. During 1971 and 1972 the Ohio State contract was phased out; the contract faculty were replaced by civil-service instructors, so that Continuing Education

operated with the same mixture of military and civil service faculty as the rest of AFIT.

The new buildings were still only a dream, and quotas for full-time students continued to fall off. But the Institute's effort to reach out to the vast body of people who needed to be educated kept growing. Continuing education programs of all sorts, from Military Assistance Program short courses to School of Engineering update courses for Air Force scientists and engineers, continued to expand. New methods were tried: Air War College-type seminars, correspondence courses written by the Logistics faculty, closed circuit television, video tapes for use in classrooms and in a small Systems and Logistics learning center. The School of Engineering pioneered a way to reach students at the Air Force Weapons Laboratory in Albuquerque, New Mexico: record a course on videotape; send it to Albuquerque for replay; have the professor watch a duplicate tape and maintain continuous voice contact with the class by telephone. Dr. Charles J. Bridgman of the Physics department presented the first such course in the fall of 1970. The idea caught on: the benefits were apparent, both for continuing education and for degree programs. Computer use was up; by the middle of 1972, nearly 75 percent of all Systems and Logistics courses employed computer application.

Meanwhile, the war in Southeast Asia was drawing to a close. The ceasefire went into effect on 27 January 1973.

At AFIT, Pinson was about to step down after five years as commandant. During that time he had not only worked to pull the Institute together and encouraged the expansion of its continuing education programs; he had also strengthened AFIT's ties with the civilian academic community and seen the doctoral program through to full accreditation in 1972. Under his guidance, the Institute had earned a second Outstanding Unit Award for its exemplary performance in 1971 and 1972. Now he was retiring. On 20 February 1973 he turned over command of AFIT to Brig Gen Frank J. Simokaitis.

Simokaitis (who pinned on a second star a few weeks later) was the first AFIT graduate to serve as commandant since Swofford. He had flown B-26s in Europe in World War II and been released from active duty after the war -- though not for long. In 1947, while he was in law school, he had accepted a Regular Air Force commission. He had earned a doctor of jurisprudence degree through an AFIT program in 1950. Over the years he had served in several different career areas, from investigation to contingency planning, and flown more than ten different kinds of aircraft. Just before coming to AFIT, he had been executive assistant to the Secretary of the Air Force, responsible for administration and for monitoring projects of major interest to the Secretary.

General Simokaitis arrived at a time of transition from wartime to peacetime status. One of his ceremonial duties was still to give out combat medals to students recently back from Southeast Asia; in March, for instance, he presented the Air Force Cross and twelve other combat medals to a single Engineering student, Capt Ronald E. Smith, a former A-1 Skyraider pilot, who had been on-scene commander in a particularly hazardous and complex search-and-rescue mission to recover a downed F-4 pilot in the Red River Valley.

AFIT became involved in another phase of the transition. Many of the former prisoners of war, returning from years of captivity in North Vietnam, had expressed a desire to enter Civilian Institution programs. In late January 1973, AFIT had learned that they could be entered in any program they wanted, regardless of quotas. Admissions and the Civilian Institutions Directorate moved quickly to make arrangements; a few officers were placed in school as early as June 1973, many more in September.

With the end of the wartime manpower shortages and the establishment of the Air Force Health Professions Scholarship Program -- designed to provide qualified medical services personnel in an all-volunteer force -- enrollment was up in 1973. But it was not going to stay that way long. There were still too many people at high levels who questioned the necessity for more graduate education within the Air Force: since so many Air Force officers held advanced degrees already, why educate more? The facts of the matter -- that large numbers of these degrees had no relation to Air Force needs, because the officers had obtained them on their own -- did not save AFIT from yet another funding cut in late 1973.

Part of the problem was that defense budgets were declining overall; with less money to go around, in an era of soaring manpower costs and inflation, graduate education came under increasingly critical scrutiny. The Air Force was urging AFIT to use

every appropriate means to justify its education programs.

To accomplish this, Simokaitis decided to place emphasis on three things: relevance of the curricula to Department of Defense and Air Force programs, efficient placement of graduates in valid positions, and expansion of continuing education courses through innovative methods. In the first years of his tenure, the Institute developed programs to ascertain the value of research undertaken by both faculty and students, and to find out what contributions its graduates subsequently made to the Air Force, the Department of Defense, and society. Reviews of AFIT programs continued.

Among the innovative methods used for continuing education, the most prominent was a format developed around 1974 by the Civil Engineering Center and the School of Systems and Logistics, known as "Telelecture" or "Teleteach." In the beginning it consisted simply of using a speaker phone and a telephone circuit to reach on-site seminar programs; this allowed professors with full teaching schedules at Wright-Patterson to deliver occasional lectures to students somewhere else without the need of travel funds. People at AFIT -- a few, at least -- were beginning to think in terms of a worldwide classroom.

The issue of a new building for the School of Systems and Logistics became active again in late 1973, when the military construction program for fiscal year 1975 was submitted to Congress. This time the building was approved without the extraordinary and dramatic efforts that had been necessary for the Engineering building. The contract was awarded in June 1975, and the ceremonial groundbreaking took place in August.

AFIT's educational programs were not growing, however -- definitely the reverse. The undergraduate engineering program at the School of Engineering was being quietly phased out, since officers no longer came into the Air Force without degrees; the last undergraduate Electrical Engineering class graduated in June 1975. The quotas for fully-funded graduate education were steadily lower each year. In the fall of 1974, Congress had halted all entries into the Airman Education and Commissioning Program.

On 14 August 1975, a Department of Defense Committee on Excellence in Education, headed by Deputy Secretary of Defense William P. Clements, Jr., visited AFIT as part of a study on education and training programs in all services. They were favorably impressed with the quality of AFIT's programs and management, especially with the Institute's efforts to make sure the programs were relevant to Department of Defense needs.

But the Committee never published a final report, and the old questions continued to be raised, and the quotas were a little smaller every year.

Meanwhile, the new building was going up. The framework was completed in early January 1976, and the construction crew held the traditional topping-off ceremony. Because it was the Bicentennial year, they placed a Bennington flag and a Bicentennial flag on the final beam along with the traditional evergreen.

AFIT took a considerable interest in the Bicentennial. Because of the Institute's involvement in a number of Bicentennial programs, it was designated as a Bicentennial University -- the only military educational unit in Ohio, and one of only six in the nation, selected for that honor. A white Bicentennial flag, with a photograph of the Class of 1920 at the lower end, hung in a prominent place in the headquarters.

Late in 1976 General Simokaitis was given yet another school to look after: the Defense Institute of Security Assistance Management (DISAM), which was being established to provide education in security assistance management -- defense assistance, foreign military sales, and the like. It was not to be part of AFIT, however; DISAM was to remain a joint organization, with the Air Force acting as executive agent. The AFIT commandant was also to serve as commandant of DISAM.

AFIT did much of the preliminary planning for DISAM and provided it some administrative support. But the other school -- located first in Area A and later in Building 125 -- was essentially self-sufficient. Beginning in January 1977, DISAM presented a series of short courses aimed primarily at middle managers in the security assistance field.

The new Systems and Logistics building -- Building 641, across the street from the School of Engineering -- was completed in early summer of 1977. A monumental three-story structure of light reddish-brown brick, it held classrooms, office space, a branch library, and computer center. Students, faculty, and staff moved into it in July. At the official dedication on 4 October 1977, the Under Secretary of

the Air Force, the Honorable Hans M. Mark, delivered the dedication address.

Meanwhile, almost unnoticed, AFIT had begun to take a new direction. Throughout its history it had been closely associated with the old Materiel Division, the Air Materiel Command, the Air Force Logistics Command and the Air Force Systems Command. Though many of its graduates, like Doolittle and Kenney, had performed spectacularly in the operational field, the Institute itself had never explicitly developed programs to provide education to the operational Air Force. That was about to change.

Dr. Janusz Przemieniecki, who had been Dean of the School of Engineering for a number of years now, was responsible for the idea. In early 1976, while taking Air War College by seminar, he had been disappointed by the lack of application of hard analytical tools -- which he knew were available -- to problems in strategy and tactics. After discussing the situation with some of the Engineering faculty and with General Simokaitis, he had submitted his idea to the Air Staff: why not establish a graduate program in Strategic and Tactical Sciences, to prepare officers with operational background for strategic and tactical operations, evaluation, analysis, and planning roles in the 1980s and beyond?

The Chief of Staff had given personal approval to the program in March 1977, and AFIT had asked for volunteers from the operational commands. The first class -- fifteen senior captains and junior majors, with degrees in science or engineering and experience as pilots or navigators or missile crew members -- entered the Strategic and Tactical Sciences program in August 1977.

General Simokaitis meanwhile was drawing close to retirement. But one more significant event was to mark his tenure: the announcement by the Secretary of the Air Force, on 21 March 1978, that Air University -- and AFIT with it -- was going to become part of Air Training Command.

General Simokaitis retired before the merger actually took place. On 27 April 1978 Maj Gen Gerald E. Cooke assumed command of the Institute.

General Cooke was a native of Ohio and, like his predecessor, a graduate of the postwar Institute. He had begun his career as an aviation cadet during World War II and gone on to photographic reconnaissance training; the war had ended just as he was about to leave for the Pacific. He had become a member of the Reserve; in civilian life he had been commercial pilot, test pilot and flight instructor.

During the Korean War he had returned to active duty. He had flown RB-26s in Korea, in reconnaissance and bombardment missions. The end of the war, for him, did not mean the end of flying; back in the United States, he flew B-26s, B-45s, and B-57s. An assignment in 1955 took him to Germany to fly RB-47s in a special photographic reconnaissance program.

Later, he had served in the Minuteman System Program Office and in a series of school and staff assignments, including an AFIT civilian institution program which gave him a masters degree in international relations. He had gone to Vietnam in September 1968 as Assistant Chief of Staff, Seventh Air Force. On his return, he had been assigned to the staff of the Assistant Secretary of Defense (International Security Affairs); the same year, he had received a doctorate in government and politics from the University of Maryland. Several more assignments kept him in Washington through the mid-seventies. Just before coming to AFIT, he had been Deputy Director for Operations (Reconnaissance and Electronic Warfare), Organization of the Joint Chiefs of Staff.

The Institute of which he assumed command in April 1978 had just been reassembled in the same general section of Area B, after approximately two decades of separation. There were about 400 students enrolled in the resident graduate programs, and about 1600 more in civilian institutions. Most of the resident graduate students were in the School of Engineering; most were captains with several years' experience, though recent programs had brought in a fair number of second and first lieutenants.

There were more women in the Institute, though still not very many. The School of Engineering had had its first woman student in 1970. Married couples, in which both husband and wife were AFIT students, had begun to show up a little later; the first husband-wife team had entered a Civilian Institutions masters degree program in 1972, working in research and development management. At the time of General Cooke's arrival, there were even two women on the faculty: one an instructor in the Civil Engineering School, the other an assistant professor of humanities in the School of Engineering.

The students were, as ever, hardworking: their programs demanded that. But like their predecessors, they occasionally found time to produce such things as the humorous verses titled "AFIT Student Lament," which someone had attached to the door of the computer room in the School of Engineering:

My program lies under the backlog
My card deck's all over the floor
The plotter is using a crayon
And I just can't take any more.

Bring out, bring out
Oh bring out my printout today, today
Bring out, bring out
The one you ripped off yesterday.

The card reader chewed up my job card
And someone erased all my files
The system had been down for hours
While students collapse on the floor.

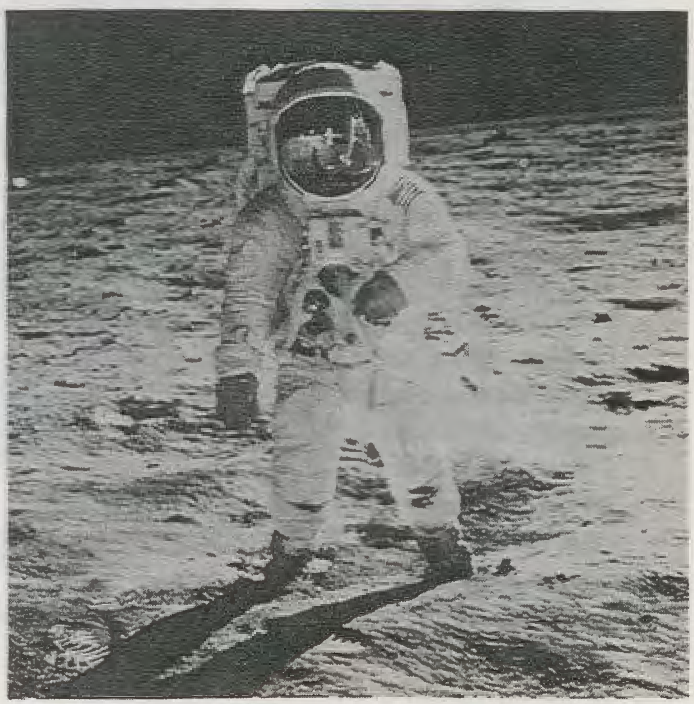
Flunk out, flunk out
I worked like a dog each day and night
Flunk out, flunk out
Twelve projects were due yesterday.

Security holes I've discovered
The records of grades now are mine
What was a 1.5 average
Will soon be a fine 3.99.

Send out, send out
Oh send out the grades to USAF
Send out, send out
They all want an engineer like me.

Humor aside, everyone did want them. There was a greater shortage of engineers than perhaps ever before.


Apollo 8: The earth seen from lunar orbit.


Astronaut Edwin E. Aldrin, Jr. ('63) was the first military man to walk on the moon.

The Exploration of Space

Meanwhile, Project Apollo had gone forward. On 14-24 November 1969, just months after the trail-blazing Apollo 11 flight, Apollo 12 had gone to the moon, making a pinpoint landing on the Ocean of Storms. Apollo 13 -- 11-17 April 1970 -- had gone less smoothly: on the way to the moon, the command service module had been disabled by an explosion. The crew had taken refuge in the lunar module, using its oxygen and electricity while Apollo 13 swung around behind the moon and back toward earth. After three days that tested the endurance of man and machine in the hostile environment of space as never before, they had made the most accurate splashdown in the history of manned space flight.

Apollo 14 -- 31 January-9 February 1971 -- had been successful. While command module pilot Stewart Roosa ('60) stayed aloft in the command ship "Kitty Hawk," Alan Shepard and Ed Mitchell descended to the lunar surface and made the longest moonwalk yet, in the foothills of the Fra Mauro region.

Apollo 15, the most spectacular manned space flight so far, took place 26 July-7 August 1971. All three crew members were AFIT graduates: Dave Scott ('62), Al Worden ('63), and Jim Irwin ('58). Instead of landing on one of the smoother areas of the lunar surface, they made the first landing in the mountains of the moon, in a crater in the rugged Hadley-Apennine region. Worden orbited in the command ship Endeavor; Scott and Irwin descended in the Falcon. On this trip they had a Lunar Roving Vehicle to aid their exploration; after setting it up, Scott and Irwin began history's first drive on the moon. They observed the canyon depths of the Hadley Rille, the crater-scarred Marsh of Decay, the towering Apennine Mountains, recording the spectacular lunar landscape on color television and gathering geological samples. When they launched the Falcon back toward the command ship, Scott switched on a tape recording of "Off We Go into the Wild Blue Yonder" -- surely the wildest yonder ever to have been background for the Air Force tune. Before leaving lunar orbit, the crew of the Endeavor launched a scientific satellite to provide further details on lunar gravity. On the way back, some 197,000 miles from earth, Worden made mankind's first walk in deep space, to retrieve some film from the instrument bay of the command module.

On Apollo 16 -- 16-27 April 1972 -- astronauts John Young and Charlie Duke ('64) explored another mountainous area of the moon, the Descartes region. During three sorties in the lunar rover, they gathered lunar material and climbed down into a deep crater to get samples of rock believed to be four billion years old.

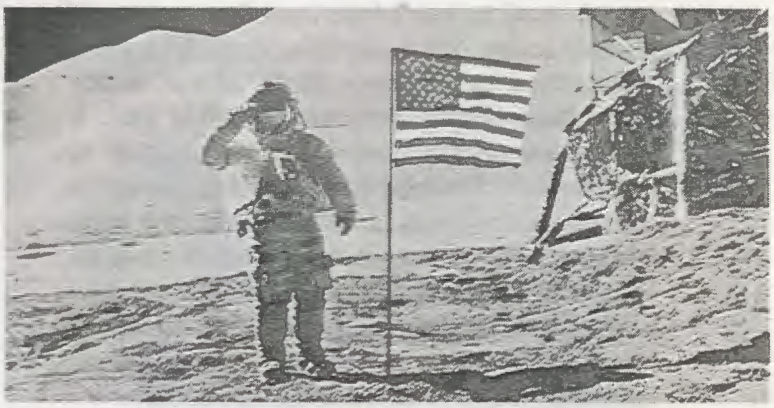
Apollo 17, the last mission of the series, took place 7-19 December 1972. For the first time a professional scientist came along as crew member and made geological observations in the Taurus-Littow region.

Apollo 8 launch from Kennedy Space Center.

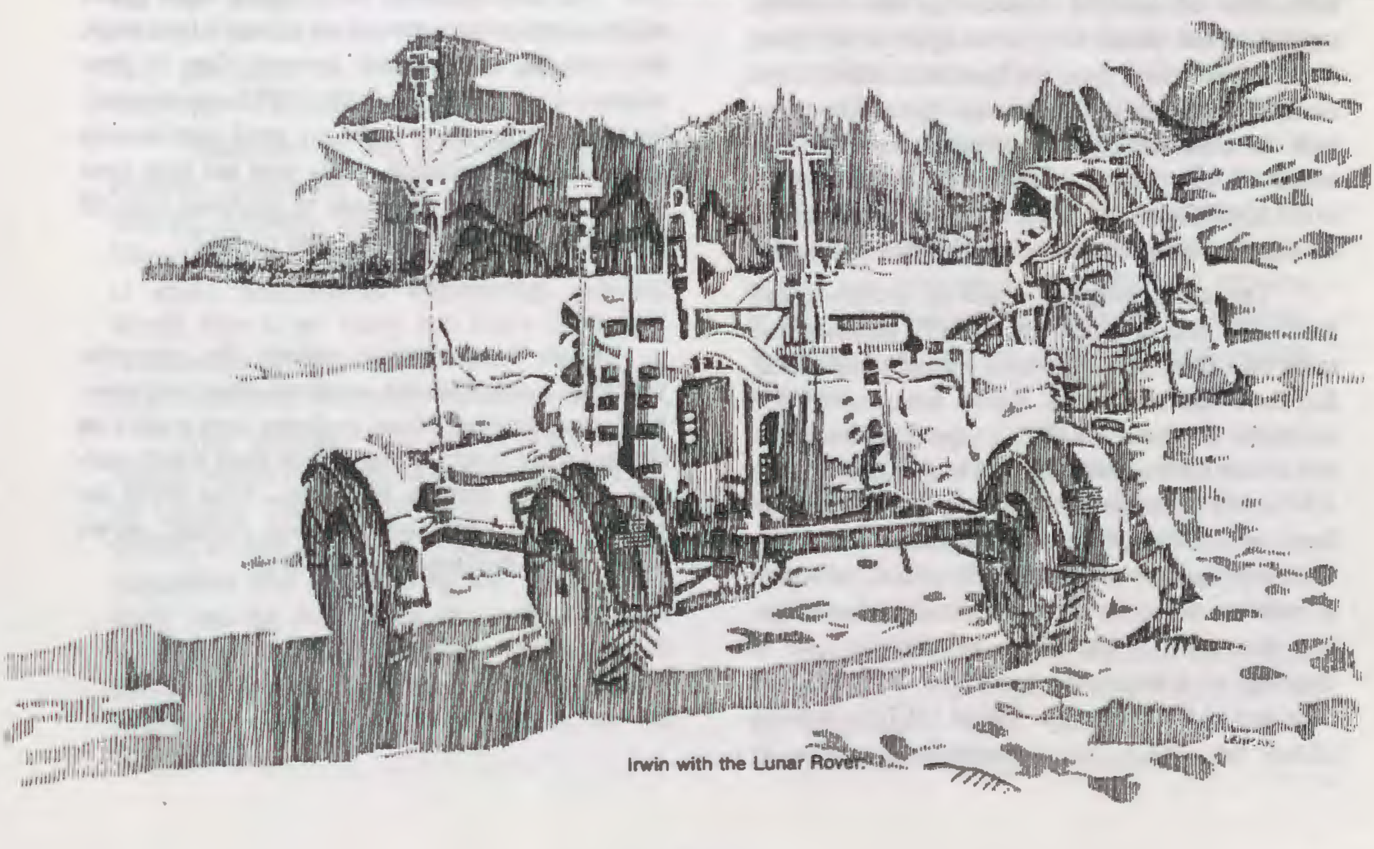
The emphasis was changing: where the first explorers had gone, the professional scientists were beginning to follow. The next major phase of the space program, Project Skylab, was already in the final stage of preparation. Skylab -- a Saturn IV-B rocket stage converted into an orbiting workshop, with docking facilities for Apollo spacecraft -- was launched 14 May 1973.

One of its solar "wings" had been torn away as it left the atmosphere along with its meteoroid shield; and the other wing had failed to deploy. When the Skylab 2 mission -- 25 May-22 June 1973 -- took the first boarding part of astronauts up to the orbiting laboratory, they installed an improvised sun shield and released the stuck solar panel. They spent 28 days in the orbiting laboratory; the Skylab 3 mission -- 28 July-25 September 1973 -- bettered that record, as the crew spent 59 days in Skylab continuing important earth and sun studies. The crew of the final mission, Skylab 4 -- 16 November-8 February 1974 -- included AFIT's William ("Bill") Pogue. They set a record of 84 days in space, completing the program of experiments and proving that man had the physical endurance to go to Mars.

Scott salutes the U.S. flag during Apollo activity on the lunar surface.



Apollo 15 crew: Astronauts James B. Irwin ('58), David R. Scott ('62), and Alfred M. Worden, Jr. ('63).



Irwin with the Lunar Rover.

Meanwhile, the plans for a manned space glider had advanced far beyond the Dyna-Soar program of the early sixties. The Space Transportation System -- better known as the Space Shuttle -- was already under serious investigation in the summer of 1969. It was to be essentially an aerospace plane, capable of being boosted into orbit and re-entering the earth's atmosphere for winged return flight to earth. Designed as an all-purpose space freighter, it would be used to fly scientists into orbit for research purposes; launch satellites and space probes; retrieve or repair satellites; take sections of space stations or space ships into orbit for assembly; and the like.

In early 1977 a series of captive inert flight tests, with the unmanned Shuttle orbiter mounted on top of a Boeing 747 carrier aircraft, had been successfully completed. Captive active tests, with two-man astronaut crews riding in the orbiter during flights on the 747, began that spring. Astronauts like Lt Col Karol Bobko ('70) were already training in shuttle simulators and making tests for the free flight missions which were to follow.

The manned captive flights were completed in July 1977. Free-flight tests began in August. The first manned orbital flight was predicted for 1979 or 1980.

AFIT people were being assigned to the Space Shuttle program in increasing numbers -- as pilot astronauts; as mission specialists, the scientist-astronauts who would work in the Spacelab the Shuttle would carry into space and back; as detailees to the simulation section at the Johnson Space Center, to train the astronauts for their missions; and elsewhere within the vast project. Many more were likely to go to the Space Shuttle program: once it was operational, the Shuttle was expected to make a flight every week.

The space program, since its inception, had been news; and in it, numbers of AFIT graduates had taken their turn on the television screens of the world. But there had been other, quieter achievements too numerous to detail. An AFIT graduate had been project officer for the Space Ground Link subsystem, the Air Force's prime system for tracking military satellites. An AFIT graduate had been chosen as the only American member of a British expedition, scheduled to make the first polar (or longitudinal) circumnavigation of the earth in late 1979. An AFIT graduate, as chairman of a permanent committee of NATO, had been one of the key people behind NATO's decision to buy the E-3A -- the unprecedented purchase by NATO of a major weapon system. An AFIT graduate had been the first woman military attache in American history. An AFIT graduate had become president of Eastern Airlines. An AFIT graduate -- the first Venezuelan Air Force exchange officer -- had designed a logistics system for the Venezuelan Air Force and seen it through implementation. An AFIT graduate had been responsible for the activation of all F-15 units, worldwide, as the aircraft came into the inventory. An AFIT graduate had been a pioneer in hyperbaric medicine, helping to set up a prototype hyperbaric medicine facility and serving as Chief of Diving Operations.

The range and diversity of their achievements was extraordinary. AFIT graduates had designed a whole spectrum of things, from the world's most accurate inertial navigation system to blast resistant missile facilities. They had been pioneers in the development of satellite laser communication, magnetically torqued spacecraft, cheap and reliable space boosters, high-resolution meteorological satellites, and a host of other innovations. They had researched an array of subjects ranging from high-energy electric lasers to the effects of ultraviolet radiation on the human eye. They had written books on everything from the integration of the Air Force to what it was like to walk on the moon.

And then there were the countless others whose achievements never appeared on anyone's front page, but were real and valuable anyway. One of them summed it up: "In no small way, AFIT was responsible for preparing me to make my small contributions to the Air Force mission. They may not have been spectacular; but for thousands of graduates over 60 years, I suspect this is the real story of AFIT."

* * * * * * *

From a cavalryman among the mesquite, watching a few kite-like airplanes skimming overhead, to an Institute whose graduates have walked on the moon and expect to make space flight a daily reality: AFIT has come a long way. What about the present? And what about the next decades, as we move toward the twenty-first century?

CHAPTER 2

LEADERSHIP AND ORGANIZATION

The Air Force Institute of Technology (*AFIT*) is the source and manager for university-level education and work in managerial, medical, scientific, technological, and other fields for the Air Force. The education is provided to carefully selected military and civilian personnel to help the Air Force meld the dynamics of a rapidly changing technology with the challenge of defense and military development.

AFIT not only provides education, but is a contributor to advanced research and development for the Air Force and the Department of Defense (*DOD*). Through attendant work, such as thesis and dissertation research or consulting, AFIT plays a key role in Air Force efforts to remain on the leading edge of technological developments.

2-1: Early History

The history of the Institute of Technology dates back to the fledgling days of powered flight, for it early became apparent that the progress of military aviation was closely dependent upon the availability of military specialists in aeronautical science and allied technical fields.

Education in the scientific aspects of aviation began in 1914 when the Army detailed Captain Virginius E. Clark to the Massachusetts Institute of Technology (*M.I.T.*) to study aeronautical engineering. During World War I, an Army and Navy School of Aeronautical Engineering was opened at M.I.T., and two classes were graduated.

The original idea of an aeronautical school within the Army was proposed in 1919 by Colonel Thurman H. Bane, Commanding Officer of McCook Field, Dayton, Ohio. The suggestion was approved by the War Department, and the Air School of Application was established within the Engineering Division at McCook Field in November 1919 with seven officers enrolled and Colonel Bane as the Commandant.

In 1920, following the creation of the Air Service, the school was redesignated the Air Service Engineering School. Classes were small and informal. Student officers were instructed by engineering specialists assigned to McCook Field and the Commanding Officer of McCook Field also served as the Commandant of the school.

The second stage in the development of the Institute of Technology occurred in 1926 when Congress authorized the creation of the Air Corps and an accompanying five-year expansion program.

Engineering and test activities at McCook Field required more extensive facilities and in 1927 these activities were moved to a 4,500 acre tract of land donated to the government by citizens of Dayton. The new installation was named Wilbur Wright Field in honor of one of Dayton's celebrated native sons, Orville and the late Wilbur Wright.

The Air Service Engineering School now became the Air Corps Engineering School. Although the one-year course and the general curriculum were retained, there were certain fundamental changes in philosophy and policy stimulated by the increasing importance of science and the need for specialization in the development of air power. Originally designed to provide technical education for senior officers holding command positions, the school was now given the additional mission of preparing younger officers to fill positions in research and design within the Engineering Division.

When the Air Corps Engineering School was forced to suspend classes shortly after Pearl Harbor, it had graduated more than 200 officers. Among these were many of the nation's foremost wartime and post-war leaders of aviation.

The school remained inactive until April 1944, when it was reopened to conduct a series of accelerated three- and six-month-long courses to meet emergency needs.

After the cessation of hostilities in 1945, a survey of the Army Air Force Officer Corps indicated a general lack of educational attainment and the need for improving the competence of the Corps.

A board of officers, appointed in 1945 by the Commanding General of the Air Technical Service Command to study the problem, recommended that the Army Air Force establish a technological school under the immediate supervision of the Commanding General, Air Technical Service Command, using the existing Army Air Force Engineering School as a nucleus for expansion to accomplish the recommended action.

Instructions from the Office of the Chief of Air Staff provided for the appointment of a resident committee of Air Technical Service Command officers to prepare an operational plan. At the same time, a second group -- civilian scientists and educators appointed by Dr. Theodore Von Karman, Chairman of the Army Air Force Scientific Advisory Board -- was also surveying the Institute project. The latter group, headed by Dr. John R. Markham, Associate Professor of Aeronautical Engineering at M.I.T., recommended that the Institute offer two programs, one in engineering and a second in business administration and logistics as applied to the supply and procurement problems of the Air Force. Courses were to be patterned after those offered in leading civilian universities, with necessary changes to meet specific Air Force needs. It was also recommended that the Institute ultimately include graduate level training. Findings of the Markham Committee closely approximated those of the Resident Committee and previous groups.

As a result of these preliminary efforts, the Army Air Forces Institute of Technology was officially opened on 3 September 1946 by Lt Gen Nathan F. Twining, Commanding General of the Air Materiel Command. The original faculty of the Army Air Force Institute of Technology consisted of eight civilians and five officers and the initial enrollment of officer students totaled 189. The Institute was composed of two colleges: Engineering and Maintenance, and Logistics and Procurement. These colleges were later redesignated the College of Engineering Sciences and the College of Industrial Administration, and in December 1951, they were combined into the Resident College.

When the Air Force became an autonomous unit in the military establishment during 1947, the Institute was renamed the Air Force Institute of Technology. It was at this same time that Wright Field, with its extensive research and development facilities, was combined with neighboring Patterson Field, center of Air Force supply and procurement activities, to form the present single installation, Wright-Patterson Air Force Base.

On 1 April 1950, command jurisdiction of the Institute was transferred from the Air Materiel Command to the Air University.

The Institute's progress toward the 'graduate school' goal was marked by the enrollment of eight officers in the first Advanced Engineering Management Class in January 1951. Later, the Institute offered graduate programs in several fields of engineering as well as senior-level undergraduate programs in engineering sciences. Because of the increasing emphasis on science and engineering, graduate management programs were then conducted in civilian institutions, beginning in September 1960.

The location of the Institute of Technology, at a large center for aeronautical research and development and at the headquarters of Air Force materiel activity, provided many unusual advantages. In making recommendations in 1947 in connection with the Institute of Technology, General Joseph T. McNarney, then Commanding General of Air Materiel Command, stated that he saw no prospects "of a better location for it than here in close association with the Materiel Command in an environment and atmosphere charged with the type of problems which student officers are preparing themselves to solve."

This view was corroborated by a statement appearing in the *1951 Report of the Air University Board of Visitors*: "To insure a broad concept of training, the courses and curricula of the Institute of Technology must take full advantage of the clinical opportunities and

resources which exist in the laboratories and operations at Wright-Patterson Air Force Base and utilize the real situations and problems available there."

In addition to the resident School of Engineering, Civil Engineering Center, and Logistics School of the Air Force, the Institute of Technology conducted and supervised the educational programs of Air Force personnel in civilian institutions and selected industries. In the 1960s the Air Force educational program had two major phases: Scientific Education (science, engineering, training-with-industry, meteorology, medical training, and short courses) and the Professional Education (management, social studies, Category 'C' program, and the Air Force Academy instructor program). The total program had a student input of about 4,000 students per year.

The Civil Engineering Center was established at the Installations Engineering School of the Institute in October 1947 to train officers for installations engineering duties at air bases, major command and Headquarters USAF levels. Its courses of study covered all aspects of air base construction, operation, and maintenance, with emphasis on the technical, managerial and administrative functions of the base civil engineer. The first class was enrolled in March 1948, and by the end of 1960, the school had graduated 2,295 officers.

The Civil Engineering Center offered five courses -- The Base Civil Engineer Course, the Staff Civil Engineer Course, and three special short courses. The nine-week Base Civil Engineer Course was designed to prepare qualified engineers who were new to the Air Force civil engineering occupational field for base-level assignments. The thirty-seven week Staff Civil Engineer Course prepared experienced civil engineering officers with limited formal engineering education for more responsible positions at staff-level. The three special short courses covered executive engineering, missile support facilities and nuclear defense planning.

In response to the growing need for trained senior officers qualified to deal effectively with Air Force worldwide logistics problems, an experimental six-months advanced logistics course was started by the Institute in October 1955.

The staff of the Institute of Technology analyzed the problems involved in developing and operating the Logistics Course and selected Ohio State University to research, develop, and present certain phases of it and to provide the bulk of professional and academic resources. It was decided that all of the instruction would be given at Wright-Patterson Air Force Base, next to Headquarters, Air Materiel Command, (later redesignated the Air Force Logistics Command), nerve center of the Air Force Logistics System.

This initial course, later called the Advanced Logistics Course, was designed to be a partial but essential long-term solution to the problem of developing senior field-grade officers qualified to deal effectively with logistics problems. The success of the 'pilot-model' course was immediately apparent. Obviously, there was a capability that could be put to additional use.

In 1958, Headquarters United States Air Force authorized and provided funds to Headquarters Air Materiel Command (*AMC*) to establish an educational capability in logistics management to include, to a greater extent than ever before, its many civilian managers. In view of the success and capability already developed by the Institute of Technology in establishing the Advanced Logistics Course, the Institute was asked by AMC to establish a logistics education center for the development and administration of logistics management courses.

As a result, the School of Logistics was established. Its curriculum included the Advanced Logistics Course as well as twenty-two other courses offered in conjunction with the Air Force Logistics Command's Logistics Education Program. Its capability placed the school in the position of real leadership, Air Force wide, in logistics management education for military and civilian personnel alike.

The Air Force Logistics Command's Logistics Education Program was a major and integral part of the School of Logistics. It

comprised the greater portion of the academic effort of the school and attracted the major portion of the student body.

Congressional action during 1954 resulted in Public Law 433, 83rd Congress, which provides that:

> under regulations prescribed by the Secretary of the Air Force, the Commander, Air University, may, upon accreditation of the Institute of Technology by a nationally recognized accreditation association or authority, confer degrees upon persons who meet all requirements for those degrees in the resident Schools of Engineering and Business.

In April 1955 a Committee of the Engineers' Council for Professional Development (*ECPD*) visited the Institute to review the programs and facilities of the engineering curricula. As a result of this visit the ECPD, on 19 October 1955, accredited the undergraduate Aeronautical Engineering and Electrical Engineering curricula. The first degrees to be granted by the Institute of Technology were conferred at graduation exercises on 13 March 1956.

In February 1958 a Committee of the American Association of Collegiate Schools of Business (*AACSB*) visited the Institute to review the programs and facilities of the business curricula. As a result of this visit the Institute School of Business was admitted to membership in the AACSB on 2 May 1958 and accredited to award graduate degrees. The first degrees granted by the Institute under this authority were conferred at the graduation exercises on 27 August 1958 to qualified members of the graduate programs in Engineering Administration, and Applied Comptrollership. When these programs were transferred to selected universities on 31 August 1960, a total of 383 Master of Business Administration degrees had been conferred on graduates of Management programs.

On 1 April 1960 the Institute was accredited as a Master's degree-granting institution by the (*NCA*) regional accrediting association, (i.e., the North Central Association of Colleges and Secondary Schools).

In its School of Engineering, School of Logistics, Civilian Institution Programs, and Civil Engineering Center, the Institute carried forward its fourth decade of technical and professional officer education. Its students had to be equipped to deal with eventualities not even foreseen when they were actually attending classes. The Institute met this challenge by employing a flexible curriculum geared to future developments.

In the 1960s, all logistics education at the Institute was provided on contract with the Ohio State University (*OSU*), designated as the Defense Management Center. All logistics faculty were on contract with the Ohio State University Research Foundation, and were deemed adjunct faculty of the College of Commerce and Administration. In 1963, the School of Logistics changed its name to the current School of Systems and Logistics in order to reflect its systems management program. In 1964, an engineering school building was completed, and accreditation for graduate degrees was awarded by the North Central Association. Later, an associate dean was appointed; still later, military department heads and course monitors were installed who became the opposite number of the OSU department heads and course directors. In 1971, as a result of a cost study, the Ohio State contract was not renewed for FY 72. The Air Force hired the OSU teaching faculty as civil servants, retained its own Deans and Department Heads and thereby assumed full management of the School.

The seventies experienced a similar expansion as technology accelerated further. AFIT graduates were closely involved in the Apollo space program. New construction at the Institute was marked by the erection of a new School of Systems and Logistics facility in 1977. Later that year, the School of Engineering started a unique program in strategic and tactical sciences after Dean Janusz S. Przemieniecki proposed a graduate program combining quantitative sciences, weapons engineering and military operations.

AFIT became a member of the Dayton Miami Valley Consortium in 1967. The consortium was an association of colleges, universities, and industrial organizations in the Dayton area which united to promote educational advancement. AFIT was traditionally active in both the consortium and in other community and interinstitutional programs.

In May 1978, Air University and AFIT became part of the Air Training Command (*ATC*), the largest USAF major command.

2-2: 1980s: Period of Growth

In the 1980s there were three schools, School of Engineering, School of Systems and Logistics, School of Civil Engineering and Services, and the Civilian Institution Programs Directorate.*

In the early 1980's, the pace of technology continued to accelerate. The Air Force Institute of Technology grew in the areas of faculty development, research and consulting, library expansion, data processing facilities, and programs. Programs developed included: information processing, laser technology, signal processing, electro-optics, radiation hardening, advanced composites, and space structures. These programs were designed to keep the Air Force Institute of Technology in the forefront of high-technology education.

The results of the educational efforts of the Air Force Institute of Technology have been extraordinary. Institute graduates have helped to design the world's most accurate inertial navigation system, satellite laser communications, space structures, spacecraft, boosters, and high resolution meteorological satellites.

* Supporting the educational, research, and consulting activities of AFIT were eight staff and support agencies under the command section. They were: (1) the Operations and Plans Directorate (*XP*), (2) the Admissions / Registrar Directorate (*RR*), (3) the Academic Library (*LD*), (4) the Communications-Computer Systems Directorate (*SC*), (5) the Directorate of Public Affairs (*PA*), (6) the Resource Management Directorate (*RM*), (7) the Directorate of Personnel Resources (*DP*), and (8) the Directorate of Administration (*DA*).

The Air Force Institute of Technology nears its eighth decade through the growth of technology and the need for specialized military education. From Colonel Bane's viewpoint on the back of his horse in Mexico to that of Institute graduates who have walked on the moon, the Air Force Institute of Technology has progressed far. In 1994, the current Commandant, Colonel Joseph Koz, continues to stress excellence in education and research to move the Air Force Institute of Technology into the twenty-first century, retaining its flexibility and resourcefulness in accomplishing its mission as it has done over the past 75 years.

2-3: Changes in Key Personnel

On 3 September 1988, Dr. Lynn Wolaver retired as Dean for Research and Professional Development.@ Following Dr. Wolaver's retirement, the decision was made to return the functions of the Institute-level research office to the schools. The position of Associate Dean for Research was reestablished in the School of Engineering and was filled on 12 December 1989 by Dr. Charles Bridgman, formerly a Professor of Nuclear Engineering in the Department of Engineering Physics. At the same time a new position, the Assistant Dean for Research and Consulting, was established in the School of Systems and Logistics with Lt Col Larry Emmelhainz as its head.

On 1 October 1989, Dr. Janusz S. Przemieniecki, who served as the Dean of the School of Engineering for over 20 years, assumed the duties of the newly-established position of *Institute Senior Dean and Scientific Advisor*. Dr. Robert A. Calico, Jr., a former Professor of Aerospace Engineering, Department of Aeronautics and Astronautics, was appointed Interim Dean of the School of Engineering and, after a national search, his selection as Dean was announced on 10 July 1990.

The Director of Academic Affairs, Dr. Robert N. Faiman, retired on 3 July 1990 after serving in that capacity for over 16 years. Fol-

[@ Dr. Wolaver now serves as mayor of the city of Fairborn.]

lowing an extensive search, Dr. James M. Horner, former President of Central Missouri State University, assumed the position of Director of Academic Affairs.

2-4: 1990s: Period of Consolidation

Restructure History. Efforts began in March 1992 to restructure AFIT along the lines of graduate education and Professional Continuing Education (*PCE*). The primary purpose of reorganization by education types was to recognize the unique nature of each, especially with respect to faculty requirements. The initial thrust provided by the AU Commander was toward a split that would lend itself to placing all PCE under the umbrella of AU's Center for Professional Development (*CPD*) and, ultimately, a separate pay scale for the PCE faculty. Although physical relocation of AFIT's resources was not considered, just the attempt to separate PCE organizationally from AFIT presented itself as an obstacle. Likewise, the plan to create separate pay scales for an historically integrated faculty was received by the PCE AFIT faculty with little enthusiasm. With our restructure temporarily stymied, the AU Commander deferred to the judgement of the BOV during a specially convened session in July 1992. Led by the outgoing chairman, General Bryce Poe (USAF, Ret.), the BOV recommended that more rigor be put into the PCE faculty promotion process, but that AFIT not revert to separate pay scales. With that issue decided, pressure to split faculty resources between AFIT and the CPD was similarly relieved, and AFIT proceeded to create the structure that exists today.

A Restructured AFIT. The most significant changes that occurred from a restructure of AFIT were as follows: (1) placing all graduate programs under either the Graduate School of Engineering (*EN*) or the newly created Graduate School of Logistics and Acquisition Management (*LA*); (2) placing all PCE courses within the School of Civil Engineering MWR and Services (*CE*) or the School of Systems and Logistics (*LS*); (3) dividing the AFIT support staff among those directorates which provide direct student support and those that provide traditional administrative support to the Commandant and the Institute; (4) downsizing the central staff through position reductions and transfers of personnel to the schools. In addition, directorates providing student support, i.e., Registrar / Admissions (*RR*), Communications-Computer Support (*SC*), and the Academic Library (*LD*) were placed under the supervision of the Director of Academic Affairs (*CF*) which was then made a line-supervisory position.

Other changes. For some time, the central support staff had appeared to AU as an oversized bureaucracy in need of streamlining. As a fallout of the restructure of grad ed/PCE, many of the administrative support directorates were drastically reduced in size. The Resource Management Directorate (*RM*) was divested of many of its financial management personnel who were placed in Civilian Institution Programs (*CI*) to track expenditures within its schools and universities. Also, RM's supply and fabrication shop personnel were transferred to EN, a school they primarily supported. The Instructional Media Division was reassigned to the Center for Distance Education (*LSE*). With the loss of these responsibilities, and only financial management remaining, RM became Financial Management (*FM*). The financial management function in CI was subsequently placed under FM to more efficiently organize all financial activities. Operations and Plans (*XP*) experienced an authorization reduction of three as well as an across-the-board reduction in grade authorizations. Finally, the remaining directorates, Public Affairs (*PA*), Information Management (*IM*), Personnel Resources (*DP*) and Orderly Room (*CCQ*) were either consolidated, reduced, or, in the case of Mission Support (*IM/DP/CCQ*), both.

Restructure Assessment. The split of graduate education and PCE was viewed as a logical realignment. The creation of the new Graduate School of Logistics and Acquisition Management (*LA*) was also most beneficial, once the green light was given to hire a full time dean. Some obvious growing pains resulted from the necessity to share faculty and other resources, but these were offset by the

ability to focus more intensely on graduate education issues, just as LS became free to focus exclusively on PCE and the rising influence of outside actors, such as Defense Acquisition University (*DAU*) and the Acquisition Professional Development Program (*APDP*). LS established a DAU/APDP Program office in Apr 1993. Likewise, the transfer of the Graduate Environmental Engineering Management Program (*GEEM*) from the largely PCE School of Civil Engineering and Services to the Graduate School of Engineering was a logical one. In addition, software engineering PCE courses were transferred from EN to LS, thus divesting EN completely of any recurring PCE courses.

The problems that arose as a result of the 1992 restructure were typically resource-related. The creation of the new graduate school predictably created a demand for a dean, associate dean, and administrative support, not all of whom were initially available to fill these positions. Also, the general reduction of personnel authorizations, with no lessening of the administrative requirements, put a strain on the remaining staff. Management continued to assess the impact of personnel reductions to our Mission Support Branch and asked AU to validate those reductions through a comprehensive manpower study. The bottom line: despite some initial misgivings, AFIT appears to be restructured correctly to meet the dynamic changes brought on by what General McPeak termed "The Year of Training and Education" in the Air Force.

The Graduate Programs Director (*LAA*) administers graduate student operations. The Logistics School created two new offices in 1989. The Office of Research and Consulting (*LSC*) (now LAC), was established to improve school-user interface in consultation/research and interdepartmental expert information exchange. The Director of Information Resources (*LSI*) office [which stayed in the PCE school, after the reorganization in 1992] was established to manage the computer resources in the School and act as a liaison with Air Force computer activities.

2-5: AFIT Deans

Graduate School of Engineering Deans

C. Ray Wylie, Jr., -- 1946-48

William H. Crew -- 1948-50

Reginald H. Downing -- 1951-56

Gunther G. Graetzer -- 1956-61

Reginald H. Downing -- 1961-69

Janusz S. Przemieniecki -- 1969-89

Robert A. Calico, Jr., -- 1989-Present

Graduate School of Systems and Acquisition Management Dean

Col Thomas F. Schuppe -- 1992-Present

School of Systems and Logistics Deans

Col Eugene R. Magruder -- 1955-59

Col Donald J. Green -- 1959-62

Col Charles A. Stone -- 1962-66

Col Eugene C. Parkerson -- 1966-67

Col Roy W. Amick -- 1967-69

Col Paul Bard -- 1969-71

Col Gage H. Crocker -- 1971-72

Col John J. Apple -- 1972-74

Col William B. Haidler -- 1974-76

Col William G. Comstock -- 1976-78

Col Lewis M. Israelitt -- 1978-80

Col Charles R. Margenthaler -- 1980-81

Col Larry L. Smith -- 1982-88

Col Richard S. Cammarota -- 1988-91

Dr. William A. Mauer -- 1991-92

Col Paul T. Welch -- 1992-present

School of Civil Engineering MWR and Services Deans

Col Glynn O. Mount -- 1948-50

Col A. M. Musgrove -- 1950-54

Col Clyde B. Thompson -- 1954-55

Lt Col Walter H. Gerden -- 1955-57

Col C. A. Eckert -- 1957-62

Col Vernon L. Hastings -- 1962-66

Col Charles W. Sampson -- 1966-67

Col Robert H. Armstrong -- 1967-68

Col Albert M. Nemetz -- 1969-72

Col Walter Grande -- 1973

Col James S. MacKenzie, Jr. -- 1973-77

Col Oren G. Strom -- 1977-81

Col Phil V. Compton -- 1981-84

Col Marshall W. Nay, Jr. -- 1984-87

Col George E. Cannon, Jr. -- 1987-90

Col Gerald R. Adams -- 1990-91

Col Steven C. Mugg -- 1991-Present

Civilian Institution Programs Deans

Col Marvin F. Stadler -- 1950-52

Lt Col Willard R. Middleton -- 1952-56

Col John Tyler -- 1956-61

Col Miles R. Palmer -- 1961-69

Col Thomas S. Ford -- 1969-71

Col Robert H. McIntire -- 1971-73

Col Robert H. Kelley -- 1973-75

Col Eldon W. Downs -- 1975-77

Col Jimie Kusel -- 1977-79

Col Donald R. Edwards -- 1979-81

Col James H. Havey -- 1981-83

Col Edwin M. Gleason -- 1983-89

Col David C. Whitlock -- 1989-92

Lt Col Norman Paulsen -- 1992

Col Bennie J. Wilson, III -- 1992-Present

2-6: AFIT Commandants, 1919-1967

Col Thurman H. Bane, -- 1919-22

Maj Lawrence W. McIntosh, -- 1922-24

Lt Col John F. Curry, -- 1924-27

Brig Gen William E. Gillmore, -- 1927-29

Maj Gen Benjamin D. Foulois, -- 1929-30

Brig Gen Henry C. Pratt, -- 1930-35

Brig Gen Augustine Robins, -- 1935-39

Maj Gen Charles A. Branshaw, -- 1944-45

Maj Gen Hugh Knerr, -- 1945

Brig Gen Mervin E. Gross, -- 1946

Maj Gen B. W. Chidlaw, -- 1946-47

Brig Gen Edgar P. Sorenson, -- 1947-48

Maj Gen Laurence C. Craigie, -- 1948-50

Maj Gen Grandison Gardner, -- 1950-51

Brig Gen Leighton I. Davis, -- 1951

Brig Gen Ralph W. Swofford, -- 1951-55

Maj Gen J. K. Lacey, -- 1955-57

Col John Tyler, -- 1957

Maj Gen Cecil E. Combs, -- 1957-65

Col John A. McCann, -- 1964

Maj Gen Victor R. Haugen, -- 1965-67

2-7: Biographical Sketches of AFIT Commandants, 1967-1994

Maj Gen Ernest A. Pinson, -- 1967-1973

General Pinson earned AB degree from DePauw University, Ph.D. from University of Rochester School of Medicine, and a second Ph.D. from University of California, Berkeley. Completed Air Command and Staff College. Served as Chief, Radiobiology Laboratory, Cambridge MA; Chief, Biophysics Division, Albuquerque NM; Technical Director, Sandia Base NM; Commander, Air Force Cambridge Research Lab MA; Deputy Commander and then Commander, Office of Aerospace Research, Washington DC.

Maj Gen Frank J. Simokaitis, -- 1973-1978

General Simokaitis earned a doctor of jurisprudence degree from St. Louis University School of Law in 1950. Completed aviation cadet flight training at Ellington Army Air Field in 1943. Served as flight commander with 478th Bombardment Squadron as a B-26 pilot. Flew 27 combat missions with Ninth Air Force in European Theater. Completed Office of Special Investigations training school in 1950. Served with OSI in Illinois and Wiesbaden,

Germany. Attended Air Command and Staff School. Served as pilot with 1608th Air Transport Wing; Deputy Chief of Staff for Personnel, HQ USAF; Plans and Programs at HQ PACAF; and Executive Assistant to the Secretary of the Air Force.

Maj Gen Gerald E. Cooke, -- 1978-1980

General Cooke earned a BS degree from the University of Maryland, Master's degree from San Francisco State College, and doctorate from the University of Maryland. Completed Air War College. Was commissioned from cadet training as a pilot. Completed photographic reconnaissance training in P-38 aircraft. [As a post-war civilian worked as a commercial pilot, test pilot, and flight instructor.] Flew as B-26, B-45 and B-57 pilot at both George AFB CA and Hill AFB UT. Flew RB-57s from Rhein-Main Air Base, Germany. Served in Minuteman System Program Office of the Ballistic Systems Division, Los Angeles CA. Served as Assistant Chief of Staff at HQ Seventh Air Force, RVN. Served as Director, Air Force Board Structure, Office of Vice Chiefs of Staff; and Secretary for the Joint Chiefs of Staff, Washington DC. Served as Deputy for Operations, JCS.

Maj Gen Stuart H. Sherman, Jr., -- 1980-1982

General Sherman earned BS degree from US Naval Academy and two M.S. degrees from University of Michigan in astronautical and instrumentation engineering. Graduated Armed Forces Staff College and National War College. Served as astronautical engineer on Atlas, Titan and Minuteman intercontinental ballistic missile systems; director of programs for 4000th Support Group at Offutt AFB NB; and as chief of Missile Branch in Office of Deputy Chief of Staff, Research and Development. Served as executive assistant to undersecretary of the Air Force; vice commander of 91st Strategic Missile Wing at Minot AFB ND; and commanded 321st Strategic Missile Wing at Grand Forks AFB ND; the 1st Strategic Aerospace Division at Vandenberg AFB CA; and the Air Force Management Engineering Agency at HQ USAF.

Maj Gen Herbert L. Emanuel, -- 1982-1983

General Emanuel earned undergraduate degree from the University of Massachusetts and master's degree from the George Washington University. Graduated Armed Forces Staff College and the Industrial College of the Armed Forces. Served as personnel staff officer and acting director of personnel at 7500th Air Base Group, Third Air Force, USAFE; director of cadet activities at the US Air Force Academy CO; and helped establish the Air Force Military Personnel Center at Randolph AFB TX. Served as deputy director of personnel plans at HQ PACAF, Hickam AFB HI; director of requirements, HQ Seventh Air Force, Tan Son Nhut AB, RVN; vice commander of AFMPC; and director of personnel programs at HQ USAF.

Maj Gen James T. Callaghan, -- 1983-1986

General Callaghan earned BS degree from the University of Detroit and MS degree from George Washington University. Graduated from the National War College. Completed pilot training and flew 425 combat missions in Southeast Asia. Served in various assignments in HQ Air Force, HQ US Air Forces in Europe, and Joint Chiefs of Staff. Following his tour as AFIT Commandant, served as Commander, US Forces Korea; Commander of the 314th Air Division in South Korea; and Commander of the Allied Forces Southern Europe. Promoted to Lieutenant General Dec 1990, and retired in 1993.

Brig Gen Richard J. Toner, -- 1986-1987

General Toner earned BS degree from US Naval Academy and MS degree from Rensselaer Polytechnic Institute NY. Distinguished graduate of Industrial College of the Armed Forces. Served as commander Detachment 4, 823rd Civil Engineering Squadron 'REDHORSE' at Bien Hoa AB, RVN; chief of Plans Branch in the 'BARE BASE' System Program Office at ASD, WPAFB OH; and politico-military affairs officer assigned to Air

Staff in Washington DC. Served as USAF executive assistant to the Supreme Allied Commander, Europe, SHAPE; deputy director of policy, SHAPE; vice commander and commander of 7206th Air Base Group in Greece; commander Air Force Commissary Service-Europe at Ramstein AB, Germany; and executive assistant to the Air Force Chief of Staff.

Brig Gen Stuart R. Boyd, -- 1987-1991

General Boyd earned BS degree from the Air Force Academy and MS degree from Golden Gate University. Graduated from the Industrial College of the Armed Forces. Completed pilot training and also graduated from the US Air Force Test Pilot School. Served in Southeast Asia with the 497th Tactical Fighter Squadron 'Night Owl' where he flew 107 combat missions and later at Clark Air Base, Philippines. Other assignments included director of projects in the F-16 Program Office; F-16 Program Manager at the Ogden Logistics Center; Commander of the International Logistics Center.

Col Frederick C. Bauer, -- 1991-1992

Colonel Bauer earned BS degree from the US Air Force Academy and MS degree in Systems Management from University of Southern California, and one from the Air Force Institute of Technology in aerospace engineering. Assumed duties of Vice Commandant of the Air Force Institute of Technology in July 1989; came to the Institute from the National War College in Washington DC where he was a member of the faculty and director of part of the Joint and Combined Warfare Course which fulfilled the Joint Chiefs of Staff requirements for education of Joint Specialty Officers.

Col David C. Whitlock, -- 1992-1993

Colonel Whitlock earned a BGE degree, and MA degree, prior to being awarded a Ph.D. degree in Communications and Theatre from the University of Colorado, Boulder. Graduated from Air Command and Staff College and Air War College. Assumed the duties of Dean, Civilian Institution Programs in March 1989. Came from Zweibrucken Airbase, Germany, where he had been the Air Base Commander of the 26th Combat Support Group. Had formerly been Associate Dean of AFIT Civilian Institutions Programs from 1984-86.

Col Joseph P. Koz -- 1993 to the Present

Colonel Koz earned BS degree from US Military Academy, MS degree from University of Northern Colorado, and a Ph.D. degree from American University, Washington DC. Graduated from Armed Forces Staff College, Air War College, and Industrial College of the Armed Forces. Completed pilot training at Webb AFB TX, assigned to Da Nang AB RVN where he flew F-4s; also flew F-4s at Holloman AFB NM. Assigned as air officer commanding at the US Air Force Academy in Colorado Springs CO. Returned to Southeast Asia, served as an F-4 pilot and chief of scheduling at Udorn Royal Thai Air Base, Thailand; achieved total of 350 combat missions. Assignments included 51st Tactical Fighter Squadron, Suwon Air Base, South Korea, and 613th Tactical Fighter Squadron, Torrejon Air Base, Spain. Assigned to the Defense Intelligence Agency as director, Office for Attaches from November 1990 until assignment to AFIT.

The Civil Engineering Team **'Presented to the School of Civil Engineering by Eleonora McCann – 1966'**

The broad diversity of skills found in the Air Force Civil Engineering work force is illustrated by the subjects in the painting . . . field engineer . . ., a surveyor, the white collar professional engineer, a military person, the blue collar craftsman, and the technician. * * *

Staff in Washington DC. Served as USAF executive assistant to the Supreme Allied Commander, Europe, SHAPE; deputy director of policy, SHAPE; vice commander and commander of 7206th Air Base Group in Greece; commander Air Force Commissary Service-Europe at Ramstein AB, Germany; and executive assistant to the Air Force Chief of Staff.

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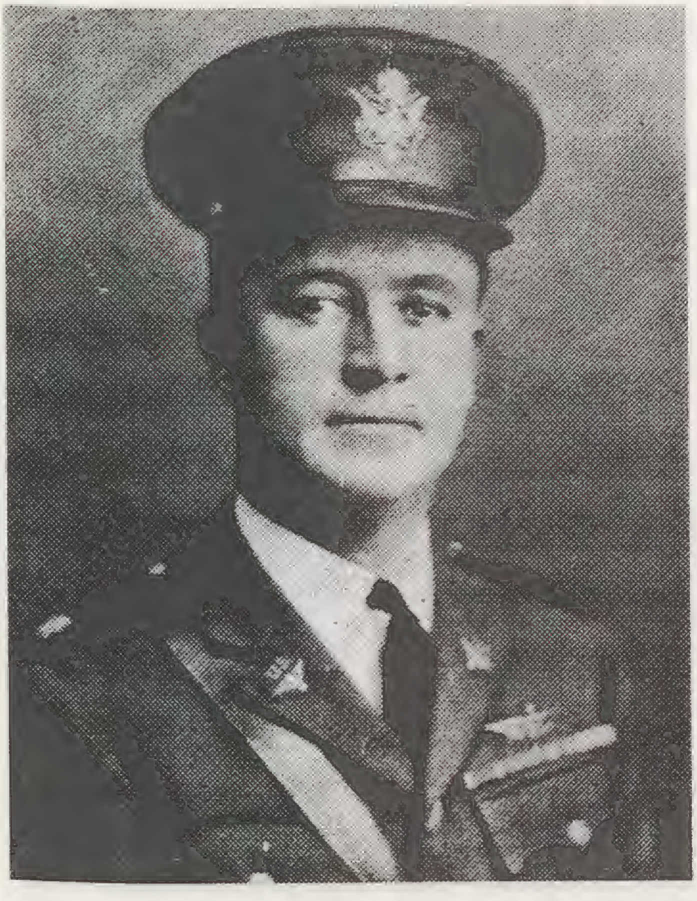
Colonel Thurman H. BANE,
1919-1922

Colonel Lawrence W. McINTOSH,
1922-1924



Lieutenant Colonel John F. CURRY,
1924-1927

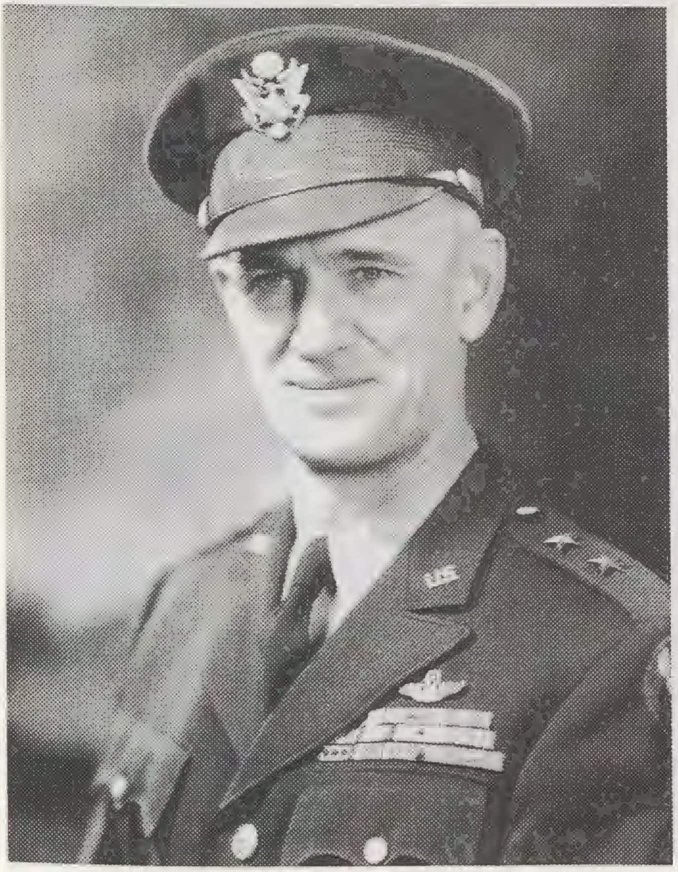
Brigadier General William E. GILLMORE,
1927-1929

Major General Benjamin D. FOULOIS,
1929-1930

Brigadier General Henry C. PRATT,
1930-1935

Brigadier General Augustine W. ROBINS,
1935-1939

Major General Charles BRANSHAW,
1944-1945



Major General Hugh KNERR,
1945

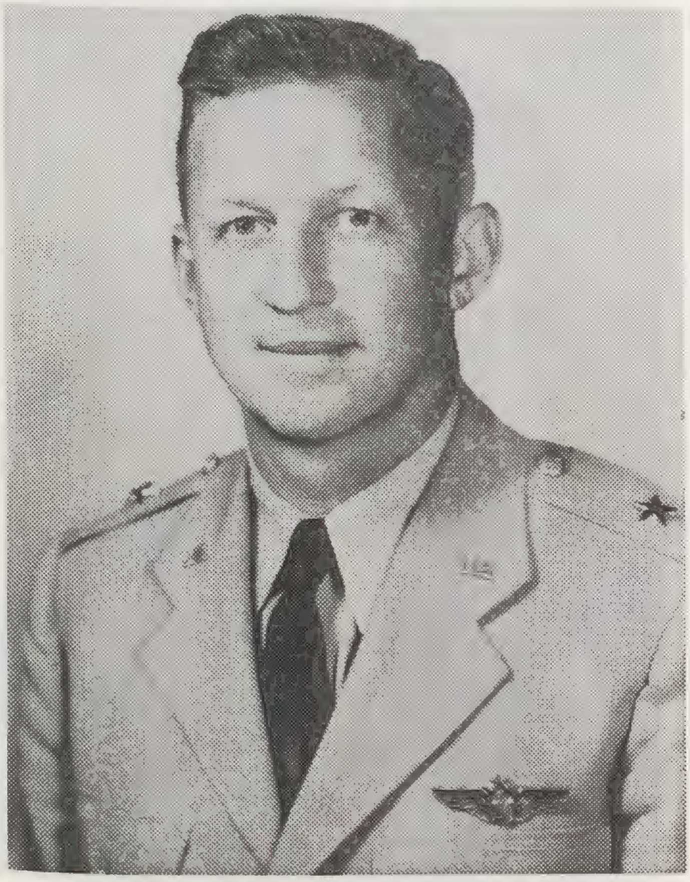
Brigadier General Mervin E. GROSS,
1946-1946

Major General B. W. CHIDLAW,
1946-1947

Brigadier General Edgar P. SORENSON,
1947-1948

Major General Laurence C. CRAIGIE, 1948-1950

Major General Grandison GARDNER, 1950-1951



Brigadier General Leighton I. DAVIS, 1951

Major General Ralph P. SWOFFORD, Jr., 1951-1955

Major General J. K. LACEY,
1955-1957

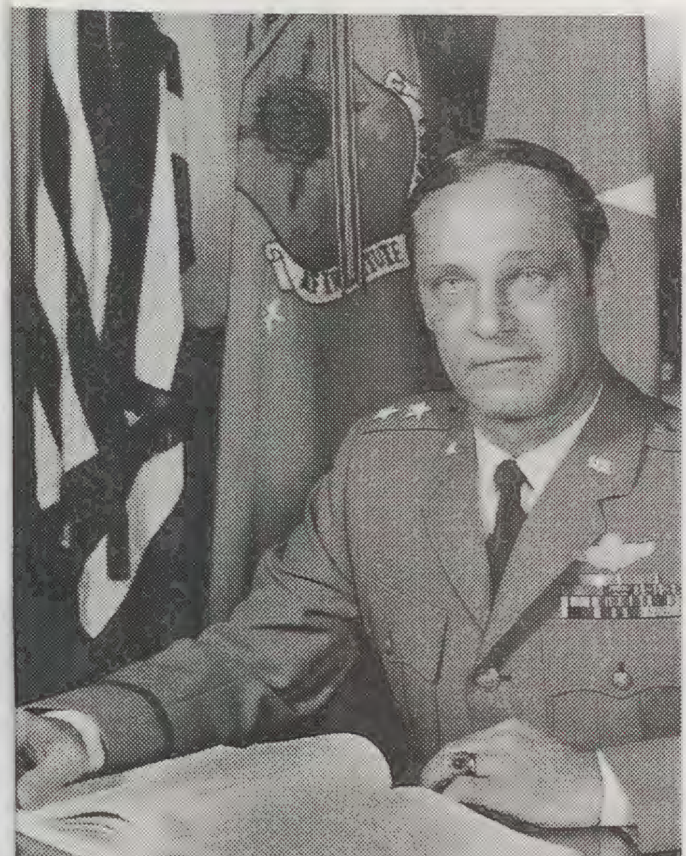
Colonel John TYLER,
1957

Major General Cecil E. COMBS,
1957-1965

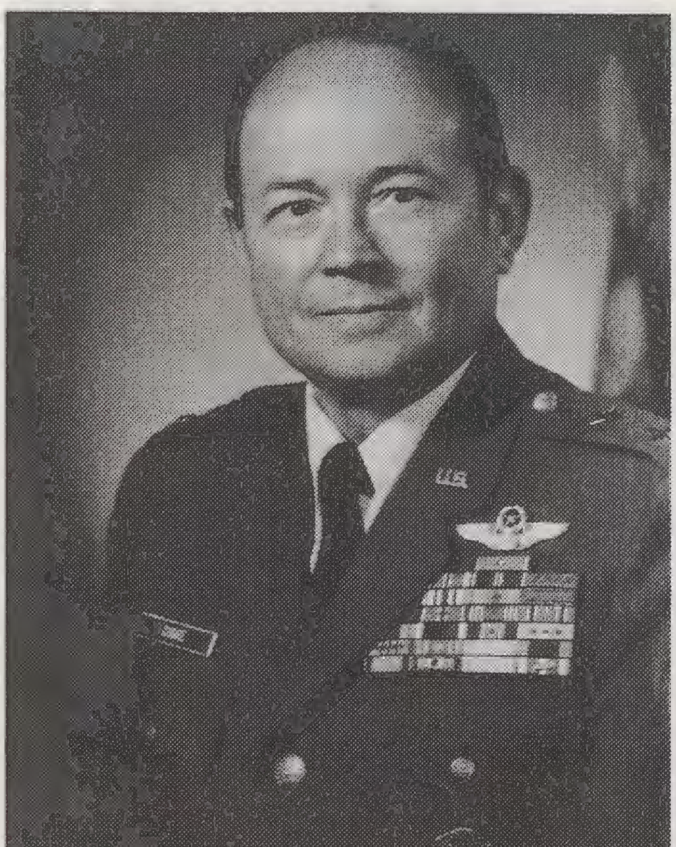
Colonel John A. McCANN,
1964

Major General Victor R. HAUGEN,
1965-1967

Major General Ernest A. PINSON,
1967-1973

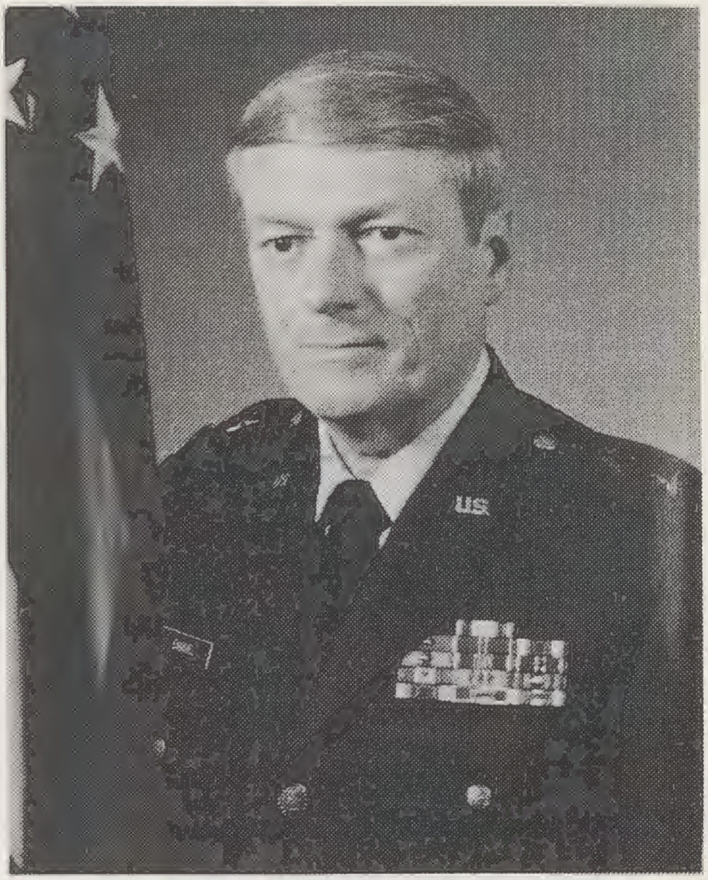


Major General Frank J. SIMOKAITIS,
1973-1978

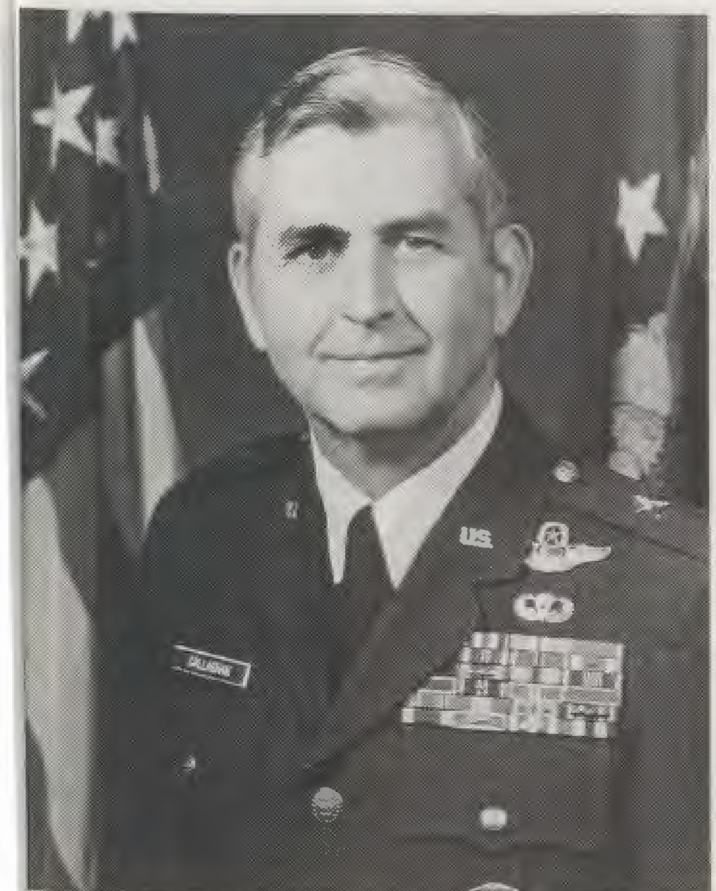


Major General Gerald E. COOKE,
1978-1980

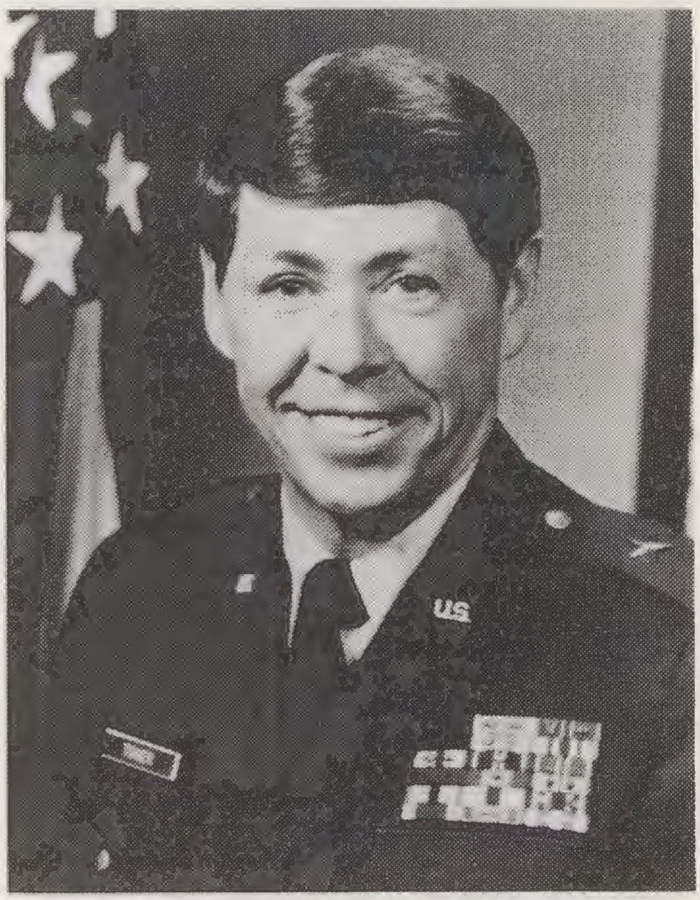
Major General Stuart H. SHERMAN, Jr., 1980-1982



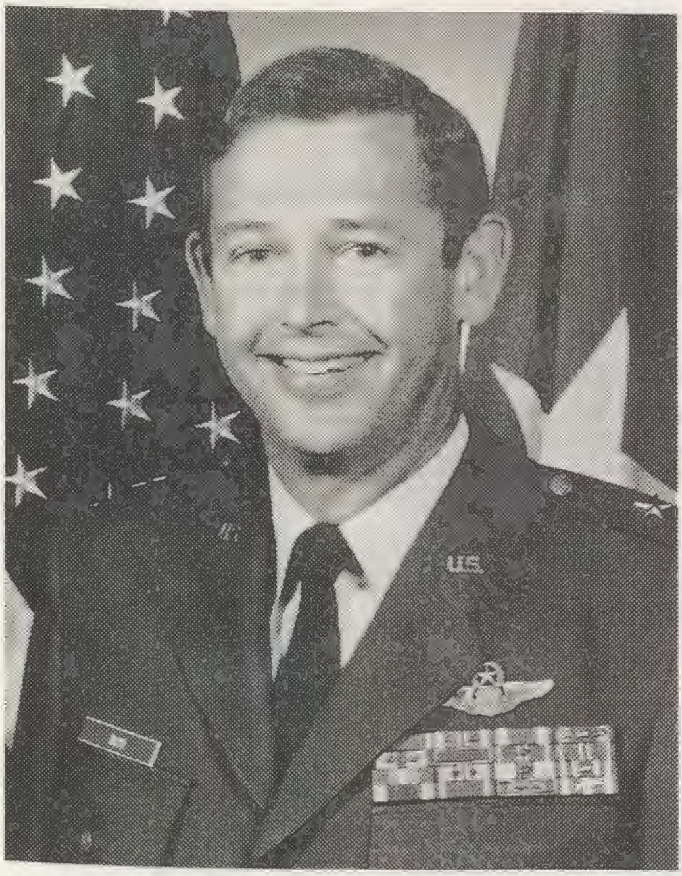
Major General Herbert L. EMANUEL, 1982-1983



Major General James T. CALLAGHAN, 1983-1986



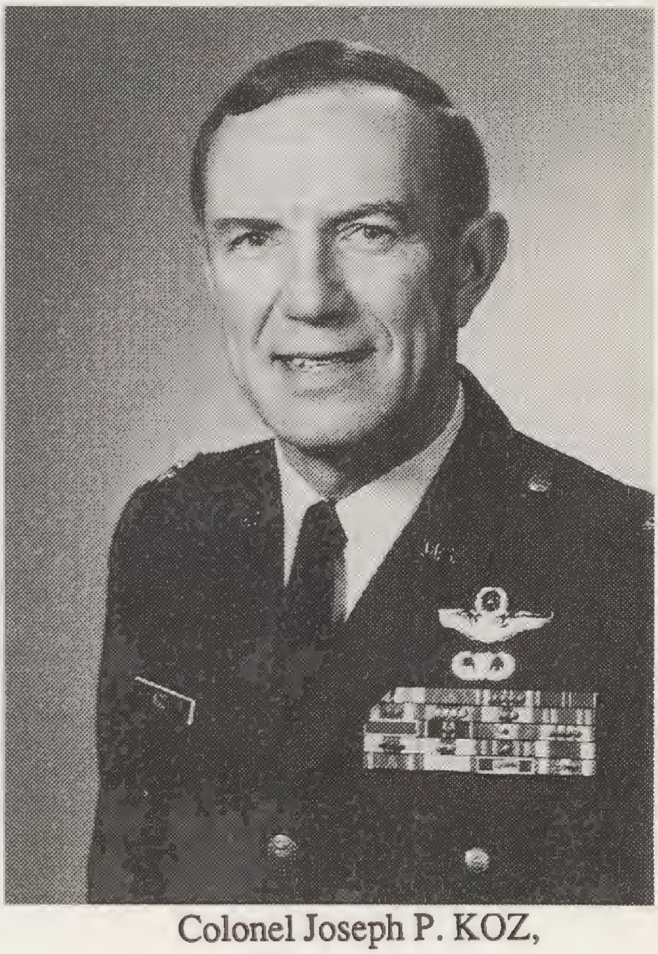
Brigadier General Richard J. TONER, 1986-1987



Brigadier General Stuart R. BOYD,
1987-1991

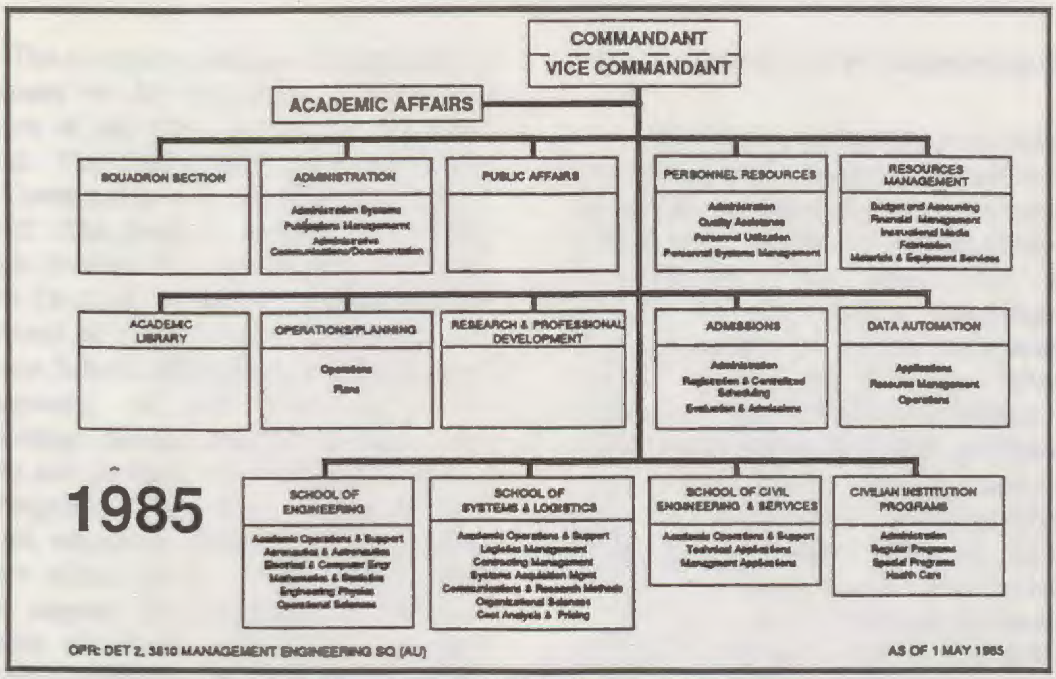
Colonel Frederick C. BAUER,
1991-1992

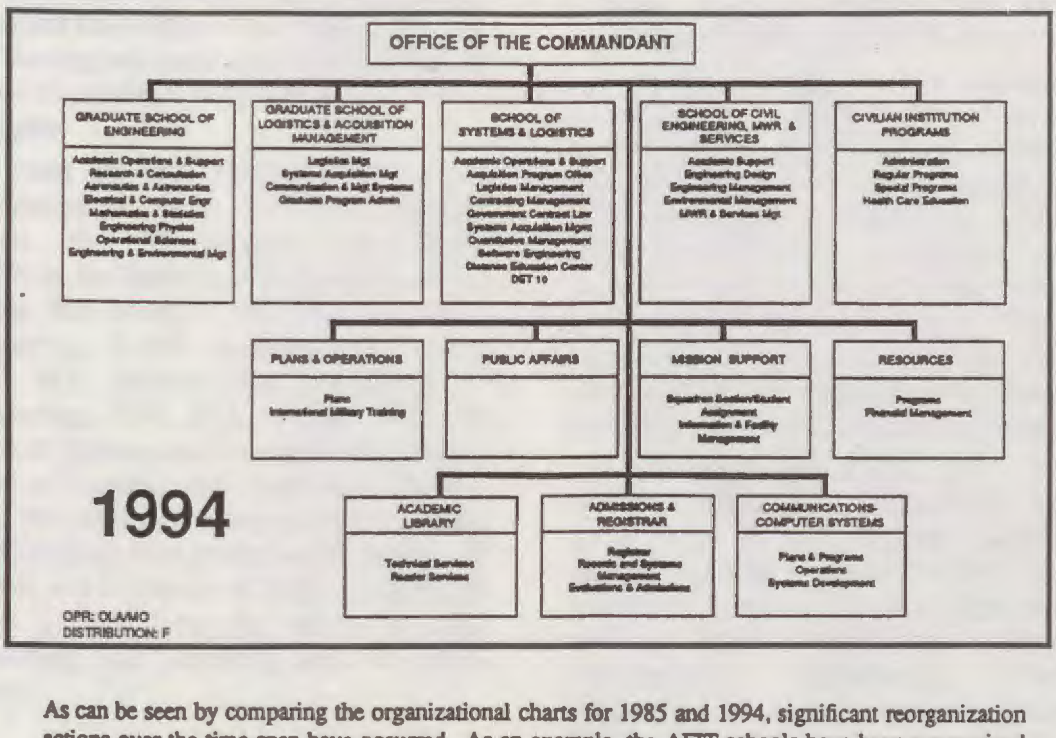
Colonel David C. WHITLOCK,
1992-1993



Colonel Joseph P. KOZ,
1993 to the Present

COMPARISON OF AFIT ORGANIZATION 1985-1994





As can be seen by comparing the organizational charts for 1985 and 1994, significant reorganization actions over the time span have occurred. As an example, the AFIT schools have been reorganized from three to four and a significant reduction in support elements from ten to seven resulted. Additionally, the functions of Vice Commandant, Director of Academic Affairs, and Senior Dean are all in the office of the Commandant.

CHAPTER 3

MISSION AND FUNCTION

The Air Force Institute of Technology, a component of Air University, is under the direction of the Commandant, an Air Force Colonel. The Commandant is assisted by the Vice Commandant who functions as the chief of Staff. The Institute performs its mission through division into five mission elements: (1) the Graduate School of Engineering, (2) the School of Systems and Logistics, (3) the Graduate School of Logistics and Acquisition Management, (4) the School of Civil Engineering, Morale Welfare & Recreation (*MWR*) and Services, and (5) Civilian Institution Programs. These five organizations provide the education, research, and consulting services called for by AFIT's mission. The active support of laboratories on Wright-Patterson Air Force Base (*AFB*) and other government facilities and organizations constitutes an excellent resource for equipment and specialized knowledge. This support provides AFIT faculty and students an almost unlimited number of problems and programs in which to participate.

From the time AFIT received its first accreditation in 1955 from the Engineers Council for Professional Development (*ECPD*) to the December 1993 graduation, the institute has awarded 920 B.S. degrees in engineering, 11,898 masters level degrees [7,492 M.S. degrees from the School of Engineering, 4,011 M.S. degrees from the School of Systems and Logistics and Graduate School of Logistics and Acquisition Management, 384 Master of Business Administration (MBA) degrees from the School of Business in 1958-60, and 11 Master of Engineering Applications degrees from the School of Civil Engineering and Services] and 205 Ph.D. degrees.

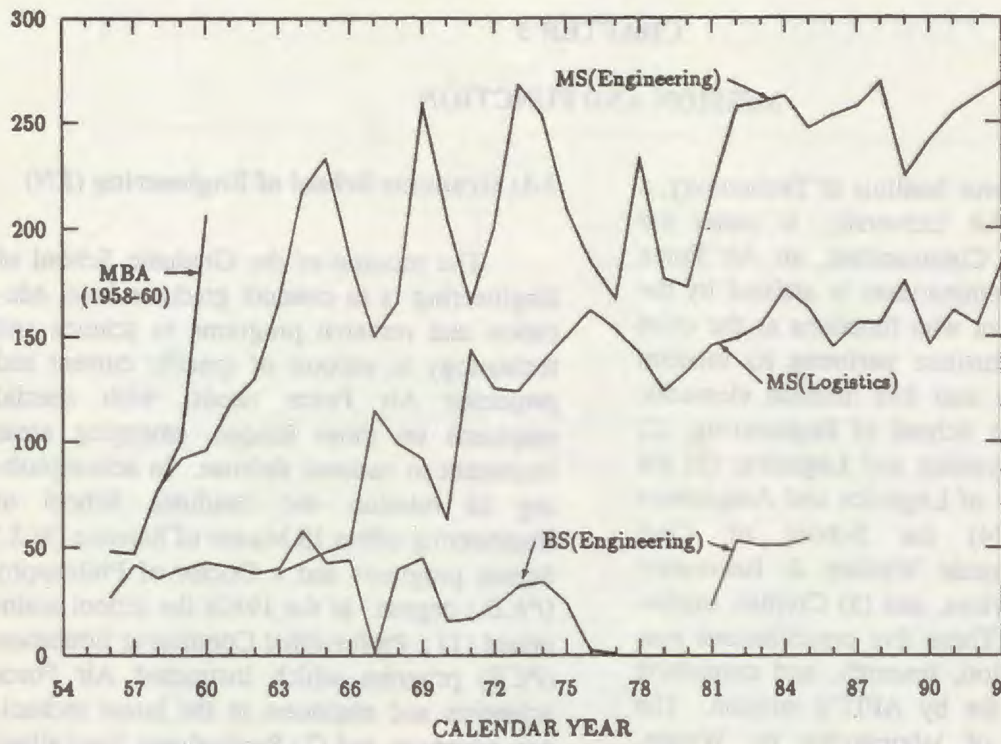
3-1: Graduate School of Engineering (EN)

The mission of the Graduate School of Engineering is to conduct graduate-level education and research programs in science and technology in support of specific current and projected Air Force needs, with special emphasis on those unique, emerging areas important to national defense. In accomplishing its mission, the Graduate School of Engineering offers 13 Master of Science (*M.S.*) degree programs and a Doctor of Philosophy (*Ph.D.*) degree. In the 1980s the school maintained (1) a Professional Continuing Education (*PCE*) program which instructed Air Force scientists and engineers in the latest technology advances, and (2) Professional Specialized Education (*PSE*) programs in both Reliability and Maintainability (*R&M*) and Computer Systems Teleprocessing, the latter specialty specifically designed for the US Army.

Teaching faculty, staff technicians, and students combine efforts to provide the widest possible range of research and consulting services in support of the school's mission. The Graduate School of Engineering, under the direction of the Dean, is organized into the academic Departments of Aeronautics and Astronautics, Electrical and Computer Engineering, Engineering and Environmental Management, Engineering Physics, Mathematics and Statistics, and Operational Sciences.

EN was redesignated The Graduate School of Engineering, effective 24 Aug 93. In addition to the doctoral program in engineering, the school offers ABET* accredited Master of Science degrees in the following areas: Aeronautical Engineering, Astronautical Engineering, Computer Engineering, Electrical Engineering, Engineering Physics, Nuclear Engineering, and Systems Engineering.

* Accreditation Board for Engineering and Technology



Degrees awarded by the resident schools in AFIT.

Master of Science degrees are also offered [with specialization] in the following areas: Applied Mathematics, Applied Physics, Electro-Optics, Engineering and Environmental Management, Strategic and Tactical Sciences, Operations Research, and Space Operations.

Department of Aeronautics and Astronautics (ENA). This department provides the educational expertise in Aeronautical Engineering, Astronautical Engineering, Systems Engineering, Mechanical Engineering, and Engineering Mechanics. The major department effort is devoted to teaching and research in support of programs leading to the Masters degree in the first three of these program areas and Doctoral studies in any area of departmental activity.

The programs in Aeronautical Engineering, Astronautical Engineering and Systems Engineering are all accredited by the Accreditation Board for Engineering and Technology (*ABET*).

Three major areas of expertise can be identified within the Department. These are: (1) Fluid Mechanics and Energy Transmission, (2) Solid Mechanics and Structures, and (3) Dynamics, Systems and Controls.

(1) The Fluid Mechanics and Energy Transmission Division provides courses and opportunities for research in aerodynamics, (compressible, incompressible, viscous and computational), propulsion (air-breathing, rocket, and non-chemical), and heat transfer (convection, conduction, and radiation).

(2) The Solid Mechanics and Structures Division provides course offerings and research programs covering such topics as applied mechanics (elasticity, plasticity, and continuum mechanics), structures (stability, shells, and finite element methods), and structural materials (fracture mechanics, composite materials, and fatigue).

(3) The Dynamics, Systems and Control Division provides courses and research activities in aircraft flight mechanics (performance, stability, and control), astrodynamics (orbital mechanics and optimal trajectories) spacecraft attitude dynamics, systems (engineering modeling of large scale systems and weapons analysis), and robotics (manipulators, remote systems and man-in-the-loop control).

Department of Electrical and Computer Engineering (ENG). The department now consists of three divisions. The Computer Science and Computer Engineering faculty were merged to form a consolidated group. They now constitute the Computer Science and Engineering Division in the Department of Electrical and Computer Engineering. They conduct two programs: Graduate Computer Systems and Graduate Computer Engineering. The other two are the Electrical Engineering Division, in charge of the Graduate Electrical Engineering Programs, and the Laboratory Division.

Software Engineering courses have been taught at AFIT for over 18 years. It is now recognized as an important discipline that impacts all major weapon systems. Based on an Air Force-wide Broad Area Review (*BAR*), the extensive requirements for Software Engineering were finalized. To meet the requirement, AFIT/ENG developed a set of five courses, of 2-weeks duration each, to provide the needed education. After the set of courses was developed, the short course program was established as a separate program administered by AFIT/LSS. Also, a graduate specialty in Software Engineering is included in the Graduate Computer Systems and Graduate Computer Engineering programs. The graduate program and the set of five short courses provide the means for qualifying for the newly instituted 4935B (3353B) Air Force Specialty Code (*AFSC*), Communication-Computer Systems Software Engineering.

The Electrical Engineering specialty in Electromagnetics has a new specialty in Low Observables. The emphasis is on reduction of radar cross-section (*RCS*). A modern laboratory includes an anechoic chamber containing an RCS range. The student gets an understanding of current measurement techniques by hands-on experiments. Extensive research is conducted by the students and faculty in direct support of Air Force and DOD projects.

A specialty in robotics is offered jointly by the Department of Electrical and Computer Engineering and the Department of Aeronautics and Astronautics. A mix of electrical and mechanical engineering courses provides the interdisciplinary knowledge required in this specialty. Extensive use of robots is coordinated with the AF Robotics and Automation Center of Excellence.

An advanced specialty in Very Large Scale Integration / Very High Speed Integrated Circuits (*VLSI/VHSIC*) has been offered as a specialty in the graduate electrical engineering program for 15 years. It incorporates a comprehensive synthesis of computer architecture and design, solid state technology, and computer science to create powerful signal and data processing systems. Design methodologies are explored with emphasis on design trade-offs which include performance, circuit area, and design time. The student gets hands-on experience by designing, laying out, and validating a complex integrated circuit of more than 10,000 transistors. The integrated circuit is fabricated by a National Science Foundation silicon foundry. Then the chip is evaluated functionally and parametrically. Extensive research is performed, supporting this DOD critical technology.

Department of Engineering and Environmental Management (*ENV*). As a newly formed department in the Graduate School of Engineering in 1992, it was created to initially support the new Graduate Engineering and Environmental Management (*GEEM*) program, later redesignated as the Graduate Environmental Management (*GEM*) program. Initial department resources were derived from the previous graduate program in Engineering Management which resided in the School of Systems and Logistics. The goal of the GEM program is to provide the Air Force with

officers who have a strong background in environmental sciences and engineering and the capability to apply that background in environmental management and decision making. The technical, quantitative framework for management is critical for the success of the graduates. The program has grown dramatically and now serves 37 education quotas per year at the masters level plus several Air Force civilian students funded from the Defense Environmental Restoration Account. The curriculum provides students with the opportunity to develop and apply a variety of quantitative and qualitative concepts, skills, and techniques to integrate science and policy issues into a decision-making framework for enhanced management of the environment and man's activities as it effects the environment. Coursework includes a probability, statistics, and chemistry background; air, land, and water resource management; environmental risk analysis; pollution prevention and economics; environmental planning; and project management; as well as minor sequences offered from other departments throughout the school. Thesis efforts are routinely submitted for peer-reviewed publication and have been a significant source of Air Force field guidance in the environmental management discipline.

Department of Engineering Physics (ENP). The Engineering Physics and the Electro Optics Programs were Combined. There was a significant increase in the number of students in the doctoral program in the department. Doctoral quotas in physics have risen from approximately two or three per year (in the late seventies) to over ten per year in the early nineties. This increase in Ph.D. quotas strongly influenced the significant increase in departmental research activity over this period.

Low Observables program was initiated in the School of Engineering in 1983. Although this program is based in the Department of Electrical and Computer Engineering, there is a strong physics department input. Physics offers the optical engineering core of five courses and an in-depth laboratory as part of the program. The courses cover optics, lasers, optical radiometry and detection, electro-optical systems and optical observables reduction. The laboratory occupies two rooms in Bldg 194 (in Area B) and consists of experiments in infrared signatures, laser cross section, infrared and visible atmosphere propagation, etc. This program was brought on-line initially as a six-month short course program in 1983 and quickly evolved to a full 18-month masters program, as it remains today.

The combination of the Engineering Physics Program and the Electro Optics Program has been responsible for providing a highly significant proportion of the officers who developed this country's expertise in laser and directed energy weaponry. The emphasis of the Engineering Physics Program was shifted to the high energy laser area in the early seventies and this emphasis remained and was expanded to include particle beam and high energy microwaves during the Space Defense Initiative (*SDI*) years of the eighties. The lion's share of this work was located at the AF Weapons Laboratory (now the Phillips Laboratory) at Kirtland AFB NM. The Engineering Physics Department student output in this area was over ten officers per year during the height of this effort. These officers contributed significant leadership in these programs. For example, the development of the Airborne Laser Laboratory, consisting of a high energy laser mounted in a KC135, was initiated by Colonel Donald Lamberson (later Major General Lamberson), a graduate of the department's Nuclear Engineering Program, and the development of the new Chemical Oxygen-Iodine Laser (*COIL*), with great promise for high energy application, began with the research of Major Nick Pchelkin, a graduate of the Engineering Physics Program.

Department of Mathematics and Statistics (ENC). The primary function of this department is to provide instruction in graduate level mathematics and statistics courses for all Masters and doctoral programs in the Graduate School of Engineering. Some courses are also provided for programs in the Graduate School of Logistics and Acquisition Management. In addition, the department has

responsibility for the Graduate Applied Mathematics (GAM) Program, and, although the number of graduates in the department had remained quite modest over the last several years, there has been a small increase recently in the number of Ph.D. students.

Department of Operational Science (ENS). This department offers three programs leading to the Master's degree: operations research, strategic and tactical sciences and space operations. The focus of these programs is on the proper employment or optimal use of resources and weapons systems. In addition, a Ph.D. with focus on operations research is also offered.

The operational research program emphasizes traditional operations research techniques such as math programming, simulation, probability, statistics, econometrics and systems analysis.

The strategic and tactical science program was built on the operations research program but focuses on weapons effects, operational planning, and the optimal use and employment of weapons systems.

The space operations program, while offering some operational research courses, is primarily a multi-disciplinary engineering-related curriculum which focuses on the effective use and employment of space assets. All three programs require a strong technical background and are highly quantitative.

The Department of Operational Sciences inaugurated a Ph.D. program in Operations Research. The first Ph.D. student, Capt Mark Gallagher arrived in Sep 1989, and graduated in 1992, on schedule.

3-2: Graduate School of Logistics and Acquisition Management (LA)

The mission of the Graduate School of Logistics and Acquisition Management is to provide the education required by future Air Force and DOD leaders and managers to efficiently and effectively acquire and support the complex, high-technology systems necessary for national defense. To accomplish its mission, the School offers six Master of Science degree programs. The School, as a separate organization, was first established on 1 April 1992 by taking over the graduate program from the School of Systems and Logistics. It operated in a test status as the School of Logistics and Acquisition Management until 31 August 1992. During this time the Associate Dean for the School of Systems and Logistics, Dr. Richard Murphy, also served as the Acting Dean of the School of Logistics and Acquisition Management. As of 1 Sep 92 the School was officially established, the test successfully concluded. Shortly thereafter Colonel Thomas F. Schuppe was named as the School's first Dean.

The creation of a separate graduate school has provided the opportunity to examine how graduate education supports the Air Force's system of acquiring and supporting its weapon systems. As the Department of Defense restructures itself in response to the changed security environment, the management of resources, that is the foundation of LA's academic programs, will be in the forefront of implementing new ways of doing business. LA will prepare its graduates to lead in the downsizing of the Air Force to ensure that logistics support is attainable and equipment readiness insured. As a means of leveraging AFIT's research abilities, increased emphasis is being given to the student thesis projects. By promoting closer ties between an individual faculty member's research and that of the students he or she advises, the school's output will be enhanced, and higher quality solutions to Air Force management problems can be generated.

On 24 Aug 93, LA was redesignated the Graduate School of Logistics and Acquisition Management. It is now organized into three teaching departments: Graduate Acquisition Management, Graduate Logistics Management, and Graduate Management Systems.

Master of Science degrees are offered by the school in the following specialty areas:

Acquisition Logistics Management,
Contracting Management,
Cost Analysis,
Information Resource Management,
Logistics Management,
Maintenance Management,
Software Systems Management,
Supply Management,
Systems Management, and
Transportation Management.

Department of Graduate Acquisition Management (LAS). This Department was originally responsible for five graduate programs as well as the support areas of accounting, financial management, contracting, systems management, and economics. In January 1993, one graduate program (Information Resources Management) and the economics support faculty were moved to the Department of Graduate Management Systems. Since that time the Department of Graduate Acquisition Management has directed the Graduate Systems Management Program, the Graduate Contracting Management Program, the Graduate Cost Analysis Program, and the Graduate Software Systems Management Program. Lt Col Michael Heberling was the first Department Head, with Dr. Roland Kankey joining the Department Faculty and assuming the Department Head position in April 1993.

The Department of Graduate Acquisition Management directs four programs:

Graduate Systems Management (GSM) Program: The GSM Program is designed to provide students with the knowledge and skills which will enable them to excel as project managers in the defense acquisition management arena. The graduates of the GSM Program are able to apply project management principles to effectively plan, organize and control project resources in order to accomplish project objectives. These graduates are able to apply acquisition management theory, policy and practices to develop and implement appropriate acquisition strategies. In addition to the specialized acquisition management courses, the graduates of this program also develop managerial, problem solving, and decision making skills through more general courses such as statistics, operations management, and organizational behavior. The program is conducted in five academic quarters. The vast majority of the graduates serve as project managers at the major Air Force product centers upon completion of the program. The GSM Program was first established in the AFIT School of Engineering in the mid-1960s. The Program was transferred to the graduate division of the School of Systems and Logistics in the late 1970s. The program sponsor is the Air Force Materiel Command (AFMC/XR).

Graduate Contracting Management (GCM) Program: The GCM Program is designed to provide students with the knowledge and skills needed to analyze problems and to manage human, financial, material, and contractual resources in future assignments as middle and upper level managers in the contracting and manufacturing management career field. The program is conducted in five academic quarters. GCM students take a series of systems contracting-specific courses designed to prepare them for positions of responsibility in systems level contracting. Example courses cover pre-award and post-award systems contracting functions, systems acquisition management, contract pricing, contract negotiation and contract law. Most graduates are assigned to the Air Force Materiel Command in systems level contracting. The GCM Program began as an option under the Graduate Logistics Management Program in 1979, with the first class graduating in 1980. The growth to a full program was prompted by the criticality of contracting to DOD acquisition and logistics. The class of 1988 was the first class to be awarded the degree Master of Science in Contracting Management. The sponsor for this program is the Air Force Directorate of Contracting (SAF/AQC), Brig Gen Drewes.

Graduate Cost Analysis (GCA) Program: The GCA Program merges general management skills and concepts with the technical quantitative skills needed by a cost analyst. The program assures that the student understands the cost analyst's environment and role, the concepts of cost modeling and estima-

tion, and the correct application of quantitative techniques used in cost estimation and cost analysis. The curriculum focuses on the broad area of applying cost analysis in support of the DOD decision making process. During the students' independent study they are expected to address a current Air Force/DOD issue related to cost analysis. While the cost analysis courses are not intended to teach existing procedural requirements, much of the casework and many of the problems are drawn from or related to current cost analysis work. This format exposes the students to current cost analysis procedures and policies. This program is conducted in five academic quarters. Specific unique courses are included which address cost modeling, model diagnostics, project risk analysis, and life cycle cost. Most graduates are assigned to one of the acquisition centers within: Air Force Materiel Command, the SAF/FM organization, or the AF Cost Analysis Agency. The GCA Program grew from a need identified by the Air Force Comptroller for a graduate program in cost analysis in 1981. Discussions with AFIT followed, resulting in the creation of a cost analysis option to the GSM program in 1981. The first students entered in 1982 and graduated in Sept 1983. The GCA Option transitioned to a full graduate program in 1987. The sponsor for the program is now the Secretary of the Air Force (Financial Management), with particular ties to the SAF/FMC (Cost and Economic Analysis) organization headed by Mr. Leroy Baseman.

Graduate Software Systems Management (GSS) Program: The GSS Program provides military and civilian software managers with the concepts, analytical skills, and methods of software systems management so that its graduates are prepared to handle the acquisition and management of large software systems, including those embedded in other systems. This program is aimed at resolving and precluding Air Force mission difficulties in the critical and growing area of software development. The program is conducted in six academic quarters (18 months). Students take a sequence of software engineering courses in AFIT's Graduate School of Engineering and build on this base with a series of software management and other courses in the Graduate School of Logistics and Acquisition Management. Graduates may expect to be assigned to positions requiring the management of people and resources in a software acquisition organization, software development organization, or the software side of a system acquisition organization. The program traces its roots to the *USAF Software Broad Area Review* in 1989, where the participants noted a serious management deficiency in the acquisition of software. With the support of the Commandant, AFIT faculty members proposed the creation of a new graduate program to address the deficiency. Twelve students entered the program in 1990. The Deputy Assistant Secretary of the Air Force (Communications, Computers, and Logistics), Mr. Lloyd K. Moseman, became the sponsor of the program in the Summer of 1992.

Department of Graduate Logistics Management (LAL). The Department of Graduate Logistics Management offers a program leading to the Master of Science in Logistics Management. Designed to prepare defense managers to apply a full range of logistics theories, concepts, and techniques to improve performance throughout the defense community, the curriculum broadly consists of three categories of courses: foundation courses which provide the analytical tools the logistician may use, general management courses, and applied courses in various aspects of the field of logistics. Five options in the curriculum allow for a concentration in a single field.

The Graduate Logistics Management (GLM) Option is the broadest of the options in scope and focuses on the integrated nature of logistics. A customer service orientation provides the integrative concept for covering individual logistics elements and for linking these elements in the design and management of a logistics system. Students examine logistics management theory and practices in both commercial and defense applications. Strategic management is the framework for addressing the role of logistics in both the grand strategy of the Air Force as well as in commercial enterprise.

The Graduate Acquisition Logistics Management (GAL) Option stresses the importance of logistics as a life-cycle process and introduces students to the concepts of managing logistics during system acquisition. Courses offer a description of the acquisition process, basic life-cycle cost techniques, the impact of reliability and maintainability on the operation and support of a system, the Integrated Logistics Support elements, logistics support analysis in the systems engineering and design processes, and use of computer-aided acquisition logistics tools.

The Graduate Supply [Inventory] Management (GIM) Option raises the professional competence of supply officers through course work in inventory management of reparable and consumable items, forecasting techniques, and practical application of quantitative and qualitative techniques to supply management.

The Graduate Transportation Management (GTM) Option is aimed at preparing the transportation officer for a DOD environment characterized by shrinking resources, a fee-for-service operating system, and the need for innovative solutions to transportation problems in an integrated logistics setting. Courses provide a conceptual foundation to transportation management, application of transportation principles to real-world problems, public policy as it relates to transportation and the implications of this policy on strategic mobility.

The Graduate Maintenance Management (GMM) Option develops an understanding of the role of the USAF maintenance subsystem in the overall DOD logistics system and of the formulation of logical approaches to selected maintenance decision problems. Various topics of importance to the maintenance community are offered including reliability and maintainability, depot operations, and scheduling.

Department of Graduate Management Systems (LAR). The Department of Graduate Management Systems offers courses in communication, the organizational sciences, economics, information resources management, and research methods. The common interests of these seemingly disparate disciplines are centered in student thesis research and the resultant research results report, the master's thesis. Department faculty are also active in Air Force and DOD consulting efforts in strategic planning and management, reorganization, quality, and documentation production.

The department supports the core course requirements in most of the Institute's resident masters' programs. Specifically, each program in the Graduate School of Logistics and Acquisition Management requires four to eight of the department's courses, and many of the programs in the Graduate School of Engineering require one to three courses. In addition, thirteen elective courses are offered.

The department is also responsible for the *Graduate Information Resource Management (GIR) Program.* This is a relatively new management concept that has emerged as the focus of information systems in organizations has shifted away from the boxes-and-wires of the computer system and focused instead toward the strategic management of data as a corporate resource. Accordingly, this program strives to develop functional users literate in information resource management rather than to improve the technical skills of computer systems professionals. The GIR program accomplishes this task by providing students with both the technological underpinnings of the information systems field as well as the organizational theory required for the development of rational planning, sound strategy, and appropriate economic justification. Example courses in the curriculum include business process re-engineering, strategic planning for information systems, information engineering, database management systems, and artificial intelligence for managers. The program is conducted in six academic quarters. The majority of graduates serve at MAJCOMs or higher levels upon completion of the program. The GIR program was initiated in November 1984 when AF/DA submitted a written request for establishment of a management-oriented information systems degree that would support

their mission change from general administration to information management. Since that time the program has gone through numerous changes and improvements. These efforts culminated in 1993 when the program was honored by the Information Resource Management Association as the state-of-the-art information resource management program in the country (placing above such schools as Harvard, MIT, and Carnegie Mellon), certification by the Defense Information Systems Agency (*DISA*) as the DOD educational institution for information resource management and business process re-engineering, and designation by Texas Instruments as the DOD Flagship in information engineering education. The program is sponsored by SAF/AAI and maintains strong ties to DISA's Corporate Information Management (*DISA/CIM*) program.

3-3: School of Systems and Logistics (LS)

From its inception in 1955, the mission of the School of Systems and Logistics has been to educate Air Force and DOD personnel in technical management with emphasis on acquisition and logistics, and to conduct related research and consulting. This mission has three principal elements. First is the teaching of students. Second is research and its accompanying publication for professional development and for curriculum application. Third is to provide access of faculty expertise and experience to other organizations of the Air Force and Department of Defense through consulting.

To perform its mission, the School of Systems and Logistics is organized into six teaching departments. These are:

Department of Government Contract Law (*LSL*),

Department of Logistics Management (*LSM*),

Department of Contracting Management (*LSP*),

Department of Quantitative Management (*LSQ*),

Department of Software Engineering (*LSS*), and

Department of System Acquisition Management (*LSY*).

Each department is supported administratively and logistically by the school's Department of Academic Operations and Support (*LSA*), the Information Resources Center (*LSI*) and the Acquisition Program Office. In addition, the executive agent for the Center for Distance Education (*LSE*) resides in LS.

The function of the school is to develop each individual's ability to apply sound management techniques to better manage valuable resources. To accomplish this mission, courses are offered in the areas of contracting, systems management, software systems management, cost estimating and analysis, contract law, and logistics. In Fiscal Years 1992-3, 76 faculty representing all three military services taught 374 offerings of 58 courses varying in length from three days to four weeks. Some 277 of these offerings were taught in residence. The remaining 97 offerings were taught at various sites in the Continental United States and overseas. This combined effort enabled the school to educate 7358 students in residence and 2472 students at on site offerings.

There were several PCE Program/Course changes in the late 1980s. The School of Systems and Logistics' Department of Government Contract Law (*AFIT/LSL*) created a new course titled PPM 302JA, Government Contract Law for Attorneys. Under the direction of Professor Timothy J. Dakin, the course provides beginner USAF Judge Advocates (*JA*) specialized education in Government Contract Law to help anticipate, focus on, and provide answers to Government Contract Law problems they have or will encounter. This course was requested by USAF/JA and has been presented on a trial basis twice. Requirements are based on a lack of Air Force quotas at the USA/JA School at Charlottesville, Virginia, and the lack of specialized staff at the USAF Judge Advocate General (*JAG*) School at Maxwell AFB, Alabama. The class is offered twice a year with an enrollment of thirty stu-

dents per class. The class is unique for two reasons: (1) Unlike the USA/JA School at Charlottesville which is Army oriented, this course is Air Force oriented, and (2) the class is geared toward a morning lecture with the afternoon seminar organized into groups which participate in actual practical applications which are overseen by active duty Judge Advocates.

Two new courses were established for offering in 1990, LAWS 551 (Legal Aspects for Contracting for Non-Contract Managers) and LAWS 699 (Independent Study in Law). SYS 201 (Mission Critical Computer Research Acquisition) and SYS 202 (Mission Critical Computer Software Support Management) were combined into SYS 212 (Mission Critical Computer Software Project Management). COST 672 (Model Diagnostics) was split into two separate courses: COST 672 (Regression Analysis) and IMGT 676 (Software Cost Estimating).

New Courses in Acquisition Management and Software Engineering. Keeping current in one's job is never easy, even when the right courses are available. If the course isn't full, it may be too long because of job responsibilities. A 'new' Air Force program may offer a solution in the acquisition management business. AFIT initiated a program which is designed to shorten the length of courses in acquisition management and add more offerings. It replaces the familiar System Program Management Course (SYS 223), for upgrade in specialty code (*AFSC*) 27XX, (i.e., Systems Acquisition Officer).

The program offers updated basic acquisition management and program management courses, commencing in January 1982, entitled Introduction to Acquisition Management (SYS 100), and is a prerequisite for several specialty courses, such as Acquisition Logistics or Configuration Management. Acquisition Planning and Analysis (SYS 200), designed for project managers and program analysts, began in July 1982.

Since a large number of personnel need the basic acquisition management course, it was offered both in residence and through the Teleteach Expanded Delivery System, through both AFLC or AFSC networks. Increased use of videotapes at each site, followed by discussion periods, improve student understanding of the material. AFIT continues to design new programs, providing needed education for Air Force managers. Through these efforts both the individual, as well as the Air Force, benefit from knowledge gained, with less time spent away from the job.

During 1989, a new series of Professional Continuing Education (*PCE*) courses in the area of Software Engineering were created. As the result of a cooperative effort between the Air Force Institute of Technology, Air Force Systems Command, Air Force Communications Command, and Air Force Logistics Command, six new military faculty positions were provided, along with six million dollars in FY90, to get this series of courses ready. Beginning in FY91 five different two-week courses were offered, as follows:

Software Engineering Concepts,

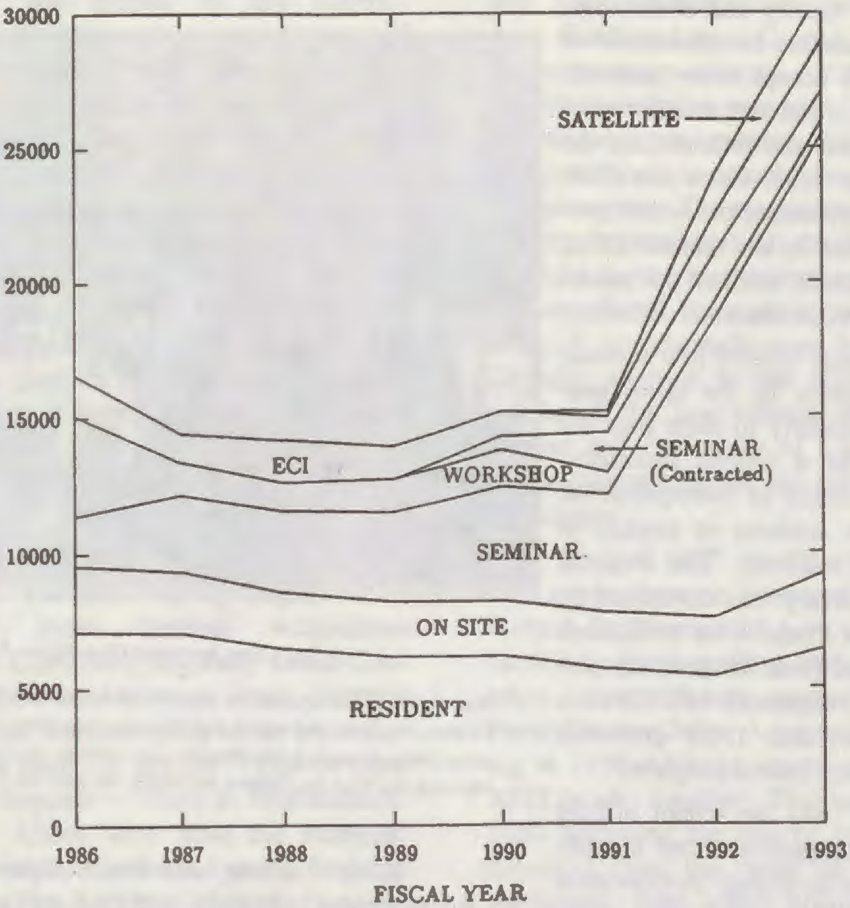
Specification of Software Systems,

Principles and Applications of Software Design,

Software Generation and Maintenance,

Software Verification and Validation.

In all, a total of twenty-seven offerings were provided annually to over five hundred students in the three sponsoring major commands (AFSC, AFCC, and AFLC). This represents a more than doubling of the previous PCE effort formerly conducted by the School of Engineering in all disciplines.



Professional Continuing Education (PCE) course completions: School of Systems and Logistics.

Recent Organizational Changes and Issues in the School of Systems and Logistics (LS). In addition to the absorption into LS of the software engineering PCE courses, one of the most significant organizational changes in 1991 through 1993 was the creation of a Center for Distance Education (*CDE*) to meet the increased demand being placed on AFIT's resources in the area of distance learning (*DL*) by the Acquisition Professional Development Council (*APDC*). In Feb 92, the Commandant created the CDE from several agencies within the Institute and designated LS as executive agent. With the APDC funding AFIT's DL initiatives, placing the CDE under LS brought this service in line with the customer-provider link. The CDE also serves other schools within the Institute, however, and supports AU in the development of a command DL initiative. Other organizational changes to deal with the growing demands of the APDP and the DAU were conceptualized, such as the creation of a separate program office within LS to deal with DAU and APDP quota requests, course content demands, and resource supplementation.

A satellite broadcast capability provides greater access to those courses experiencing the highest demand. The instruction presented in a resident offering is simultaneously broadcast over a satellite network to multiple locations. Each site receiving the broadcast is the equivalent of an additional course offering. In Fiscal Year 1992, for example, 51 offerings were broadcast to nine sites reaching an additional 1,501 students. Fifty-eight offerings were broadcast to 13 sites via satellite in Fiscal Year 1993, reaching 1,757 students.

The number of faculty and classrooms, even with the use of satellite broadcasts, limits the school's ability to accept every potential student. Consequently, alternative sources of education are developed and provided by the school. In Fiscal Year 1993, 42 on site offerings were presented by contractors whose personnel had been certified by the school. Using contractor-provided faculty enabled the school to reach an additional 1092 students.

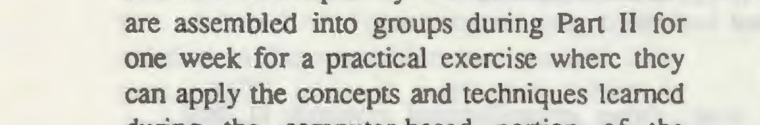
Eight courses were offered in a seminar mode, providing students in the same geographic area the opportunity to learn together with the assistance of a trained facilitator. Seven courses were offered as correspondence courses, allowing the students to engage in individual self-paced learning. The material for both modes of delivery was developed by the school faculty. In Fiscal Year 1992 there were 10,930 graduates from the seminar program [plus the above referenced 1,501 in nine offerings via satellite] and 1,468 graduates from the correspondence course program.

In Fiscal Year 1993 the school offered its first course via computer-assisted instruction, enabling students to engage in individual self-paced learning at their work sites, using software developed by the school. Students are assembled into groups during Part II for one week for a practical exercise where they can apply the concepts and techniques learned during the computer-based portion of the course.

SYS 111 First Academic Class (92A), February 1992

(Left to right) Lt Col Schneider, Mr. Steiner, Capt Burkes, Maj Flake, Mr. Urrutia, Maj Alleca, Capt Cavallaro, Maj Rakel, Maj Metcalf, Capt Thompson, Capt Wood, Capt Maxwell, Maj Goodwin, Capt Lewis, SMSgt Stubblefield, Maj Chimelski, Capt DiPadua, Maj Calvin, Lt Col Welch, Capt Brescia, Maj Lucas, Maj Shaw, Maj Castanon, Maj Sabicer, Mr. Rose, Maj Rubin.

A new course, Air Force Operational Requirements Process (SYS 111) was developed to meet training and education needs of all MAJCOMs in the critical early phase of acquisition. The February '92 SYS 111 class covered mission area analysis and the documentation of mission needs and operational requirements in Mission Needs Statement and Operational Requirements Documents. This process was a key link between the Acquisition Management System and the Planning, Programming, and Budgeting System. Twenty-five action officers from all MAJCOMs and AFOTEC completed the initial course.



Department of Contracting Management (LSP). This department develops, manages and teaches 10 professional continuing education courses in Contract Administration, Production Management, Property Management, Contractor Overhead Management, and Value Engineering for the DOD. Nine of the courses are taught under the auspices of the Defense Acquisition Univer-

sity, which was created by the Defense Acquisition Workforce Improvement Act of 1990. Department faculty research, prepare and update course material to ensure currency and consistency with current law as well as DOD requirements. Faculty members counsel students concerning professional certification requirements, evaluate student performance, and supervise graduate student thesis research. The department faculty also provide consulting services throughout DOD and to other government agencies on request. In addition, the department is responsible for an extensive on-site program at locations throughout the United States, Europe, and Asia.

Department of Government Contract Law (LSL). The most heavily taught course, PPM 302 [now Defense Acquisition University's CON 201], originally called Contract Law for Non-Attorneys, (later Contract Law 166), has retained much of its basic format over the years. A day on 'Types of Contracts' was dropped -- 'Truth in Negotiations' was added. Cases were from the students' experience and were presented on the final day of class. The first half-hour of the day was the 'course director's time', tying things together -- especially valuable since many guest lecturers were used. Considerable time was spent by the course director recruiting lecturers, arranging accommodations, and so forth, for guest speakers.

From the beginning, the faculty relied upon the handy AFM 110-9, "Procurement Law" as a text. In addition, DAP 27-153 "Procurement Law," DAP 27-150 "Cases," and DAP 27-151 "Statutes" were useful too. The Navy's "Navy Contract Law" treatise (1959) was also used. The students studied the Air Force manual, but did not get to keep it. Hand-out materials were supplied, organized in a three-ring binder. These included hypothetical cases, based upon reported cases and were used for discussion in class.

Text writing was a low priority for service lawyers. All three service manuals became out-dated by 1967, when AFIT decided to do their own. Thus, in 1968, the first of nine text editions was born, together with James Mahoy's own creation, "Government Contract Law - Cases," -- to follow in five subsequent editions. A third manual of statutes and clauses was added later -- making a three-pronged approach for student study. The case book is actual cases, organized by subject matter. The statute and clauses subsequently became part of the text book. The faculty kept the text current and eventually it was distributed for students to use as a desk book. It is informally used by AF JAG and formally adopted as the text at Air Force Academy, the law schools at University of Denver and University of California (Davis) and numerous colleges and universities around the country.

In April 1987, the Government Contract Law course became centerpiece of the newly formed *Department of Law* (AFIT/LSL). A breakthrough in staffing had come in 1983, when a senior faculty suggested that an Air Force Reserve Judge Advocate who was serving at 2750 ABW/JA might serve also as an AFIT faculty member. That led to Lt Col Dan Shell becoming the first of eight law faculty members from the ranks of Reserve Judge Advocates, from which position they served both on-site as well as in resident courses.

Although the student population always ranged from GS-07 to GS-13 and from O-1 to O-6, the typical student appeared to be a GS-09 Contract Specialist with some experience in the field. Two-week length courses did not recognize honor students per se, but the ranking military student, as class leader, was informally recognized at graduation. Special recognition was also given to each thousandth graduate, beginning with number 5,000, in June 1974. The total, to date by AFIT law faculty alone, has reached 22,500, with 40 law offerings per year taught.

Following 22 years service by Dr. James O. Mahoy as head of the section/department, he retired as *Professor Emeritus*, and John Garrett served as head from May 1985 until Bob Wehrle-Einhorn became current head in 1991.

The department has trained instructors in European Command (*EUCOM*), CTO, and

the Army Logistics Management College (*ALMC*) to teach PPM 302. The Department has been chartered by HQ USAF to develop and teach Alternate Disputes Resolution in the context of (1) contracted, (2) personnel (3) base closing and (4) environmental matters. In addition, the Department has developed three graduate courses: LAWS 550, LAWS 551 and LAWS 699. Department members teach such subjects as Alternative Dispute Resolution (*ADR*), and Environmental Contracting in three courses in AFIT LS, CE and EN schools. One of the ranking Reserve Adjunct faculty members, Col John Hoff, was appointed Individual Mobilization Augmentee / Assistant to the Commandant (*IMA/ATTC*).

Department of Logistics Management (LSM). This department develops, manages, and teaches 10 resident and non-resident professional continuing education courses. The department is responsible for courses in logistics operations, maintenance, supply, transportation, and provisioning management. Four of these courses are part of a Logistics Professional Development Program (*LPDP*) ranging from entry level to a Colonel/GM-15 level course. The department teaches and manages two courses under the auspices of the Defense Acquisition University (*DAU*). Department faculty research, prepare and update course material to ensure the courses reflect what AFIT customers require. Faculty provide consulting and research services throughout the Air Force, Department of Defense, and other governmental agencies. Faculty publish in appropriate media on topics pertinent to the Institute's mission. In addition, the department has provided educational programs to allied nations, most recently Canada, Portugal, and Turkey.

Department of Quantitative Management (LSQ). This Department is responsible for the development, administration and instruction of 23 professional continuing education courses. These courses provide instruction in the areas of contract pricing, cost estimating, financial management, quality improvement, cost/schedule control systems criteria, as well as in reliability and maintainability. The department teaches and manages 6 courses under the auspices of the Defense Acquisition University. The department also offers several courses in support of the Acquisition Professional Development Program as well as in the Professional Designation in Cost and Price Analysis. Faculty members regularly provide consultation to Air Force and other DOD acquisition offices in areas of quantitative analysis. Faculty members also publish research in pertinent professional journals and offer workshops and seminars in support of professional societies within acquisition career fields.

Department of Software Engineering (LSS). The youngest department in LS was brought over from EN during the reorganization of the schools. The department was established to teach the five Software Professional Development Program (*SPDP*) courses already mentioned. This all-military department recently lost the last of the six original faculty members who developed the instructional material. This has moved the department into a new phase of its existence.

As well as the five SPDP courses, the department is acquiring responsibility for a VHSIC Hardware Description Language (*VHDL*) course which was developed by Synopsys, Inc. for the U. S. Army. Also, the department is providing software engineering expertise for the Software Acquisition Management course which will be sponsored by DAU and taught by LSY.

Even while teaching a full load of classes, the Software Engineering faculty pursue an aggressive schedule of consultation and research. Consulting for projects like the F-16 software upgrade and the Government Acquisition Through Electronic Commerce (*GATEC*) project, the Department maintains a high degree of participation in real-world projects. The faculty also publishes papers and participates in conferences like the NATO Workshop on Software Engineering for Large, Complex Systems and the SEI Conference on Software Engineering Education.

Distance Education is an idea whose time has come for the Department of Software Engineering. Several course conversion options including research into the use of computer mediated conferencing using the department's network of Sun computer systems are actively being explored to support distance education over the internet and via satellite.

Department of System Acquisition Management (LSY). A significant portion this department's efforts for the last few years has been directed toward the implementation of multiple modes of distance learning. Distance learning really started in LSY in the mid 1980s when two short-duration, low-intensity courses were videotaped and customer personnel were qualified to conduct the courses at their home stations. Since then, LSY has expanded into satellite broadcasting, computer based instruction, and a formalized adjunct faculty-training program. In addition, plans and acquisitions are underway to establish a CALS (Continuous Acquisition and Life-cycle Support) LAB to provide student hands-on education in digitized data storage, retrieval and transmissions. The most recent initiative involves working closely with the Defense Acquisition University (DAU) to establish LSY as a course sponsor or certified offeror of several new DAU courses.

Academic Operations and Support (LSA). This department's mission is to serve as the administrative focal point for resident and non-resident PCE courses and provides general administrative support for the school. The Data Collection Branch maintains records of enrollment, grades, course offerings and other performance data. The Student Operations Branch oversees the resident and onsite course programs. The Administrative Branch supports the school through management of supplies and equipment, travel orders and a variety of related items.

3-4: School of Civil Engineering and Services (CE)

The School of Civil Engineering and Services in 1989 offered 113 resident and 35 off-site education courses, provided consulting, and performed research that prepared over five thousand engineering and services personnel to design, construct, and maintain one hundred fifteen billion dollars worth of Air Force facilities worldwide and to improve the quality of housing and food service in peace or war.

Senior leadership within the school consists of the Dean and Associate Dean. In addition, there are four department heads and a division chief: Head, Department of Engineering Design (*CEC*); Head, Department of Services Management (*CES*); Head, Department of Engineering Management (*CEM*); Head, Department of Environmental Management (*CEV*); and Chief, Academic Support Division (*CEA*).

Department of Engineering Design (CEC). Formerly the Department of Technical Applications, this department has transitioned from a narrowly focused curriculum of applied engineering courses to one that includes comprehensive planning, design, programming, and contingency engineering courses. The first three of these (comprehensive planning, design, and programming) are not new to the educational arena; but the last (contingency engineering) is. The Air Base Combat Engineering course, ENG 485, was created in 1979 to provide civil engineering (*CE*) officers an exposure to contingency requirements which cannot be obtained during the performance of peacetime duty. ENG 485 prepares officers to provide essential air base facilities and to conduct civil engineering operations during contingency situations. The course teaches expedient methods of force beddown, air base operability, and base recovery. The curriculum also includes Air Force civil engineering responsibilities; assets; aircraft beddown; expedient airfield pavements; airfield criteria; expedient buildings; munition storage; disease control; water, waste, fuel and electrical system design; aircraft arresting systems; wartime fire protection

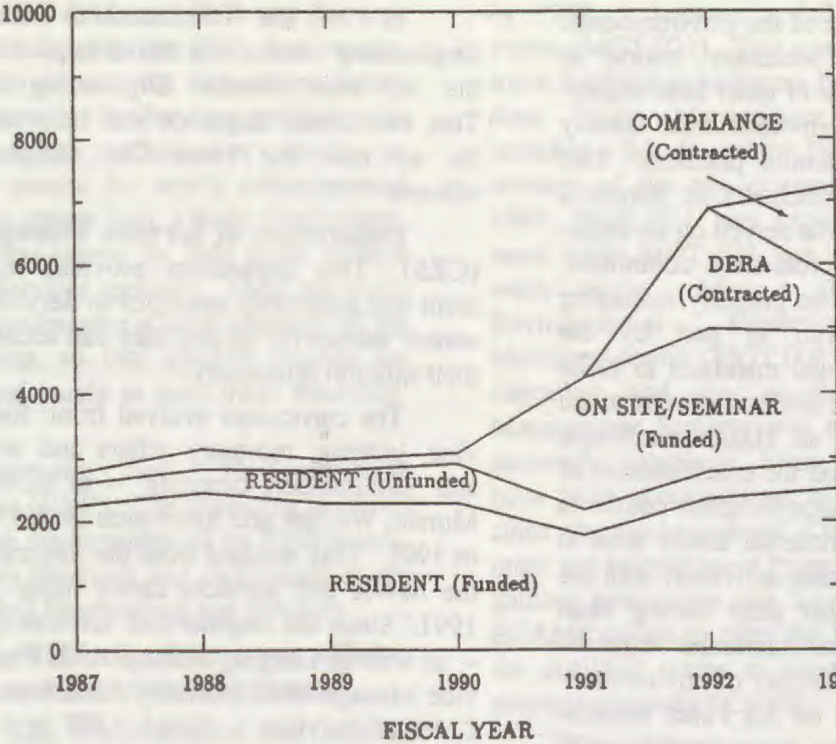
and crash rescue. Also covered are: facility hardening measures; camouflage, concealment and deception; structural and utility repair; chemical defense; damage assessment; explosive ordnance reconnaissance; rapid runway repair; enemy threats and capabilities; base denial; and leadership of troops in a contingency environment. The information is presented to the students through formal lectures and group exercises. Students actually create plans for their "team's" deployment to fictitious forward air bases. The course does *not* address contingency planning, above base level.

The ENG 485 course, as originally created, was two weeks of classroom education at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. The length of the course has changed a number of times since then and was recently lengthened to four weeks in order to provide better coverage of all our wartime tasks as well as provide a more conducive learning environment. The first three weeks are typical classroom education, but the fourth week of the course, referred to as Officer Field Education (*OFE*), is rather unique because it is not conducted in a classroom and it does not take place at Wright-Patterson AFB. Rather, OFE takes place at Tyndall AFB, Florida. The concept of Officer Field Education was created and added to the ENG 485 curriculum in 1987. OFE is a joint initiative between AFIT and the Air Force Civil Engineering Support Agency (*AFCESA*) aimed at providing young civil engineering and services officers more hands-on education so that they can better understand contingency and wartime CE equipment capabilities and limitations as well as wartime tasks and procedures.

Air Base Combat Engineering: ENG 485 has been extremely successful in preparing young officers to perform and lead in contingency situations. We receive constant student feedback from those who have had the opportunity to apply the things they learned from ENG 485 on deployments to places like Saudi Arabia, Turkey, Kuwait, Somalia, Venezuela, Honduras, and Homestead AFB FL. Unanimously, students thought our course prepared them well for the uncertainty and challenges of a military deployment. This overwhelmingly positive feedback serves to validate the requirement for this unique course. It also tells us the course we created in 1979 is still meeting the objective of providing CE officers with a crucial exposure to contingency situations before they're sent into a "real" combat/contingency environment.

Department of Engineering Management (CEM). In concert with the continuing changes within the Civil Engineering career field over the last fifteen years, this department (previously the Department of Management Applications) has continued to evolve and provide management and supervisory personnel with the latest concepts, techniques and strategies necessary to effectively execute the Civil Engineering mission.

The Management Applications Course (*MAC*) series comprised the cornerstone of the department curriculum. As the Civil Engineering squadron underwent substantial changes in its organization over the years, the MAC was expanded and modified as well. The current configuration of courses in the series, (taught concurrently yet each targeted to a different, specific group of managerial personnel), can be traced back to 1980. At that time, Financial Management and Fire Protection Management were added to the then existing four MAC courses (Industrial Engineering, Family Housing, Engineering and Environmental Planning, and Operations). Periodically, throughout the 1980's and into the early 1990's, as the Civil Engineering squadron reorganized, (as the overall force grew, and then began to shrink), the MAC curriculum was reworked and tailored to the new requirements. In 1990, the first (and, to date, only) MAC series to be offered on-site took place in San Antonio TX. Resources Management replaced Financial Management in the MAC in 1992, reflecting a branch functional redesignation and realignment, with a separate course for financial managers being established independent of the MAC.



Professional Continuing Education (PCE) course completions: School of Civil Engineering, MWR, and Services.

Readiness Management was added in 1992 as a seventh MAC course, but then subsequently incorporated as part of a consolidation of war readiness functions. An Environmental MAC was also developed and incorporated in 1992, but was directed by the newly established Department of Environmental Management.

The Civil Engineering Management Applications Regional Seminar (*CEMARS*), as much a well-known part of the Engineering Management Department as the MAC, was conducted at an overseas location for the first time at Ramstein AB, Germany in 1978. Previous to 1985, CEMARS was offered at only one site per year, with two back-to-back offerings at that one site. That changed in 1985, when CEMARS was offered at three different sites in the PACAF theater, thus beginning a new emphasis on making the seminar available to more people annually. CEMARS became the Civil Engineering and Services Management Applications Regional Seminar (*CESMARS*) in 1986, reflecting the incorporation of Services personnel, and was targeted at base level Civil Engineering and Services organizations. An Executive Management seminar was offered for the first time in 1987 for top-level engineering and services managers at the Air Force Regional Civil Engineer -- Atlanta GA.

Beginning in 1988, the first Customer Service on-site seminars were conducted in direct response to an overwhelming demand, (in and out of the Air Force), for a reorientation to customer needs, improvements in quality and more effective use of dwindling resources.

The growing environmental awareness of the late 1970's and early 1980's, coupled with substantial and comprehensive environmental legislation, was directly reflected in the Engineering Management curriculum as far back as 1979. Environmental Planning Applications (not associated with the MAC) were established in 1979 and represented the beginning of a major effort within the department to educate Civil Engineering officers and equivalent-grade civilians on environmental issues, technology and programs.

The establishment of the Environmental Protection Committee Members' course in 1982 recognized the role of other base organizations in improving environmental quality and eliminating past harmful practices. This course was targeted principally at non-civil engineering personnel who served on an installation environmental protection committee. The growing emphasis on properly managing hazardous waste, driven in part by the identification of, and legal mandates to clean up past hazardous waste disposal sites, resulted in the initial offering of Hazardous Waste Management in 1986 and the establishment of the Installation Restoration Program course in 1990. By then, environmental issues were at the forefront of installation activities, with the Civil Engineering career field having been charged with overall environmental responsibilities. The growing number of environmental requirements levied on Air Force installations, and the need for a systematic means of evaluating compliance was met with the Environmental Compliance Assessment and Management Program (*ECAMP*). Beginning in 1991, the department began offering the ECAMP course designed to educate a number of Air Force career fields on the procedures and areas of emphasis of environmental auditing. In 1994, the ECAMP Course was provided via the Air Technology Network (*ATN*) satellite system to remote sites; additional offerings in this mode will occur later in FY 94.

There was a measurable and noticeably steady increase in the number and types of courses offered each year in the department beginning in 1984. Such courses as Real Property Management, Readiness and Logistics Management, Project Programming (1985), Engineering and Services Information Management System (*ESIMS*) System Manager (1986), Project Management (1990), Maintenance Engineering and Zonal Maintenance Management (1992) and others were indicators of a rapidly changing resource environment, requiring new approaches, methods and attitudes. The department responded with enthusiasm and a vast array of professional expertise.

In 1993, the 'Introduction to Base Civil Engineering' course was linked sequentially to the Air Base Combat Engineering course. This two-course sequence was now required for *all* new Air Force Civil Engineering officers.

Department of Services Management (CES). This department provides management and leadership strategies to Services personnel worldwide so that they can accomplish their mission effectively.

The curriculum evolved from: food service, lodging, mortuary affairs and services, and 'commanders concepts' -- to incorporate Morale, Welfare and Recreation (*MWR*) issues in 1992. This resulted from the integration of the MWR and Services career fields in late 1991. Since the original four services courses -- as well as Lodging Management, Food Service Management, Mortuary Affairs and Base Chief of Services -- joined AFIT in 1986, a revised AFIT program has evolved over these seven years. The Services courses transferred from Air Training Command (*ATC*), (where they had been formerly taught at Lowry AFB CO) in 1986, by direction of the Air Force Civil Engineer (*AF/CE*).

At this time Civil Engineering and Services were functionally aligned together at the Air Staff and MAJCOM level. Therefore the AF/CE and MAJCOM/CES wanted to educate their engineers along the same lines as the Services officers. After the courses transferred, additional courses evolved over the years to meet the needs of the community. A readiness course was added to educate the Services personnel in field operations, which personnel were then able to train along-side their engineering counterparts in the field.

Customer Service 'on-sites' were added to assist managers (as well as to lower educational costs and time spent away from Air Force bases). The introductory course for junior officers included all the contemporary issues of the AFSC, as well as developing a track for junior officers (with information very specific to their career field).

In response to the need of the newly integrated career fields of MWR and Services (simply called Services) in 1993, four courses are offered to present the key contemporary issues and strategies for Services professionals, innovations to the commanders' course, an introductory course for newly commissioned officers in the career field, a flight chief course, and a readiness course for field grade officers new to the Services specialty. Over the years, reservists have become a large customer of the Services arena, so that specific courses are developed and taught to meet these reservists' needs.

Department of Environmental Management (CEV). The following is a brief history of the development of an *Environmental Education* Program and curriculum at the School of Civil Engineering and Services.

In May 1985, the School was offering four courses with Environmental content.

MGT 520, Environmental and Contract Planning

ENG 500, Sanitary Engineering Refresher

MGT 004, EPC Members Course (Also, an on-site version of MGT 004 was offered sporadically), and

Environmental section of the Management Application Course (Environmental MAC).

By the spring of 1986, MGT 521 (now ENV 521, Hazardous Waste Management) was offered and MGT 004 was thoroughly revamped to meet the current needs of the field. The on-site version, (now called the Environmental Management Seminar), was restructured and streamlined to nearly its present format.

During the following two years MGT 004 was mothballed, ENG 500 was eliminated, and MGT 520 was reduced to a two-week 'purely environmental' course. The Environmental MAC remained static. MGT 521 was (and still is) thriving. At the same time the Installation Restoration Program (*IRP*) Workshop, developed and managed by the then HQ USAF/LEEV, was turned over to the School of Civil Engineering and Services and by 1988, it became a full-fledged resident course (MGT 021). This caused some troublesome duplication problems because the Hazardous Waste Management course already included a full day of the IRP coursework. A revision of the two courses ensued and, by 1989, MGT 021 was expanded to one full week while MGT 521 was reduced to a one-week course. After a short revival the Environmental Protection Committee Members' course (MGT 004) was permanently cancelled and the on-site Environmental Management Seminar was offered, as a very successful substitute. More than 55 seminars have been accomplished to date. Moreover, since the Environmental Compliance Assessment and Management Program (*ECAMP*) was gaining momentum, the School established an ECAMP course to meet the field requirements for qualified teams to conduct internal (and monitor external) ECAMP.

The School soon realized that an environmental introductory course was also a must and the Introduction to Environmental Management offering was established. At the same time the Air Force Civil Engineer was questioning the usefulness (and relevance to the current issues facing the Air Force) of the 15-month Graduate Engineering Management (*GEM*) Program. After much deliberation, and not much choice, the GEM program, (greatly enhanced and improved with up-to-date environmental content) was renamed the Graduate Engineering and Environmental Management Program (*GEEM*) and transferred from the School of Systems and Logistics to the School of Civil Engineering and Services. By December of 1990, the transfer was completed and in May 1991 the first students were admitted. Alas, the school-graduate curriculum association was short-lived. A spring 1992 reorganization of AFIT sent the GEEM program to the School of Engineering [with plans for it to be an 18-month program, by May 1994].

The expansion of activities in the environmental arena resulted in a reorganization of the School of Civil Engineering and

Services, and thus the department of Environmental Management (*CEV*) was created. Additional faculty was acquired. The prefix of *all* Environmental course numbers changed to *ENV*.

Finally, the Environmental MAC was updated. It became Environmental Management Applications (ENV 416). In addition to the graduate program, between 1990 and 1993 a rapid succession of events ensued.

1. In collaboration with the newly established Air Force Center for Environmental Excellence (*AFCEE*) at Brooks AFB, a new course was established, Environmental Restoration Project Management (ENV 417).
2. Responding to a directive by the Air Force Chief of Staff, a course in Pollution Prevention (ENV 022) was developed and the Commanders' Environmental Management course (ENV 400) was established. Moreover, the School is administering the Commanders' Environmental Leadership Course (ENV 002) (offered upon request) at Major Commands for general officers.
3. Courses in Environmental Restoration Contracting (ENV 418) and Environmental Planning Restoration Programming and Budgeting (ENV 419) were also instituted. As of October 1992, the School inherited the 'Air Force/EPA Team Approach to Environmental Clean-up' course jointly offered by AFIT and EPA.

Parallel to the academic activities, the School established the Office for Nonresident Environmental Education (*ONEE*), a clearinghouse for short courses on subjects not offered at AFIT. The Center provides guidance and funding to all Air Force personnel on a need-to-learn basis. ONEE activities are supported by both Defense Environmental Restoration Account (*DERA*) funds and Compliance funds. Hence AFIT/CE has become the center for educational environmental materials.

The Department of Environmental Management is an active, healthy, academic department in the forefront not only of the Air Force but of the entire academic world in professional continuing education (*PCE*).

Civil Engineering Computer Support: 1979 - 1994. Due to the increasing need for computer time among School of Civil Engineering and Services (*SOCES*) students in the 1980s, a second computer classroom, which accommodates twenty-four students, was constructed. Zenith laptop personal computers were also obtained for students to complete homework assignments in their rooms. When not needed by the students, these computers were checked out to faculty and staff.

Civil Engineering in 1994 is now able to completely process all civil engineering data on the Work Information Management System (*WIMS*). WIMS is run on WANG mini mainframe computers located in all civil engineering squadrons. The new software reduces civil engineering dependency on the standard base-level computer and enables civil engineering data to be processed dynamically -- as data is entered -- all on one system, rather than overnight in batch mode. The new software provides enhancements and additions to the existing WIMS software, but most significant is that it precludes the Communications-Computer Support branch (*SSC*) from having to modernize the Base Engineering Automated Management System (*BEAMS*).

Most improvements will be transparent to customers, but one major apparent improvement is that Job Orders and Work Orders will be combined into a single Work Request System.

WIMS was initially fielded in September 1986 and contained the foundation upon which the new software is built. WIMS extrapolated on the capabilities in the Sperry-based BEAMS, developed in the early 1970s. Since 1986, MAJCOM civil engineering implementation teams have been employing WIMS at their bases. WIMS is now fielded at all CONUS bases and at all but two overseas bases. These civil engineering units, their MAJCOMs, AFCESA, and the Pentagon are networked via DDN and can send reports,

data, word processing documents, and design drawings around the world, literally in seconds.

Overall, the new WIMS software will enable civil engineering to provide improved customer service and mission support. The School of Civil Engineering and Services has an on-line prototype WIMS to provide functional education to civil engineering managers. Instruction emphasizes the importance of information management and retrieval, as well as the use of information in decision support.

3-5: Civilian Institution (CI) Programs

Civilian Institution Programs directs three thousand higher education and four thousand continuing education students in AFIT-sponsored programs through a worldwide command network of almost four hundred locations. Staff annually executes a thirty-three million dollar budget, representing over 50 percent of AFIT's entire annual budget, thus providing graduates with enhanced capabilities to meet increasingly complex Air Force operational mission objectives.

Civilian Institution Programs complement the AFIT resident schools by providing both degree-granting as well as specialized education programs at civilian colleges and universities, medical centers, and industrial facilities that have special capabilities and competencies not available within the resident schools, or that can be obtained more economically off campus. Through its strong ties with civilian universities and industries, CI provides AFIT with the flexibility to respond quickly to changing Air Force educational requirements. CI's primary mission is to place Air Force officers in quality civilian institutions of higher learning and then manage their programs to successful completion.

The civilian institutions programs include graduate programs in:

Engineering,

Humanities,

Physical Sciences,

Social Sciences, and

Computer Science,

AFIT Faculty Preparation,

Air Force Academy Faculty Preparation, and

Scholarship, Fellowship and Grant Programs.

The latter include

Rhodes Scholarships,

Olmsted Scholarships,

Guggenheim Fellowships,

Fulbright Scholarships, and

National Science Foundation Fellowships.

In addition, the following special programs are included

Health Care Education Program,

Medical and Dental Postgraduate Allied Health Program,

Health Professions Scholarship Program,

Legal Education Program JD & LLM, and

(AFROTC) Educational Delay Programs which are administered by the Civilian Institutions Programs.

A financial management branch was established in 1992 within CI to oversee the accounts of the various civilian colleges and universities within CI.

Regarding personnel changes, in Feb 92, the Dean, Colonel David C. Whitlock, was appointed as AFIT Commandant to replace Colonel Fred Bauer, who retired. In Aug 92, Colonel Bennie J. Wilson III became the CI dean.

CI Student Output/Achievement. In 1993, CI students produced 175 theses and 29 doctoral dissertations. Medical Service officers produced 55 articles and presented 35 research papers at national meetings. CI stu-

dents were singled out for standing achievement, such as Capt Lili Mann, attending the Naval Postgraduate School, was selected as Graduate with Distinction, and was also nominated for the NPS Outstanding Academic Achievement Award for Department of Defense students.

Current 1994 Enrollments. 2957 enrolled at 486 different civilian institutions, including 113 Education-With-Industry (*EWI*) students at 60 different industrial locations.

CI Helps Fill AF Need for Engineers and Scientists. In 1981, the Undergraduate Engineering Conversion Program (*UECP*) was implemented in response to a shortage of Air Force engineers and scientists. Civilians that had recently earned non-scientific bachelor degrees were recruited to spend two more years in school to earn an engineering or scientific degree, with subsequent attendance at Officer Training School. In 1982 CI experienced a 10-15% growth in enrollments in UECP and similar programs primarily driven by Air Force engineering degree needs. The UECP was terminated in March 1985 as the Air Force was able to fill its need for engineers through other sources.

CI Helps Fill Air Force Meteorology Degree Requirements. 1983 saw a continued CI student increase in practically every category, especially Basic Meteorology, whose enrollments quadrupled from a 1982 level of 16 to 63, to support the newly activated Over-The-Horizon-Backscatter (*OTH-B*) radar system. By 1984, there were 86 students enrolled, primarily to fill the recently formed 4th Weather Wing at Air Force Space Command.

Budget Cut Woes. In 1986, budget cuts forced major revisions to CI quotas and placement policies. AFIT graduate education programs were threatened by PCS funding reductions of 75% in Air Force regular graduate education and 50% in the Education With Industry (*EWI*) program. Although the graduate education cut was ultimately reduced to 15%, it still represented 83 graduate quotas. In response, AFIT worked closely with AFMPC to restore original quotas while saving PCS costs through a 3-part process of close proximity moves, turnarounds from the Airman Education Commissioning Program, and direct accessions from AFROTC. By carefully placing students following extensive coordination with AFMPC, CI program managers successfully restored all graduate education and EWI quotas by using no-cost PCA moves. The initiative exceeded all expectations, saving approximately $750,000 in PCS funds as 161 FY87 graduate/EWI quotas were filled using PCA moves. Enrollment dropped, though, from 4392 at start of 1986 to 3842 by year end. EWI participation dropped from 156 to 81, with 12 medical officers moved under the Senior Health Policy Fellowships program. (In 1987, HQ USAF again directed implementation of restated financial reductions, but AFIT used its 1986 strategies once more to save 161 quotas.)

CI Program Managers Develop E-Mail Capability. In 1989, two CI Program Managers, Capt Hosea Battles, Jr., and Capt Thomas R. Vermillion with the cooperation of SC, developed electronic mail (*E-Mail*) capability for CI, which enabled electronic communications between staff and students around the world. This network is also used to communicate with incoming students at their duty locations to give preliminary information. E-Mail greatly reduces mailroom volume and the time required for replies to correspondence.

CI Initiates Part-Time Program. CI, in response to a tasking from CSAF, initiated the Part-Time Program in 1989 for officers in the engineering and science fields assigned to the high cost areas of Boston and Los Angeles. This program was in response to junior officer concerns that many qualified officers who wished to pursue higher education could not afford to attend schools in high-cost areas. Air Force Chief of Staff, General Larry D. Welch, approved a pilot program of 25 officers from the Boston and Los Angeles areas. These selectees would work part-time at their current unit of assignment while being allowed to attend school part-time with AFIT picking up the cost of all tuition and fees. The 25 officers were chosen from the Air Force Systems Command in Space Systems Division and Elec-

tronic Systems Division. The universities participating in the program included the University of Southern California, Loyola Marymount, Northeastern, Massachusetts Institute of Technology, and Boston University. The program was terminated in 1993.

CI Implements the Graduate School Program. Per US Air Force Academy (*USAFA*) requirements, CI implemented the Graduate School Program in 1989, which gives recent USAF Academy graduates the opportunity to obtain a non-thesis masters degree in 12 months. These students eventually return to the Academy as teaching faculty.

Assistant Secretary of Defense for Health Affairs. This office approved new additions to Armed Forces Health Professions Scholarship Program (*HPSP*):

1989 -- Nurse anesthesia program was established.

1991 -- First nurses sent to school for environmental health degree

1991 -- Dental and Optometry scholarships included.

1992 -- Clinical Psychology scholarships added.

Education With Industry Innovations:

1981 -- First EWI civilian students -- 5 from AFSC/AFLC

1983 -- First orientation class for logistics, supply and maintenance officers. All EWI students attended seminars, cosponsored by AFIT and several civilian companies, designed to help them get the most from their program.

1991 -- EWI expanded to include 18 engineers under the Engineering Management option.

CI Program Manager Develops IDEA Program. In 1991 the Industrial Development Education in Acquisition (*IDEA*) program was developed by CI Program Manager Major Robert L. Landry. This program sponsored civilian and military personnel in a shortened, job-specific version of EWI. In the 1993-94 academic year, 20 officers and 12 civilians were enrolled in this program.

3-6: Directorate Missions and Functions

Admissions/Registrar Office (RR). The mission of the Admissions/Registrar Directorate is to supervise the administration of United States Air Force (*USAF*) and AFIT admissions policies for graduate education. The Directorate works directly with Headquarters (*HQ*) USAF, Air Force Manpower and Personnel Center (*AFMPC*), Air University, and other agencies to fill USAF educational quotas, and is involved in preparing studies and reports on educational enrollment and officer education levels. The Directorate maintains the education records for all USAF active-duty, Air Force Reserve and Air National Guard officers. The Directorate also performs all resident student registration, scheduling, grading, and transcripting tasks. The International Military Student Office, recently moved within the Plans Directorate, serves as the admissions focal point for foreign military officers applying to AFIT, administratively supporting them after arrival, and managing the DOD Informational Program.

Admissions/Selections responsibilities include:

- Evaluate officers as they enter active duty for eligibility for graduate education programs
- Evaluate officers' requests for evaluation for specific programs
- Evaluate records for specific programs in DOD and AF upon request from agencies
- Compute Grade Point Averages (*GPAs*) for evaluations
- Act as an educational consultant for various boards and planning committees
- Maintain yearly quotas for AFIT sponsored programs

- Work closely with MPC to fill all quotas
- Provide student reporting instructions into education programs.

New reports were developed to track: (1) where graduates are assigned following their AFIT tour; (2) resident part-time enrollment demographics illustrating users in the Wright-Patterson community; and matrices were created to aid preparations for graduation planning. Several innovative admissions and selections reports improved the dissemination of 'quota reporting' to senior leaders in the Institute.

During Calendar Year 1992, the Academic Scheduling & Registration Section registered 2,662 full-time student courses [over the six-quarter calendar] and there were 752 separate quarter courses maintained for which students registered. The Section also processed 10,832 grades, including 180 changes, 32 transfer credits were processed, and 3,560 grade reports were issued. Additionally, 485 official transcripts were issued, 48 end of quarter statistical reports compiled, and 431 theses titles entered into the computer database.

Academic Library (LD). The primary mission of the AFIT Academic Library is to provide comprehensive library services in support of the instructional and research requirements of the Institute's faculty, students, and academic staff.

Under the Director, the AFIT Academic Library is divided into two major functional divisions: Reader Services and Technical Services. Library services are organized to meet the qualitative and quantitative requirements of the Institute's diverse research and instructional programs.

Library facilities were consolidated into a new central facility which opened in July 1989. The new centralized library center contains administrative offices, a large reference reading area, an archival room, twelve student seminar rooms, a conference room, closed reserve reading room, special services room for audio-visual material, microform, student network PCs, reading printing equipment, photocopy equipment and multimedia workstations; open book and periodical stacks, and stand-alone CD-ROM workstations.

The total library collection is made up of close to 1.3 million items including 100,000 monograph volumes, 1300 serial subscriptions with long back runs, 1400 audio-visual items, 75,000 paper bound tech reports, 8,000-plus student theses, and over 1 million tech reports in microform.

While the library strives to provide a solid core of library materials directly tied to the AFIT curriculum, it maintains symbiotic relationships with other area academic libraries in order to facilitate resource sharing. Through the library's online public access catalog, library users can tap into the Internet and find materials throughout the world via computers. In addition to being linked to NASA and DTIC databases, the library currently subscribes to twelve bibliographic and full text services that are available to users on workstations housed in the library (via compact disk).

A new service, the *FirstSearch* Catalog, is now available through the AFIT Library's online catalog. FirstSearch is an interactive online service that offers our users direct access to the following databases:

***Worldcat**, which contains more than 30 million records describing items on thousands of subjects dating back over 900 years. Types of publications include books, journals, AV materials, and newspapers. It does not include book chapters or individual articles from journals or newspapers.

***Articlefirst**, contains records that describe articles listed on the table of contents page of more than 11,000 journals in science, technology, and social sciences. Many records contain an abstract. Coverage is from 1990 to the present.

***Contentsfirst**, provides the complete table of contents from individual issues of over 11,000 journals. Each record lists the table of contents of one journal issue. Coverage is from 1990 to the present.

Academic Library: A Constant Improvement of Services. Extensive computerization during 1992 led to greater accessibility for academic library patrons. For example, an on-line purchase request program was initiated that allowed AFIT faculty and staff to place purchase requests for books. A *LIBS Internet Access* program was installed that gave patrons greater access to hundreds of Internet-accessible catalogs and databases. Also, AFIT personnel could access the on-line catalog from their office PC's through the Novell file server. Many additional projects were initiated that provided students, faculty, and staff unprecedented PC access to additional databases and application programs from other computers through the file server system. More than 50 new journal titles were added, (in the environmental management area), using environmental compliance funds.

During CY92, the AFIT Academic Library conducted two user surveys of the graduate students, established a student center for a computer-aided instructional course using Computer-Based Instructing Hypertext and videotapes (e.g., SYS200T), upgraded the Online Public Access Catalog (*OPAC*) so that it was available from the Novell file server, added an online order form for faculty, made hundreds of catalogs and databases accessible via the LIBS Internet System, established a network access PC area for AFIT personnel, acquired the library's first "full-image" CD-ROM, implemented a Senior Executive Reading Program, received a donation of books from the American Production and Inventory Control Society, provided library orientation and in-depth bibliographic instruction for graduate students, and continued staff involvement in professional activities.

Hypertext Instructional Program Implemented. During August 1992, the library installed a downloadable hypertext library instruction file on the file server network which provided an overview of research tools available in the library, organized by the various degree programs. Students are able to download the file and then navigate through the data (according to a specific degree program) to locate relevant library indices and sources. The Hypertext software was developed by Capt Frank Jones, a 91D LS graduate student.

Network Access PC Area. The library set aside a network access PC area for AFIT personnel during February 1992; the computers allow patrons to access applications on file servers and central computer systems from within the library. Three scanning workstations were later added to the network which enabled AFIT personnel to scan and save material in text and graphic formats.

General Periodicals Ondisc. Research II Edition, installed in November 1992, provided indexing and abstracting access to over 1200 general-interest periodicals with full text article retrieval available for 200 of the periodicals. In addition, a state-of-the-art workstation including all hardware, software, and database updates was included. Subject coverage focused on the most requested general interest periodicals found in library collections, (back to January 1986) and updated monthly.

Communications-Computer Systems Directorate (SC). The mission of the Communications-Computer Systems Directorate is to provide the Institute with continuous and reliable automation services. This is accomplished through planning, acquisition, operation, and maintenance of quality information system resources. Associated activities include: working closely with other offices and agencies, plans and programs, information systems equipment policies, acquisition or development of software, information systems procurement, and operation and maintenance of computer rooms in all four resident schools.

The Communications-Computer Systems Directorate is supported by four divisions: (1) the Systems Development Division (*SCV*), (2) the Resource Management Division (*SCP*), (3) the Operations Division (*SCO*), (4) and the Small Computer Support Center (*SCU*). The Systems Development Division monitors all requests for computer software services. The Resource Management Division manages, monitors and budgets for all of the Information Processing Equipment (*IPE*) sys-

tems, recording machine use and downtime. The Operations Division manages all centralized computer systems. The Computer Support Division manages small computers and provides user training.

Responding to a critical lack of capabilities in the early 1980's, the Institute's Communications-Computer Systems Directorate put together and executed a strategic plan that provided world class computing capability in support of academic excellence well into the 1990's. First addressing the needs of the academic mission of the Institute, a central computing facility was initially built around several VAX-class minicomputer systems. This capability evolved over time through the Large Computing Capability program to include ELXSI super-minicomputers, VAX Clusters, and ultimately to a distributed network of advanced workstations from SUN, Silicon Graphics, and others. Supercomputing capability is now provided through our association with the Ohio Higher Educational Computing Council and the Ohio Supercomputer Center.

Secondly, administrative computing resources were initially provided by a number of distributed multi-user systems from the Burroughs Corporation. With the arrival of the personal computer, the Burroughs systems were replaced with PC's and terminals accessing Q-Office office automation software residing on a centralized minicomputer. As the personal computer became more powerful, office automation capability .began moving toward a distributed network of PC's connected to a Novell file server network. Standard applications such as WordPerfect and Harvard Graphics were made available to all Institute personnel. In 1994, these applications have been supplanted by a Microsoft Windows-based suite of office automation tools.

Automation is reaching the Office of the Registrar by way of an advanced image processing system which allows the Records Management Section to store educational transcripts and other material on CD-ROMs, eliminating the need to physically store over 1 million paper documents. Throughout the Institute, the development of a large centralized database using the Oracle database management system allows staff and faculty to view a large variety of information on students, classroom schedules, and financial information.

Finally, an advanced communications network provided the medium to tie all the academic and administrative computing resources together. Phase I of the AFITNET program, begun in 1984, used digital switching technology from Gandalf Corporation to tie AFIT's three main buildings together, offering limited service to students, faculty, and staff. Phase II of AFITNET, however, provided a robust multi-protocol network capable of servicing the data and video communication needs of a growing Institute well into the 1990's. With connections to the Defense Data Network, the Ohio Academic and Research Network, and other national and global networks, the AFITNET provides the networking capabilities expected of a world class institution of higher learning.

SC Development. Due to a change in postal service regulations, major database changes were needed to incorporate new mailing label formats. This effort included mass data dumps for post office review and major changes to screens, reports, tables and associated software.

A task order amendment was approved to begin work on systems analysis of MIFFS/ACES (AFIT Civilian Education System); used for Civilian Institutions surveys, and record keeping.

The ELXSI computers (galaxy and orion) were turned off permanently on 1 Jul 92. The functions provided by these systems were transferred to other AFIT systems. In Oct 92, the entire ELXSI computer system was transferred to the Aeronautical Systems Center's C-17 SPO.

Large Computing Capability (LCC) Program. SC received 6 Silicon Graphics work stations acquired under the LCC program. Maj Wishon stated that 1992 was the last year of the LCC program, and that money to upgrade and replace major computer systems would not be in the budget for at least the

next few years. The equipment bought through the LCC program in recent years must carry the Institute through the lean years.

New Sun Computers Received. SC received 80% of the Sun Microsystems computer equipment which was purchased to replace the ELXSI systems. The equipment was installed in 1992, after funding for computer room renovations was obtained and subsequent renovations were completed.

Mission Support: Consolidation and Reorganization. In an organizational move that preceded the AFIT restructure, the Mission Support Directorate was established in 1992, combining Information Management, Headquarters Squadron/Orderly Room, and Personnel into one directorate. The Facilities section was included in the IM function, while the Security function was transferred to the School of Engineering as part of the AFIT restructure. A consolidated mail room was formed, combining the IM (AFIT's central) mail room with that of EN. Also, a consolidated "one-stop" TDY orders unit was formed, combining IM's TDY orders unit and FM's travel section, which saved time and eliminated hassle for people.

The Voluntary Separation Incentive / Special Separation Bonus (*VSI/SSB*) and Reduction in Force (*RIF*) programs were announced and implemented. A total of 125 personnel (faculty, staff, and students) applied for early separation in 1992 under the VSI/SSB program. All 125 were approved. To cushion the impact for affected students within one academic quarter of graduation, an agreement was made between AFIT, the Air Staff, and Military Personnel Center (*MPC*) to allow students who chose the "voluntary" separation programs, or who had been RIF'd, to remain at AFIT in a civilian status until graduation.

Public Affairs (PA). The mission of the Directorate of Public Affairs is to plan, direct, and conduct the Air Force Institute of Technology Internal Information, Media Relations, Community Relations, and Planning and Security Policy and Review programs, and to advise the Commandant, staff, faculty, and the student body concerning Public Affairs matters of the local civilian community, the Air Force, and the Department of Defense.

During 1992, the Directorate of Public Affairs used a "back to the basics" approach to redefine essential PA services. As a result, PA eliminated "nice-to-have" services and products while maintaining value-added efforts. The redefinition of PA coincided with AFIT's downsizing which reduced PA authorizations by 50 percent, leaving one captain OIC billet and one NCO slot. Paring of nonessentials included the discontinuation of The EDUCATOR, a 28-page quarterly magazine, since it was not cost effective, removing PA from distribution for 7 regulations, and replacing PA operating instructions with simple checklists. Similarly, PA eliminated or transferred non-PA functions. For example, PA had been the OPR for foreign disclosure reviews, but that was not a PA function as defined in AFR 190-1, *Public Affairs Policies and Procedures.* Foreign disclosure reviews were more appropriately assigned to the International Student Office within the Directorate of Admissions/Registrar. PA tailored itself to respond to changing customer needs. For example, PA procured an autofocus camera for better coverage of events. Also, PA procured new display booth equipment for use in telling AFIT's story to audiences through exhibits.

Financial Management Directorate. The mission of the Financial Management Directorate (*RP*) is to provide overall management of Financial Resources to support all resident and non-resident education, consultation, and research programs of the Air Force Institute of Technology.

AFIT realigned the Financial Management Division (*CIF*) into AFIT/FM in May 1993. AFIT restructured and streamlined some staff functions. This restructure mirrors the HQ AU structure. The Financial Management Directorate was renamed the Resources Directorate (*RP*) and Manpower, Financial Management, and Programs were aligned under this directorate. AFIT also reorganized

XP. AFIT renamed Operations and Plans to the Plans and Operations Directorate (*XO*) and aligned the International Military Training Division and the Plans Division under it. This restructure was approved 18 Nov 93.

Operations and Plans. The mission of the Operations and Plans Directorate (*AFIT/XP*) is to coordinate plans, programs, policies, and operating procedures for the Institute. The Directorate monitors mission objectives, develops /coordinates /submits the Program Objective Memorandum (*POM*), implements the strategic planning process, manages graduate and professional continuing education programs, reports student statistical data, coordinates the Command Derived Educational Requirements System (*CDERS*) requirements and provides support for other special activities for the Command Section, as required.

AFIT/XP reorganized in May 1993, eliminating all divisions in XP.

Det 2, 3810 MES became an AU Operating Location in Jan 1993 and in Jul 1993 it became part of AFIT/XP; then it was merged into AFIT/RP on 1 Oct 93.

3-7: Program Reviews

The Graduate School of Engineering held program reviews in the years 1985, 1988, and 1991. The program review is normally held every three years and provides an effective mechanism to formally review all engineering education programs, as well as provide an interactive forum between users and faculty. The 1985 working-level sessions were attended by 44 non-AFIT people; the senior review session at the general officer level had 24 attendees. There were 91 attendees for the 1988 working-level review and 18 at the senior review session. The 1991 review, held at the working-level only, was attended by 74 people representing organizations throughout the AF and DOD. Specific areas of discussion in the program reviews, besides the details of the engineering graduate programs, included discussions on identifying advanced academic requirements in AF organizations, the quota process, and methods to provide adequate numbers of qualified officers to the engineering doctoral program.

The DOD Curriculum Advisory Council (*CAC*) met twice during 1989 to review, update, and exchange information concerning acquisition program courses in the Department of Defense. The first meeting, hosted by AFIT/LS, was held on 3-4 May 1989 and included a curriculum review of AFIT mandatory courses. The second meeting was held on 14-15 November 1989 at the Naval Facilities Contracts Training Center.

At the request of the Program Review Committee (*PRC*), the Environmental Compliance Assessment and Management Program (*ECAMP*) workshops were developed and offered by AFIT commencing November 1989. This workshop was incorporated into a AFIT course in 1991.

In April 1989, the AFIT version of the Installation Restoration Program (*IRP*) workshop was presented, at a significantly less cost than the contract version. The workshop was also offered in September 1989. In October 1989, after obtaining PRC approval, the workshop became a full AFIT course.

The Civilian Institution Programs was tasked to generate several reports for the Air Force Management Engineering Agency (*AFMEA*) team after their visit in the fall of 1989. These reports required modifications in several programs and the creation of new programs to generate the data from R:base. Captain Battles, Captain Vermillion, and Sharon Mullins programmed and printed these reports. These reports included cost data, average student load, tuition cost range, overhead costs associated with CI programs and ranks of students in CI programs. Colonel Whitlock edited the compendium of AFIT responses to the AFMEA recommendations.

On 11 July 1989, after discussing the issue with the Air Force Chief of Staff and Air University Commander, Lt Gen Thomas J. Hickey, the Deputy Chief of Staff (*DCS*) of

Air Force Personnel, requested that the AFMEA examine different ways of providing the most cost effective education programs in a time of limited resources. As directed by the Air Force Vice Commander (*AF/CV*), the study focused on where the Air Force Institute of Technology has been and where they were headed, the number of people going through AFIT, cost, alternative paths, cost comparisons, how the right level was determined, and whether the process involving MAJCOM's inputs was adequate.

On 2 November 1989, an Organizational Analysis Study Charter for AFIT was compiled by the AFMEA in close coordination with AF/DP/Programs and Resources (*PR*) and Air University. The Charter included a timeline which began with the establishment of the study team on 6 October 1989 and concluded with the staffing of the final report on 16 February 1990. Its purpose was in line with Lieutenant General Hickey's request and included the following objectives: (1) Evaluate graduate and continuing education programs; (2) Analyses of processes to identify unnecessary work/sequencing, identify sufficiency of resource inputs, and evaluate sufficiency of internal quality control mechanisms; (3) Evaluate the AFIT management information system process inputs; (4) Evaluate current organization structure; and (5) Identify significant external policies that impact mission accomplishment. The final AFMEA Report included observations and recommendations, with the authority to implement resting with AU/Commander (*CC*), in coordination with HQ USAF/DP.

3-8: Science And Technology Educational Forecast (STEF)

To identify clear directions for the Institute in the areas of defense science and technology, the School of Engineering in 1988 conducted a forecast study, designated as the Science and Technology Education Forecast (*STEF*), which was designed to provide a roadmap for the Institute to follow in the 1990s and beyond. The project consisted of the evaluation of the Air Force Systems Command Technical Objective Documents and other Air Force reports, including the AF Forecast II report, followed by an assessment of individual technologies and systems, an examination of the present support in those areas by AFIT, and an analysis of the projected plans and requirements. This forecast project provided AFIT with a documented list of initiatives for course content changes, new courses and programs, and research emphasis required to provide a more effective support for the emerging weapon technologies, systems, and operational management in the Air Force. Since AFIT has the responsibility of providing the educational base for the Air Force in the areas of defense science, engineering, and management, it is imperative that all AFIT programs should be designed with the specific objective of enhancing the scientific and technological potential of the Air Force. The STEF study and the formal program reviews conducted jointly with the users of AFIT graduates have clearly met this objective.

3-9: AFIT Board of Visitors

The AFIT Board of Visitors consists of nine regular members. The Board advises the Commandant on policies relating to AFIT educational programs including admissions, standards, curricula, instructional methodology, facilities, faculty, and other management aspects of the Institute. The Board is the Institute's most significant annually recurring event for maintaining its accreditation and national standing as an institute of higher learning. Gen Bryce Poe II, (USAF, Retired), served as the Chairman until 1989; Gen Robert T. Marsh, (USAF, Retired), served 1990-1993; and Gen John A. Shaud (USAF, Retired), is the current Chairman.

The 28th Annual Board of Visitors (*BOV*) met at AFIT from 6-8 March 1994, with the following members:

Gen John A. Shaud, USAF, Retired (Chairman)
Dr. Frank E. Perkins

Dr. E. Frank Harrison
Dr. Paul Y. Thompson
Dr. Bernard J. LaLonde
Col Frederick D. Gregory, USAF, Retired
Dr. Dorothy D. Reed (AU Observer)
Maj William I. Havron (Air Staff Observer)
Dr. Ronald C. Calgaard (AU BOV Chair).

Questions raised, studied, and observations reported by the Board included the following subjects:

Why AFIT -- The Student's View;
Graduate Education Requirements;
AFIT Laboratory Facilities;
Civilian Faculty Vacancies;
PCE Faculty Concerns;
Better Business Practices;
Dayton Area Graduate Studies Program (*DAGSI*);
AFIT's Distance Learning Project;
Education Program Initiatives:
Modeling, Simulation and Analysis;
Air Force Environmental Education Center;
Spacecast 2020. *

A Summary of the Board's finding is quoted below:

> AFIT is without question providing quality continuing education and graduate education to an outstanding set of students. They have stepped up to the challenge of using better business practices and with equal forcefulness have pursued initiatives such as participating in Spacecast 2020. The BOV underscores, one more time, that AFIT is a precious and fragile resource for the United States Air Force.

3-10: Accreditation

In 1955 AFIT received the first accreditation of its engineering programs by the Engineers' Council for Professional Development (*ECPD*).

The Air Force Institute of Technology is accredited institutionally by the North Central Association of Schools and Colleges (*NCA*). The purpose of this accreditation is to provide public confirmation that the institution is providing quality service and, assists the institution in improving that service. Reaccreditation evaluations completed by the North Central Association of Schools and Colleges in October 1990 led to a ten-year extension to the Doctoral level.

The Air Force Institute of Technology applied for accreditation in January 1989, which initiated a two-year self-study process which, along with the Institute's *Self-Study Report*, is the heart of the system. This report follows a decade of relative organizational stability and anticipates a decade which promises to be somewhat turbulent because of probable and unpredictable adjustments in the mission and the budget of the Department of Defense. Sixty-three study committees were organized and staffed by faculty, administration, and student representatives and a senior faculty member who was relieved of normal duties to concentrate on the coordination and editing of the final project in 1989. This final project, the Self-Study Report, was a detailed philosophical and operational report which served the requirements of external accreditation review, but which also functioned as an internal statement and evaluation of AFIT's future in a post-Cold War military/academic environment.

SCHOOL OF CIVIL ENGINEERINC
AND SERVICES

* Spacecast 2020 will identify the technologies needed for the year 2020, as well as have 20/20 vision regarding them.

CHAPTER 4

CONTRIBUTIONS TO SCIENCE AND TECHNOLOGY

4-1: The Doctoral Program

In 1994, the Doctoral Program at the Air Force Institute of Technology (*AFIT*) reached its 25th year of awarding the Ph.D. degree. The origin of this program goes back to 1963 when a small group of AFIT faculty, responding to a recommendation by the USAF Task Force on Technical Education, drafted a proposal for a doctoral program under which an Air Force student would enter the resident School of Engineering for two years followed by a reassignment to one of the AF laboratories to do research for the dissertation. Over the ensuing years the program has undergone evolutionary changes to integrate it more closely with the ongoing AF research and development programs and with the emerging weapon technologies and scientific discoveries. As of the end of 1993, AFIT has awarded 205 Ph.D. degrees from this program, 192 to AF officers, four to US Army officers, one to an US Navy officer, six to AF civilians, and two to international officers.

Coincident with the dedication of the new building for the School of Engineering at the Air Force Institute of Technology (AFIT) in August 1964 and the announcement of the newly established doctoral program at AFIT, President Lyndon B. Johnson wrote to Major General Cecil E. Combs, AFIT Commandant:

> "The establishment of a doctoral level program in the Aerospace Science, announced today by Secretary Zuckert, will expand and strengthen the important role of the Air Force Institute of Technology in our nation's defense program. This program is in keeping with my recent remark made at the Industrial College of the Armed Forces, directing the Secretary of Defense to strengthen and broaden opportunities available to members of the military services to further their education while still in service."

In the same letter the President also acknowledged that "The Institute [AFIT] has made many outstanding contributions to the building of the greatest military power in history; a power dedicated to the preservation of peace and freedom throughout the world."

Over the last 25 years, the story of the AFIT doctoral program is indeed a success story of contributions not only to Air Force Science and Technology, but also to the strengthening of graduate Masters level programs in AFIT. Both of which provide opportunities for professional growth of the faculty.

Program History. The first official recognition of the possible potential of AFIT to offer academic work at the doctoral level is a study made by the USAF task force on technical education convened in 1962. This task force made a number of short and long range action proposals including the following: "The Commandant, Air Force Institute of Technology, will study the feasibility of presenting doctoral programs in science and engineering at the resident School of Engineering." The Task Force report also stated:

> [A] Highly specialized doctoral level program in the fields of Foreign Technology may prove desirable. Doctoral level study in conjunction with the Air Force laboratories may also prove feasible and valuable. The objective would be to develop doctoral programs unique to the needs of the Air Force. The Resident School of Engineering has contributed much research and experience to the national educational capability in specialized engineering fields. In conjunction with the Air Force Systems Command, it could provide additional new subject areas to help meet the needs of Technological Warfare.

The second official recognition can be found in the 1963-1973 *Air University Long Range Plan* prepared at the request of the Board of Visitors of Air University. This plan recommended that "AFIT investigate the desirability of raising the level of education offered in the resident school above the master's degree to satisfy the need of service personnel for extended knowledge in science and engineering peculiar to the Air Force."

The next step was taken by the AFIT faculty when, in June 1963, an informal steering committee under the chairmanship of Dr. W. L. Lehmann, Head of the Physics Department, was formed at the request of Major General Cecil E. Combs, AFIT Commandant. This committee, which represented all departments of the School of Engineering, was established to consider the feasibility of a doctoral program at the resident School of Engineering.

Program Approval. Having received the final proposal from the Steering Committee, the AFIT Commandant appointed an ad hoc committee on 2 October 1963 by special order No. M-39 in order to proceed with developing detailed plans for the proposed program, as required at that time by AF Regulation 27-7. Dr. H. W. Barlow was appointed chairman of the committee and also served initially as its first secretary. The Dean of the School of Engineering and the department heads of the School of Engineering were nominally appointed as members of the committee, but had the privilege of designating faculty or staff members to represent them. Between October 1963 and April 1964, the Ad Hoc Committee met some eighteen times and produced a formal proposal for the new doctoral program which was sent to Air University (AU) on 16 April 1964. After the AU staff evaluated the proposal, the Vice Commander of Air University, Major General C. H. Pottenger, forwarded AFIT's proposal to Headquarters USAF (Office of the Assistant Vice Chief of Staff) on 18 April 1964. Shortly thereafter, on 25 April 1964, AU received a letter from Lieutenant General W. S. Stone, Deputy Chief of Staff (Personnel), in which he stated that "The development of this plan [AFIT doctoral program], specifically tailored to meet Air Force unique requirements at minimum costs in funds and manpower and the cooperation with and use of Air Force laboratory personnel and equipment is most commendable." He also indicated that his office "will make a concerted effort to obtain the authorization required to present the program." On 3 August 1964, Major General John K. Hester, Assistant Vice Chief of Staff, Headquarters USAF, informed AU that the doctoral level program at the AFIT School of Engineering was approved by the Secretary of the Air Force, and that AU may, upon recognized accreditation of the program, award an appropriate doctoral degree to persons meeting established degree requirements, as authorized by U.S.C. § 9314. This quick response from Headquarters USAF clearly attested both to the soundness of the concept and excellence of the plan. AFIT immediately started to proceed with necessary implementation to initiate the program in July 1965.

Doctoral Council. Once the program was approved by the Secretary of the Air Force, it became necessary to translate the proposal, which had been developed by the Steering Committee and the Ad Hoc Committee, into an implementation phase and establish a management structure for the new program. Therefore, Office Instruction No. 20-6 was issued by AFIT on 7 August 1964 establishing a Doctoral Council responsible to the Commandant for direct supervision of the academic aspects of the program and for implementation, control, modification, and continuous review as necessary. The initial Council membership consisted of the Academic Director, representatives of the office of the Dean of the School of Engineering, and the various cooperating departments and Air Force laboratories. Dr. H. W. Barlow was elected Chairman and Dr. A. J. Shine, Vice-Chairman.

Accreditation. The first task of the Doctoral Council was to prepare a self-study report for accreditation by the North Central Association of Colleges and Secondary Schools (NCA), a regional accrediting association with jurisdiction over AFIT. After the Self-Study Report had been submitted to NCA, the Accreditation Team visited AFIT on 25-28

April 1965 and, on 11 August 1965, a preliminary accreditation was granted to AFIT for the doctoral degree program in Engineering Science. Five years later in 1970, after a regularly scheduled accreditation visit to examine all AFIT degree programs, a full accreditation at the doctoral level was received from NCA. Subsequently, the AFIT doctoral program was reaccredited by NCA in 1980 and 1990.

Original Program (1965). The AFIT doctoral program was designated initially as a specialized program in Aerospace Engineering leading to a Doctor of Philosophy degree (Ph.D.). Its main purpose was to educate Air Force officers primarily for positions of leadership in Air Force research laboratories. The curriculum was interdisciplinary and it involved all the instructional departments of the School of Engineering. It was administered by the Doctoral Council, the latter appointed by the Commandant, on which all departments were represented. The program consisted of two phases: Phase I during which the prospective doctoral student was assigned to AFIT for a period of two years, and Phase II during which the student was assigned to an Air Force research laboratory for four years to conduct research on a subject approved by the laboratory commander and the AFIT Doctoral Council.

The first year of the original curriculum consisted of four courses each in advanced mathematics, theoretical and applied mechanics, and advanced physics, which formed the Doctoral Core courses. During the second year of the program the student was expected to prepare for and undertake the qualifying examinations prerequisite to admission to candidacy for the degree, to acquire (if deemed necessary) and demonstrate the ability to read technical literature in a modern foreign language, to select a major field of study, and to begin a planned program of specialized courses and research in that field. The student was also expected to select the Air Force laboratory in which to carry out the second phase of the doctoral program.

The second phase of the program consisted of a tour of duty of regular length in one of the Air Force research laboratories where, by agreement with that laboratory, the student pursued research for the doctoral dissertation on a subject pertinent to the mission of the respective laboratory.

Current Program. As in the original program, the current AFIT doctoral program is directed toward the concepts of a research degree. The Council of Graduate Schools in the United States (from *The Doctor of Philosophy Degree: A Policy Statement*, Oct 1977) articulated the nature of the research-intensive Ph.D. degree in these words:

> The Doctor of Philosophy degree is awarded by universities in many parts of the world as the mark of highest achievement in preparation for active scholarship and research.
>
> The doctoral program is designed to prepare a student for a lifetime of intellectual inquiry that manifests itself in creative scholarship and research. The program emphasizes freedom of inquiry and expression and development of the student's capacity to make significant contributions to knowledge. An essential element is the development of the ability to understand and evaluate critically the literature of the field and to apply appropriate principles and procedures to the recognition, evaluation, interpretation, and understanding of issues and problems at the frontiers of knowledge. All of this is most effectively accomplished in close association with those experienced in research and teaching.
>
> A central purpose of doctoral programs is the extension of knowledge, but this cannot be accomplished on all fronts simultaneously. Students must choose an area in which to specialize and a professor with whom to work. Individualized programs of study are then developed and committee members are selected cooperatively

as course work is completed and research undertaken. When all courses have been completed, the research finished, the dissertation written, and all examinations passed, the student will have acquired the knowledge and skills expected of a scholar and will have extended knowledge in the field.

The above words are usually what scholars mean when they say the Ph.D. is a "research" degree. Thus, the advisors and students are guided by the above statement in selecting courses of study and dissertation direction. This emphasizes the research nature of the existing program.

Doctoral Program Dissertations

The AFIT doctoral program has made significant contributions in many scientific and engineering areas, developing new concepts and applications for the emerging technologies and weapon systems. One outstanding example of such applications is the dissertation which provided the theoretical background and concept feasibility for a new surveillance and targeting system described below.

A Precursor of the Joint Surveillance and Target Acquisition Radar System (JSTARS). In 1981, Major Jerrold S. Shuster completed his Ph.D. dissertation on the concept of a Multiple Arrested Synthetic Aperture Radar (*MASAR*) for the detection of slowly moving targets in a clutter environment. This new radar system consisted of a succession of synthetic aperture antennas which were coincident in space but were displaced in time by several interpulse periods. The dissertation provided important information for the design of optimum components of the system, and demonstrated that MASAR, with an optimum component design, is a promising concept for the detection of slowly moving targets immersed in strong clutter environments, e.g., moving tanks. Subsequently, this work formed the theoretical basis for the development of the Joint Surveillance and Target Attack Radar System (*JSTARS*), which was employed in Desert Storm. The great success of JSTARS attests to the exceptional value of this original contribution by an AFIT doctoral student.

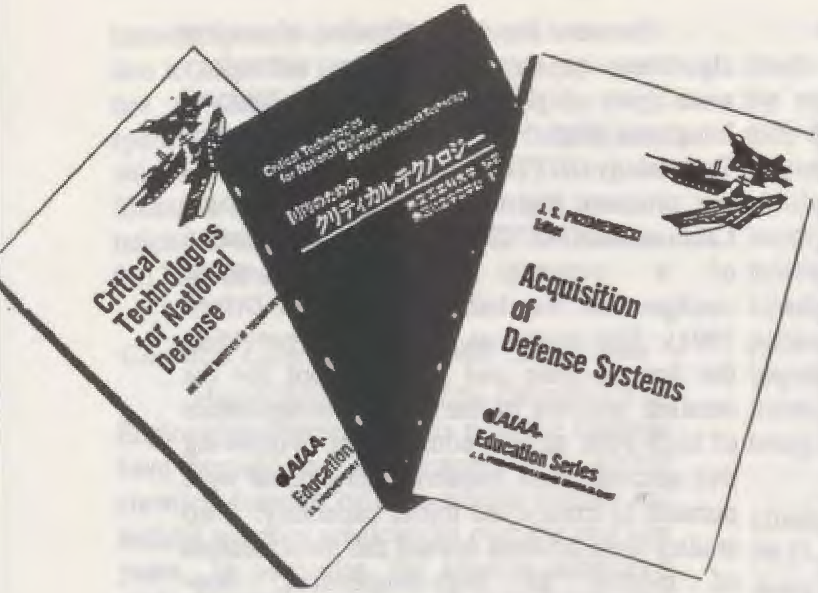
[See page 4-20 for an actual JSTARS image showing the Iraqi retreat from Kuwait (cira February 1992).]

4-2: Contributions to Air Force Research and Development

Annual Air Force Research and Consultation Reports document AFIT contributions to Air Force Research and Development programs, provide a detailed accounting of AFIT research/consulting activities and accomplishments and serve as a good way to advertise the capabilities and projects completed. The reports are distributed to Air Force labs as a reference for AFIT activities/capabilities.

The contribution of AFIT research to defense is measured in the technological change and improved weapon systems which eventually result from that research. This impact tends to occur years, even decades later and is co-mingled with the contributions of other researchers within the DOD and without. It is thus difficult to measure. Measurable quantities include the number and quality of technical publications accepted by the referees of journals, the number of presentations accepted for regional, national and international conferences, the number of research projects approved, the number of consultations performed for Air Force and DOD customers and, finally, the number of student MS theses and Ph.D. dissertations completed and submitted to the Defense Technical Information Center.

Being a part of an Air Force School, the faculty of AFIT feel a special obligation to focus their research on current Air Force and DOD problems and future systems. Evidence of this focus was that 76% of the CY 92 theses and dissertations were directly sponsored by Air Force, DOD and government agencies. In addition most of the research projects and consulting were carried out for Air Force and DOD units.



AFIT Textbooks on Critical Technologies and Defense Acquisition

The Federal Technology Transfer Act of 1986 allowed for transfer of technical knowledge through joint publications. Using the vehicle of a Cooperative Research and Development Agreement (*CRDA*) created by the 1986 Act, two AFIT texbooks were recently published by the American Institute of Aeronautics and Astronautics in Washington, D.C.: *Critical Technologies for National Defense* and *Acquisition of Defense Systems*. Under the terms of this agreement AFIT is receiving royalties from the sales of these two books.

Both texts were developed as faculty projects in the School of Engineering and the School of Systems and Logistics, under the direction of Dr. Przemieniecki. The first textbook discussed the twenty critical technologies identified by the Department of Defense in 1990. It provided a detailed description of the underlying physical and engineering principles involved and a discussion of the potential impact on future weapon systems. The second textbook provided a comprehensive description of the overall process of acquiring new defense systems: defense requirements process, formal acquisition phases, manufacturing, test and evaluation, logistics, operations, and maintenance. It is interesting to note that the *Critical Technologies for National Defense* text was translated into Japanese by the Japan Defense Research Center in Tokyo, Japan.

4-3: Significant Research

The School of Engineering continued to bring in a substantial amount of sponsor funding from other Air Force and DOD agencies. These monies provided for research equipment, services, and student and faculty travel in direct support of specific research efforts which were of interest to the sponsor. During 1993, $3.2M were provided for direct support of research activities in this manner. In addition it was estimated, by sponsors of student thesis projects, that the cost avoidance provided by student research projects was over $35.3M. In other words, it would have cost the sponsoring agencies this amount of money to do the same work on their own.

Adaptive and Reconfigurable Flight Control -- Professor M. Pachter

Professor Meir Pachter of the Department of Electrical and Computer Engineering is pursuing a sustained research effort in the area of Adaptive and Reconfigurable Flight Control. The objective is to design advanced flight control systems that can automatically adapt to a changing environment. Specifically, recent operational experience has shown the need for the automatic mitigation of control surface failure and/or combat damage.

An extensive theoretical development of the system identification and automated online robust control design disciplines has been undertaken. A novel Adaptive and Reconfigurable Control methodology that "works" has been developed and is being validated in realistic simulations. Realistic sensor noise, atmospheric disturbances, unmodeled dynamics, nonlinear effects and parametric uncertainty are included in the simulation. The adaptive flight control system is able to

accommodate the simulated loss of an aircraft elevator.

Innovative robust system identification algorithms have been developed as part of Capt Jim Brown's Ph.D. dissertation (his co-advisor is Lt Col R. Riggins). Two other Ph.D. students have recently begun work in this area; Capt Russel Miller in the area of nonlinear control and Capt Odell Reynold will continue the system identification work. The above research topics are basic building blocks on the road to practical Adaptive and Reconfigurable Control.

This research is performed in collaboration with the Flight Dynamics Directorate at Wright Laboratories. The Adaptive and Reconfigurable flight control effort is supported by the Air Force Office of Scientific Research (*AFOSR*). Indeed, the WL/AFIT team members, including Professor Pachter, have recently been selected a "Star Team" by AFOSR which is supporting this research effort. It has significant potential applications for war fighter requirements.

CFD: Numerical Modeling of High-Speed Flows -- Dr. Philip S. Beran

Dr. Philip S. Beran of the Department of Aeronautics and Astronautics and his graduate students have developed a large number of algorithms and software programs for the analysis of complex, high-speed flows. These computational fluid dynamics (*CFD*) tools have been used over the last five years to study a wide variety of practical problems in support of active Air Force programs. Emphasis has been given to the simulation of flows for which experimental data is very difficult or costly to obtain.

The research is based on a class of algorithms developed by other investigators in the early 1980s, and involves specific algorithm and software improvements tailored to problems of mission interest. These algorithms, referred to as "TVD schemes" in the literature, provide an exceptional capability to simulate flows with complex arrangements of shocks and other discontinuous structures.

The need for the application of modern algorithms to demanding new technology areas was highlighted by the National Integrated High Performance Turbine Engine Technology (*IHPTET*) Initiative. In support of this program, and through support of Wright Laboratories/(POTC), a doctoral investigation of a transonic, 2-D turbine-cascade configuration was initiated (Mark A. Driver, 1991). This work was successful in providing the first accurate and efficient tool for the detailed analysis of the aerothermodynamics of high-work turbine components. Following this success, three masters-level studies were pursued to expand the initial capability. Two studies were directed toward the incorporation of models for high-temperature, non-equilibrium effects into the framework of the initial technique. A third study was directed toward the accurate computation of unsteady, axisymmetric flows. A doctoral investigation was begun to provide Wright Laboratory/(MLNN) with a computational capability to predict the stability and pitching-moment characteristics of the "HART" high-speed missile (Kenneth J. Moran, 1994). The resulting code was successfully tested on axisymmetric and realistic finned configurations at angle of attack, and provides Air Force researchers the only current, nondestructive means for thorough testing of high-speed, finned missile designs.

In collaboration with Dr. Lamont and Dr. Hobart of the Department of Electrical and Computer Engineering, and through funding from the National AeroSpace Plane (*NASP*) program, we have begun to develop new CFD algorithms and new implementations of CFD algorithms suitable for execution on parallel computing systems comprised of tens to thousands of processors. Our goal has been to develop robust and mature CFD methodologies for the accurate analysis of high-performance, full-configuration aircraft. We have made significant progress in this direction; a parallelized, domain-decomposed version of the HART-missile code has been developed, which will be applied by Douglas C. Blake (DS-96) to more complex missile shapes. Work has also been extended to the

interdisciplinary area of fluid/structure interaction to begin the analysis of the flutter properties of full-configuration aircraft at high speeds. To this end, and as part of the ongoing work of Scott A. Morton (DS-95), we have formulated an algorithm for the rapid computation of the flutter envelope of an NACA-0012 airfoil at transonic speeds.

Chemical Laser Kinetics -- Maj Glen Perram

Major Glen Perram of the Department of Engineering Physics and his graduate students have pursued the development of a visible chemical laser for ballistic missile defense and tactical weapons applications over the past five years. In particular, the kinetics associated with chemical excitation of such lasers, and the impact on device efficiency and scaling have been examined. This research also has important applications in the areas of infrared signatures, atmospheric chemistry, advanced rocket fuels, and hypersonic physical gas dynamics. This activity has been sponsored by the Air Force Phillips Laboratory, Strategic Defense Initiative Office (*SDIO*), and Air Force Office of Scientific Research (*AFOSR*).

When energy from a chemical reaction is released into the electronic, vibrational, and rotational degrees of freedom of a small molecule in the gas phase, non-equilibrium distributions among the various quantum states are obtained. How rapidly and through what mechanisms this energy is dissipated through collisions as the system returns to equilibrium is of fundamental interest in chemical physics. There has been considerable progress in the theoretical and experimental study of the quantum-resolved collisional dynamics of the excited electronic states in diatoms, particularly for vibrational-to-translational (*V-T*) energy transfer. Typically, these studies have focused on systems where the vibrational states have large energy spacing with respect to the average translational energy. Major Perram's recent research has focused on extending the understanding of quantum resolved energy transfer to strongly coupled systems such as the diatomic halogens and interhalogens.

Using laser induced fluorescence, kinetic flow tube, and photolysis techniques, the rate coefficients for energy transfer and their dependence on quantum state, interaction potential, energy gap, and collision pair reduced mass have been measured for the important class of diatomic halogen molecules. This major improvement in the kinetic database has enabled an extensive comparison with existing theory and identified important scaling laws which enable the prediction of unknown rates for a whole class of energy transfer events.

This experimental work in chemical kinetics resulted in six M.S. theses and two Ph.D. dissertations since 1989. The Ph.D. students were David W. Melton, 1991, and Courtney D. Holmberg, 1993. In addition, one Ph.D. (Ray O. Johnson, 1993) and four M.S. students have completed complementary work on energy transfer between spin-orbit split electronic states.

Control/Structures Interaction Research -- Professor Brad S. Liebst

Professor Brad S. Liebst of the Department of Aeronautics and Astronautics and his graduate students have conducted ongoing research in the area of control/structure interaction since the arrival of Professor Liebst at AFIT in 1989.

The research effort is concerned with the design, analysis, and testing of passive and active control systems for vibration suppression of large flexible structures. Vibration suppression is particularly important in large space-based weapons systems which require extremely accurate pointing of various laser and/or particle beams. Dr. Liebst is the principal investigator for the AFIT Controls/Structure Interaction Research Facility (*CSIRF*) which provides a test bed for the design and analysis of passive and active control systems of large flexible structures. The CSIRF is sponsored by the Phillips Laboratory, Kirtland AFB. The CSIRF consists of three major experiments: Passive and Active Control of Space Structures (*PACOSS*) experiment, AFIT Cantilevered Beam experiment,

and the Boeing Company Advanced Composite with Embedded Sensors and Actuator experiment. These various experiments simulate components of large flexible spacecraft, or in the case of PACOSS an entire large flexible spacecraft.

Past and current research topics include: the simultaneous design of passive viscoelastic damping and active control, the optimal composite tailoring of torsionally excited beams for combined bending and torsion vibration suppression utilizing piezoceramic bending mode actuators only, improvements to the eigensystem realization algorithm (*ERA*) for system identification from experiments, and the use of eigenstructure assignment algorithms for structural failure detection. All of these efforts have resulted in significant advancements in the design and analysis of passive and active control of large flexible structures using a variety of methods such as viscoelastic constrained layer passive control, piezoceramic active control, and reaction mass active control.

The control/structures interaction research has resulted in five M.S. theses and one Ph.D. dissertation completed since 1989. Presently, there is one Masters student and two Ph.D. students working in the CSIRF. The completed dissertation was that of Capt Michele Gaudreault entitled "Simultaneous Optimization of Structural Damping and Control." Of the current Ph.D. students, Capt Doug DeHart has nearly completed his dissertation entitled "Simultaneous Structural and Control Optimization of a Torsionally Loaded Plate," and Capt Rich Cobb is just beginning his research in the area of "Real Time Structural Failure Detection in Large Flexible Spacecraft."

Electro-Optical Sensors and Signals -- Dr. Byron Welsh

Electromagnetic radiation emitted from, or reflected by, objects is the primary means humans use to sense information about distant objects. Remotely sensing information about distant objects, such as targets for weapons systems and objects with intelligence value, is critical to effective use of Air Force weapons systems. As a result, the Air Force engages in a continuing effort to improve the capability of remote sensing devices. Desired improvements include enhanced angular resolution, use of new parts of the electromagnetic spectrum, use of more than a single spectral band, and overcoming the effects of the atmosphere through which the radiation must propagate. This area of research is encompassed in an interdepartmental research project, involving three faculty members: Dr. Byron Welsh, of the Department of Electrical and Computer Engineering and Capt Michael Roggemann and Dr. Theodore Luke, both of the Department of Engineering Physics. The research project also currently involves four Ph.D. students and seven M.S. students. Over the last four years, the effort has resulted in the graduation of two Ph.D. students (Capt Dustin Johnston, 1992 and Capt Steven Troxel, 1994) and 15 masters students. The Air Force Phillips Laboratory and the Air Force Office of Scientific Research (*AFOSR*) have been the primary sponsors of the research.

Research in remote sensing has been conducted in two broad areas: (1) the limits of detection; and (2) signal processing and reconstruction. Studying the limits of detection of novel remote sensing ideas answers critical questions, including "Is there enough signal to make a high signal-to-noise ratio measurement of the desired quantity?," and "If one cannot measure a quantity directly, what processing must be performed on the measurement?" Signal processing and reconstruction are studied to extract the information from the data, and to remove the effects of the measurement system from the data. Recent research in remote sensing has addressed two main problems: (1) overcoming the effects of atmospheric turbulence on optical imaging and beam propagation systems; and (2) using so-called hyperspectral measurement techniques to determine the material properties of targets. These two specific problem areas are described in more detail below.

Temperature fluctuations in the extended atmosphere affect systems which must form images and propagate laser beams

through the atmosphere in much the same way the image of a distant car appears distorted when viewed down a long heated highway: the images are not well-focused, and they change in time. Systems designed to image exo-atmospheric objects, and propagate laser beams over long optical paths must compensate for turbulence effects. Adaptive optics, image reconstruction, and hybrid methods involving elements of both techniques have been used for imaging applications. Recent AFIT theses have explored hardware tradeoffs for adaptive optics systems, novel measurements combined with image post processing concepts for overcoming errors which cannot be corrected by adaptive optics, and tomographic methods for measuring the structure of turbulence.

Many electro-optical sensors in the Air Force use only a single spectral band, and present the information in a pictorial form for human use. Recent research has been directed at the problem of simultaneously forming images of an object using many narrow spectral bands. This concept is referred to as hyperspectrometry. A conventional two-dimensional image is formed in any single spectral band, and there are many spectral bands measured. This type of spectral imaging can be used for at least two problems: (1) for high resolution applications the combined spatial and spectral information could be used to determine the actual materials composing the object; and (2) it may be possible to improve the performance of optical targeting systems using lower spatial resolution, but using a few spectral bands. Recent AFIT thesis work has explored the signal-to-noise ratio of hyperspectral imaging for space object identification applications, and developing techniques to determine object material properties from hyperspectral measurements.

Fatigue, Fracture and Failure of Composite Materials -- Professor S. Mall

Professor S. Mall of the Department of Aeronautics and Astronautics has pursued a research program in the area of fatigue, fracture and failure properties of advanced composite materials at elevated temperature since 1986. This includes the determination of thermo-mechanical properties of super alloys and metal matrix composites proposed for application in advanced propulsive and structural systems, and the characterization of fracture and fatigue behavior of ceramics and carbon composites under development for future propulsion applications. The main thrust of this research has been to develop the interrelationship between the mechanical response and microscopic damage mechanisms of these materials in severe environments. This has resulted in basic and important information for developing the mechanistic-based models to predict the durability and damage tolerance of these materials when subjected to complex mechanical and thermal loadings. A few examples are: crack growth rate behavior of a titanium-aluminide alloy under thermo-mechanical fatigue loading, a micro-mechanical-based analysis for predicting behavior of metal matrix composites, thermo-mechanical fatigue behavior of metal matrix composites, and a micromechanics-based model to predict thermo-mechanical response of ceramic matrix composites.

Dr. Mall has supervised more than 35 master theses and three doctoral dissertations. The doctoral students were: John J. Pernot, 1991, Crack growth in titinium aluminide alloy under thermo-mechanical loading; David D. Robertson, 1993, Micromechanics-based analysis of metal matrix composites; and Brian P. Sanders, 1993, Fatigue of metal matrix composites.

These research activities have resulted in more than 50 technical papers. In recognition of these efforts Dr. Mall has been elected as the Fellow of American Society of Mechanical Engineers and Associate Fellow of American Institute of Aeronautics and Astronautics.

Knowledge-Based Software Engineering -- Maj Paul D. Bailor

Major Paul D. Bailor of the Electrical and Computer Engineering Department and his co-researchers, Major David Luginbuhl (now at the Air Force Office of Scientific Research), Major Mark Roth, Dr. Thomas Har-

trum, and Dr. Eugene Santos have worked over the last five years to integrate research in artificial intelligence with research in software engineering - also known as Knowledge-Based Software Engineering. The major goal of this research is to establish engineering foundations (or engineering models) for analyzing and designing large software systems while simultaneously increasing the degree of automated support for these tasks. Using the engineering foundations, properties of software system designs can be established early in the system life-cycle.

The Knowledge-Based Software Engineering Research Group at AFIT is pursuing research on how to formally capture and represent knowledge to support software system analysis, design, and implementation via composition of well-founded components within a computing domain. Example domains researched by AFIT are: digital logic design, digital signal processing, electronic warfare, radar-tracking, and command and control. For each domain, fundamental engineering knowledge is captured regarding well-founded building block components as well as knowledge about how the components are composed together to build larger systems. Mechanical reasoning systems are being investigated to provide automated assistance for determining system properties and to provide assistance with component selection and composition alternatives. Supporting technology, such as object-oriented databases, is being investigated for the capture and retrieval of the engineering knowledge.

A prototype composition tool called "Architect" has been constructed and continues to evolve. Its first use has been in support of the Joint Modeling and Simulation System program at Wright-Patterson AFB. Support for this work has come from Aeronautical Systems Center (*ASC*), Electronic Systems Center (*ESC*), Wright Laboratory (*WL*), Rome Laboratory (*RL*), National Security Agency (*NSA*), and the Air Force Office of Scientific Research (*AFOSR*). Additionally, close cooperation is maintained with several civilian R&D firms such as Kestrel Institute, Lockheed Software Technology Center, Boeing Computer Services, and Unisys Corporation.

Four Ph.D. students are involved with the research project, and their primary role is the research and development of the required mathematical foundations. The Ph.D. students are: Capt Mark Gerken (DS-95) software architecture; Capt Frank Young (DS-96) hardware and software code design; Capt Scott Deloach (DS-96) algebraic transformations; and Capt Robert Graham (DS-96) algebraic approaches to operational research problems. In addition, twenty seven masters students have been involved over the last five years, and their primary role has been in the application and integration of mathematical foundations within the prototype composition tool.

Several technical papers/reports have been produced, and the research has also lead to Small Business Innovative Research (*SBIR*) initiatives for the further development and commercialization of the research. Additionally, two technology transition workshops were conducted with government and industry participants. In 1992, Maj Bailor was an invited visiting scientist at the Software Engineering Institute.

Mathematical Modeling -- Professor Dennis W. Quinn

Professor Dennis W. Quinn of the Department of Mathematics and Statistics and his graduate students have pursued a program of mathematical modeling of Air Force application problems over the past 14 years. These investigations have concentrated on problems where existing engineering analysis tools are inadequate for solving the physical problems.

The particular applications have involved (1) a nonlinear differential equation model of the transverse vibrations of a beam to help understand nonlinear damping, (2) identification of parameters in a nonlinear physiological model related to toxic hazard risk assessment, and (3) the analysis of the smooth particle hydrodynamic method for solving hyper-velocity impact problems. The work involving the physiological models has been in support of the Toxic Hazard Division of the Air Force Armstrong Laboratory while the

smooth particle hydrodynamics work has supported Phillips Laboratory.

This research involving Air Force Applications problems has resulted in eight M.S. theses and two Ph.D. dissertations since 1980. The Ph.D. students were Carl E. Crockett, 1990 (nonlinear beam equation) and David A. Fulk, 1994 (smooth particle hydrodynamics).

Nonlinear Optics -- Professor Won B. Roh

Over the last fifteen years, Professor Won B. Roh of the Department of Engineering Physics and his graduate students concentrated their research activities in three areas: lasers, laser spectroscopy, and nonlinear optics. The common thread linking these areas is the use of lasers and optics in ways to support the R&D requirements of various Air Force laboratories and agencies. Major goals and applications for this research include: the development of coupling and phasing of multiple laser devices for enhancing the energy delivery on the target; the development of optical diagnostic tools for the combustion engine community; and the development of nonlinear optical techniques such as phase conjugation for image processing, motion detection, and electro-optic pointing and tracking applications. Professor Roh's research has been sponsored by the AF Office of Scientific Research, Phillips Laboratory, Wright Laboratory, and the Rome Laboratory.

Selected specific research projects performed are: (1) the development of a laser-based diagnostic technique for measuring the concentration of boron dioxide -- an important reaction intermediary in boron flames, (2) theoretical and experimental investigation of phasing characteristics of coupled laser devices as a means of enhancing the laser energy delivery on the target; (3) the application of optical phase conjugation techniques for moving target detection and image processing, and (4) the development of a phase conjugation technique for semiconductor laser diode arrays and its application to mode control. The research in these areas has resulted in two completed Ph.D. dissertations and 37 MS theses. The Ph.D. students were Greg R. Schneider (1987) and Mark P. Jelonek (1989).

* * *

In a related area, Capt David Neumann (Ph.D. 1979), discovered two excimers in 1979 while working toward his doctorate of philosophy degree. The two excimers, lithium-magnesium (LiMg) and lithium-calcium (LiCa), looked promising for use in lasers. He went on, from AFIT education, to work at the Air Force Weapons Laboratory at Kirtland AFB NM, continuing his research on the excimers. He hopes that they will show characteristics for use in full-scale laser application for the Air Force.

Nuclear Radiation Transport -- Professor Kirk Mathews

Professor Kirk Mathews and his graduate students have pursued a program of development and testing of improved algorithms for discrete ordinates radiation transport calculations over the past 11 years. This research area began with his own dissertation research at AFIT in 1983, advised by Professor Bridgman, and has continued since Dr. Mathews joined the AFIT faculty in 1987.

This fundamental research in tool making contributes to the USAF and DOD in several areas. The design of radiation shielding for space assets, space nuclear power systems, and inertial confinement fusion applications for nuclear weapons effects simulation and testing all require extensive radiation transport computation. The AFIT research may make those computations less expensive and more accurate, thus contributing to the design of more effective defense systems. The work has been funded by the USAF Nuclear Criteria Group Secretariat, the Phillips Laboratory, and the Defense Nuclear Agency.

Radiation transport computational techniques fall into two categories: deterministic methods and Monte Carlo methods. The latter are flexible, but expensive to run. Among the more affordable deterministic approaches, discrete ordinates methods are the most popular. Nevertheless, they suffer from a variety of

limitations: ray effects, numerical diffusion, and very large memory requirements for two dimensional or three dimensional problems. AFIT Research has addressed each of these difficulties.

Ray effects are artifacts of the discrete ordinates methods in which particle fluxes have unphysical spatial variations. The "discrete elements method" provides an implicit coupling of angular quadrature set directions and the flow of particles, resulting in a locally adaptive angular quadrature representation. This approach ameliorates ray effects.

Numerical diffusion is an artifact in which a collimated beam propagates as a broad, diffuse flow of particles. It can also appear as an excessive or inaccurate flux penetrating an absorber. New spatial quadratures developed at AFIT (the step adaptive, linear adaptive, and exponential characteristic quadratures) have been effective at reducing numerical diffusion. These methods can provide accurate shield penetration results using computational cells that are optically thick (e.g., 30 mean free paths), whereas conventional techniques require cells on the order of one mean free path thickness. This new spatial quadratures can result in a substantial decrease in memory requirements when applied in two or three space dimensions.

Discrete ordinates computations are normally done on a regular array of rows and columns of rectangular cells (like a checkerboard). Unfortunately, characteristic methods can't be applied in curvilinear coordinates. This project has developed a linear characteristic quadrature for arbitrary triangular cells which obviates the need for curvilinear coordinates. An exponential characteristic method for arbitrary triangular spatial meshes is under development.

This radiation transport research has led to three Ph.D. dissertations: Kirk Mathews, 1983 (discrete elements method in slab and x-y geometries); Dennis Miller, 1993 (linear characteristic method for arbitrary triangular meshes); and Bryan Minor, 1993 (exponential characteristic method for rectangular meshes). Another Ph.D. student is in progress (Charles Brennan). In addition one M.S. thesis has contributed (Glenn Sjoden, 1991 (exponential characteristic method in slab geometry)).

Nuclear Weapon Fallout Modeling -- Professor Charles J. Bridgman

Professor Charles J. Bridgman of the Department of Engineering Physics and his graduate students have pursued a long-running program of fallout modeling and model improvements over the past 14 years. These investigations, which were begun at the height of the cold war, were originally intended to develop tools to evaluate the direct and collateral threat to life in the event of a strategic or regional nuclear attack.

Modeling improvements have included a better specification of the spatial location of the stabilized cloud, a reinvestigation of particle-size and radioactivity-size distributions of the dust, a physical derivation of the 'rate of arrival' term which is fundamental to smearing codes, the inclusion of real varying winds and a technique for predicting those winds at any space-time point from worldwide weather observations, methods of predicting radiation dose to air crews flying in nuclear clouds and a technique for treating multibursts. The models were used on real nuclear test data to validate some of the assumptions in the "nuclear winter" study. The models were also used to simulate the ash fall from the Mount St. Helen's volcanic eruption. The simulation predicted the presence of two size distributions in the falling ash which confirmed uncertain experimental observations. The models were also used to make a comparison between predictions of dust location in the nuclear cloud as calculated by fallout codes and dust carrying hydrodynamics codes. An experimental study of ground self-shielding of gamma rays was also conducted.

A fast-running operational code: the "AFIT smear model" was developed from these studies which is in wide use. The variable wind treatment developed at AFIT was incorporated in the fallout code "REDRAM" which was used by both Aeronautical Systems

Center/EN and the Air Force Weapons Laboratory (now the Phillips Laboratory). AFIT modeling efforts resulted in the identification of non-physical discrepancies in a DOD funded and supported fallout code and in its recall and correction. AFIT student investigations and use of the Defense Nuclear Agency (*DNA*)-supported benchmark fallout code "DELFIC" resulted in the identification and correction of numerous programming errors as well as modeling improvements in that code.

The fallout modeling work resulted in 24 M.S. theses and four Ph.D. dissertations since 1980. The Ph.D. students were Winfield S. Bigelow, 1983 (smearing method); Arthur T. Hopkins, 1984 (variable winds); George H. Baker, 1987 (implications for nuclear winter) and Vincent J. Jodoin, 1994 (cloud rise modeling). During this time Dr. Bridgman was elected to the grade of Fellow in the American Nuclear Society.

Parallel Computation (Software Design and Application) -- Professor Gary B. Lamont, Lt Col William C. Hobart and Professor Thomas C. Hartrum

Professor Lamont, Lt Col Hobart, and Professor Hartrum of the Department of Electrical and Computer Engineering, along with other departmental faculty and graduate students are continuing to analyze and synthesize parallel software design techniques for critical computational applications in the USAF. Faculty from other departments also participate in these interdisciplinary investigations. Such research efforts have evolved over the past decade because of the availability of supercomputers. Current efforts focused on massively parallel processing machines. Specific activities include development of a domain-specific parallel software architecture, application of parallel genetic algorithms to combinatoric optimization problems and functional minimization problems, application of artificial intelligence techniques to solving the mission routing problem in real-time on parallel supercomputers, along with parallel discrete-even simulation, parallel electromagnetic computation, parallel computational fluid dynamics and image processing using wavelets. These continuing studies are supported by a variety of agencies including Air Force Office of Scientific Research (*AFOSR*), Advanced Research Projects Agency (*ARPA*), Electronic Systems Center (*ESC*), National AeroSpace Plane (*NASP*), Naval Research Lab (*NRL*) and Wright Laboratories (*WL*).

The development of the domain-specific parallel software architectures included the selection of a prototype parallel software architecture defined for NP-complete combinatoric optimization domain-specific problems. Many problems of this type are reflected in mission planning for military operations. Appropriate problem representations and transformations were evaluated using a variety of formal algebraic and logic systems. Definition of detailed system structure is continuing with emphasis on task management (scheduling, load balancing, allocation) transformations as supported by AFOSR. Such an environment should decrease the future cost of parallel software development and maintenance.

Functional minimization and mission routing problems were selected in conjunction with Wright Laboratories (Avionics Directorate and Materials Directorate). The use of parallel genetic algorithms and deterministic Artificial Intelligence search algorithms to solve the multi-criteria aircraft mission routing problem and molecular energy (protein folding) minimization are continuing to be investigated. Toward the routing problem solution, groundwork has been laid to use a bi-static radar model, better radar-cross-section (*RCS*) criteria, and the use of pop-up threats, replacing the previous use of monostatic, fixed-location radars. The protein-folding problem is associated with the modeling of laser light-absorbing material for cockpit integrity. Based upon current results, parallel algorithms show potential to offer accurate near-optimal solutions in real-time. Useful parallel algorithm visualization techniques have been developed in these applications using the AFIT Algorithm Animation Research Facility, an on-line graphical visualization facility.

The ability to simulate large battlefield situations is increasingly important from a training standpoint in an era of decreasing funds available for the conduct of large exercises. Efforts in this area are being supported by the Joint Modeling and Simulation System (*JMASS*) project through Wright-Laboratories/(*RWWW*). Another area of concern to the DOD is in the development of new computer products using Very High Speed Integrated Circuits (*VHSIC*) technology. Such circuits are designed using the VHSIC Hardware Description Language (*VHDL*) and simulated to analyze correctness and performance. Such simulations are typically very slow, stretching out the development cycle for large circuits. Advanced Research Projects Agency/(*ARPA/CSTO*) is supporting the "QUEST" project to investigate ways to increase the speed of VHDL simulators. The majority of the effort has involved empirical analysis of various application simulations with the goal of determining heuristic guidelines for the partitioning of a simulation across many processors. In addition, several variations of a conservative time synchronization protocol have been experimentally analyzed. We have pursued three primary applications: battlefield simulation, VHDL circuit simulation, and queuing network simulations. In addition to the experimental work, we have also begun a more analytical approach to analyzing simulations for parallel speedup.

The Discrete Wavelet Transform is becoming a widely used tool in image processing and other data analysis areas. Mappings of a nonconventional 3-dimensional wavelet decomposition technique to three different parallel processing computer architecture types were developed. Speedup analysis was performed on test results with encouraging results for real-world image tracking. We have achieved close to linear speedup over serial implementations using a distributed network and near-linear speedup on hypercubes and massively parallel machines.

This general area of parallel computational research has resulted in over fifty Master of Science theses and three Ph.D. dissertations over the past decade. The three Ph.D. students include Timothy G. Kearns, 1987, parallel architectures; Paul D. Bailor, 1989, formal languages; and Jeffery A. Simmers, 1991, parallel algorithms. The current Ph.D. students are: Laurence D. Merkle (DS-95), Daniel King (DS-96) and Edward Williams (DS-97). Research investigations have resulted in over 40 technical papers being published and presented at a variety of conferences and symposia.

Semiconductor Materials and Device Characterization -- Professor Yung Kee Yeo and Professor Robert L. Hengehold

Professors Yeo and Hengehold of the Department of Engineering Physics and their graduate students have been conducting advanced research on optical and electrical properties of various semiconductor materials including semiconductor heterostructures and quantum well superlattices using photoluminescence, selective excitation luminescence, cathodoluminescence, temperature dependent Hall-effect/sheet-resistivity, and deep level transient spectroscopy measurements. The objective of this research is to provide a better understanding of the governing principles in these semiconductor materials and quantum well structures which are used for the fabrication of the various state-of-the-art electronic and optoelectronic devices. Devices of interest are those necessary for Air Force photonic applications, which include light-emitting diodes, semiconductor lasers, and optical and infrared detectors.

Specific areas of research since 1980 include extensive studies of impurity doped GaAs and AlGaAs for diode laser applications and Si/Ge superlattices for application to optical emitters and detectors. Special emphasis has been placed on rare-earth doping of GaAs and AlGaAs. The rare-earths have the potential for producing sharp line laser diodes emitting at wavelengths in the infrared, emissions which should be nearly independent of the host material and temperature. Many of these wavelengths are perfectly matched to the requirements for maximum transmission of signals in fiber optic cables. To date, among the various rare-earth elements, *erbium* and

praseodymium were found to be the most promising. These two elements have been studied in detail, and the critical energy transfer mechanism between host and rare earth emitter was established, allowing for improvement in the luminescent efficiency of future devices. The study of Si/Ge superlattices on Si substrates will permit the fabrication of photonic elements such as laser emitters or optical detectors directly on the Si circuit chips universally in use today. Success in this area could prove revolutionary. Emphasis has been placed on the characterization of these superlattices to determine the best growth conditions. To date, these efforts have established optimum growth temperatures, substrate orientations, and so forth, for devices such as optical emitters and infrared detectors.

Recent studies have extended this work to GaSb and AlGaAsSb for mid-infrared lasers, wide bandgap semiconductors such as GaN and SiC for high temperature electronic and photonic applications, ordered semiconductors such as $ZnGeP_2$ for nonlinear applications in the mid-infrared, and $GaInP_2$ for application as high efficiency solar cells. Support for these efforts has been provided by the Air Force Office of Scientific Research, the Phillips Laboratory, Wright Laboratory, and AFIT. Strong collaborative efforts exist between AFIT, the Naval Research Lab, MIT Lincoln Lab, the Materials Directorate and the Aero Propulsion & Power Directorate of Wright Laboratory. Since 1980 this research has resulted in 27 archival publications, 80 presentations at conferences, eight completed Ph.D. dissertations and 25 M.S. theses. Doctoral students who were a part of this effort include Robert Sydenstricker, 1983 (carbon implanted GaAs); Jamie Varni, 1986 (polycrystalline ZnS); Jeffrey R. Cavins, 1988 (selective pair luminescence); Gernot S. Pomrenke, 1989 (lanthanides and actinides in III-V semiconductors); Kevin J. Keefer, 1990 (group IV elements in III-V semiconductors); Todd D. Steiner, 1992 ($Si_{1-x}\, Ge_x\, /\, Si$ superlattices); David W. Elsaesser, 1992 (Er-doped GaAs and AlGaAs) and Jose E. Colon, 1993 (luminescence from Er-doped GaAs and $Al_x\, Ga_{1-x}\, As$).

Shell Structure Analysis -- Professor Anthony N. Palazotto

A group of AFIT Graduate School of Engineering researchers have been working on the nonlinear analysis of shell structures for the past eight years. The group is led by Professor Anthony N. Palazotto and has included three Ph.D. students, four post doctoral researchers and several M.S. students. The Ph.D. students were Major Scott Dennis, Lt Col Randy Smith, and Capt Scott A. Schimmels. The post-doctoral researchers were Dr. C. T. Tsai, Dr. Lung Chien, Dr. Frank Pai and Dr. Raouf Raouf.

This research is being sponsored by the Air Force Office of Scientific Research and the vehicle subsystem division of the Flight Dynamics Directorate of Wright Laboratory. The problems addressed relate to large displacement and rotation of cylindrical, spherical and, recently, toroidal shells. The first two are major shapes in an aircraft structure while the last shape is of importance in an aircraft tire. The research includes dynamic as well as static loadings. Nonlinear material response has been included with time dependency. The results of this activity have led to over 20 publications in archival journals and one text book written by Palazotto and Dennis, *Nonlinear Analysis of Shell Structures*, American Institute of Aeronautics and Astronautics, 1992.

Smart Weapons - How to Find and Identify Targets -- Professor Steven K. Rogers

Professor Steven K. Rogers of the Department of Electrical and Computer Engineering and his graduate students have been investigating smart weapons over the last 10 years. This research has developed algorithms which can find targets in current military sensors and identify those targets as a member of a specific object class as well as friend-or-foe. These algorithms have been implemented on prototype hardware for real-time solutions to smart weapons problems. The algorithms developed include solutions to finding targets in military images. The images have included infra-red, laser radar, synthetic aperture radar as well as visible images.

This process of segmentation in highly cluttered images has been the subject of 10 masters theses and three dissertations. A unique technique for multi-sensor fusion segmentation has been developed by Capt Michael Roggemann, a Ph.D. student; a wavelet-based object moving target segmenter by Capt Tom Burns, a Ph.D. student; and neural networks-based segmentation algorithm by Capt Greg Tarr, a Ph.D. student. The use of information from one sensor to assist in the segmentation of information from another provided the AFIT solution with great probability of detection without significantly increasing the number of false alarms. The wavelet-based algorithms have generated interest in the defense community as well as from commercial vendors (i.e., for use in finding the moving parts of a scene for video teleconferencing). The neural networks algorithms for segmentation allow the adaptation of the segmenter to a particular type of image, such as desert scenes. The Ph.D. dissertation by Capt Greg Tarr has not only provided the community with a neural-based segmentation capability, his neural network software learning environment has been exported from AFIT to fifty other DOD locations for general purpose neural network applications.

Once the piece of the image or images is segmented from the scene, some measure of the information in the pixels must be extracted for identification. This feature extraction area has been the subject of an additional 15 masters theses and two Ph.D. dissertations. Capt Dennis Ruck, then a Ph.D. student, developed the theoretical foundation necessary to relate neural networks to conventional probabilistic information processing. As part of his landmark work he showed how the neural networks can answer questions such as which feature input is causing the network to call the object an Iraqian vehicle versus a U.S. Marine Corps jeep. Capt Ruck is now a Professor within the AFIT Pattern Recognition Research Group. Another Ph.D. student, Capt Kevin Priddy, used neural networks to combine segmentation and feature analysis, again linking the processing to the more conventional probabilistic analysis.

The last step in the identification of the objects is classification. Classification has been the subject of an additional 17 masters theses and two dissertations. Capt Dennis Ruck's dissertation, which was cited above in connection with feature extraction, also addressed the classification problem both in single sensor images and in multi-sensor problems. In May 1994, Capt Jim Stright will defend his dissertation which develops a general analysis of processing information over time. He applied these ideas to classifying tactical targets while they move about in images. Another related dissertation by Capt Ken Fielding (working for Capt Ruck within this group) will be defended about the same time. Capt Fielding's dissertation applies algorithms that have traditionally been applied by this group for speech processing to the problem of 3-D object classification of moving objects. The implementation of these algorithms on unique hardware has also been addressed by this group. Twelve masters theses and a Ph.D. dissertation by Mr. George Vogel, have addressed these issues emphasizing optical implementations. Dr. Vogel's dissertation designed, prototyped and tested a general purpose optical computer which included testing the application of associative memory of complete target information from a partial image.

The work of the AFIT Pattern Recognition Group has resulted in complete solutions to current military problems while solving theoretical issues of interest to the scientific community. The militarily relevant accomplishments of this group have been recognized by continual funding from the DOD agencies that have sponsored this work. They were also recognized by the award of the USAF Research and Development Award to Dr. Rogers. The scientific community has recognized the achievements of this group by the selection of Dr. Rogers as a Fellow of the International Optical Engineering Society, by his appointment as Associate Editor of the *IEEE Transactions on Neural Networks*, and by his appointment as General Chairman of the International Conference on Neural Networks 1994.

Threat Characterization For Advanced Aircraft Materials – Lt Col Kenneth W. Bauer, Jr.

Lt Col Kenneth W. Bauer, Jr. of the Department of Operational Sciences and his graduate students have established a long-term research relationship with the Survivability Enhancement Branch of the Wright Laboratories. AFIT involvement is in direct support of the WL in-house physics research effort on the effects due to the impact of high velocity projectiles into exotic new composite materials. One focus of the research is the prediction and characterization of impact effects due to armor piercing incendiary projectiles. Artificial neural networks have been used to produce highly accurate predictors of the functioning characteristics of these armor piercing incendiary projectiles as they impact Graphite/Epoxy composites. A variety of empirical models have been produced to help in the prediction of damage to single and multiple target panels. Models have also been developed for flash characterization and particle penetration for steel fragments against both aluminum and composite target panels. Initial investigations into the aircraft dry bay fire arena were also carried out by this group.

Artificial neural network predictors have been inserted into the survivability community's accepted vulnerability model, "COVART." Many of the empirical models derived by AFIT students are included in COVART as well. Data from these investigations are being used as validation data for current doctoral research in the artificial neural network area. The Ph.D. students involved are Lisa M. Belue, artificial neural network COVART insertion (1992) and extension of experimental design theory to artificial neural networks; Jean M. Steppe, validation of feature selection in armor piercing incendiary function prediction; and Robert M. Blythe, sensitivity analysis of current particle penetration codes. Since 1989, this effort has additionally produced nine masters theses. Many of the masters theses have been published as Wright Laboratory Technical Reports.

Visiting Professors in AFIT. Professor Carlos Montestruque joined the Department of Aeronautics and Astronautics in 1989 for a two-year period as a visiting professor. He was an exchange professor from the Institutio Technologica Aerronautica in Brazil and performed research with Dr. Peter J. Torvik.

Dr. Edward Keshock, Professor of Mechanical Engineering at the University of Tennessee, joined the Department of Aeronautics and Astronautics as a Distinguished Visiting Professor. During his nine-month appointment in 1989, Dr. Keshock taught courses in the areas of power systems and heat transfer and conducted research in cooperation with faculty and students.

4-4: Significant Consulting

Air Force Materiel Command (AFMC) Leadership Meeting. Lt Col Larry Emmelhainz, Lt Col John Shishoff and Capt Kevin Grant facilitated the third offsite of AFMC leadership. The meeting was for the 47 leaders to reach agreement on the commandwide objectives to be pursued by this new command. The LS role channeled the creative energy of the 27 General Officers, 14 SESs and six others into a consensus view of the major areas of emphasis for AFMC. Due to the extensive preparations and skilled execution of the LS faculty member facilitators, AFMC leaders were extremely pleased with the process and the product.

* * *

AFIT management courses stress rules through classroom and research activities. Examples of some likely ones appear below:

Ten tried-and-true rules for success as action officers are offered by the *TIG Brief.* They apply to members of all grades.

1. Keep it simple.
2. Plain English is spoken throughout the Air Force. Try it, you'll like it.
3. Keep it short. Einstein gave us relativity in one equation. If it were three pages plus tabs, he would have lost his Nobel Prize.
4. Be honest. Bluffing isn't beautiful. If you don't know, say so -- but find out as soon as possible.
5. Be receptive. If someone has a better idea, bend your thinking. Greater dedication hath no one than that he or she abandon their idea for a better one.
6. Be persistent. Keep pushing your idea if it is a good one -- or until your boss threatens to foreshorten your career. Then, back off (until later). Eventually, your boss will (1) see the light, (2) get promoted out of your chain, or (3) retire.
7. Sell your idea by knowing it inside and out. Be able to explain high points in 30 seconds. Be smooth but not oily.
8. Hustle. When you are second on the street, it's usually too late to show that you have a better idea.
9. Protect your bosses. Never, never end run your boss. (If you do, back brief.) Your bosses need to be fully informed at all times.
10. Be accurate. Don't rely on someone else to get the facts for you. Beware of the so-called experts with 25 years of experience and 10 minutes of knowledge. (AFNS)

* * *

Next Generation Mobile Kitchen (*NGMK*). In January 1991, after significant sanitation and other problems were reported by users of the available kitchens in Saudi Arabia, several Air Force agencies hurriedly developed an Air Force requirement to design a mobile kitchen suitable for (a) supporting personnel at a site physically separated from a main operating base; (b) serving as a satellite feeding facility on a main operating base; or (c) in concert with other equipment, serving as a supplement to the existing system.

This requirement arose due to Operation Desert Shield. A contract to design and build the NGMK was awarded to a Beavercreek Corporation. Due to the proximity of AFIT and Wright-Patterson AFB to the manufacturer, AFIT Civil Engineering School was given the task of monitoring the effort. With the on-site availability of locally-based Air Force experts, the time from the date of contract award until it was shipped was only six weeks.

The NGMK is a 28-foot long trailer-mounted kitchen with an internal 150 kw generator which allows an all-electric stand-alone operation. After being airlifted to Saudi Arabia, the unit was used successfully in Desert Storm where it fed 3,700 meals during a 15-day period. AFIT/DE's coordinator Capt Gregg Wears wrote: "The NGMK worked very well as a system."

4-5: Astronauts

Chronological Order Listing
32 AFIT Graduate ASTRONAUTS
[* deceased]

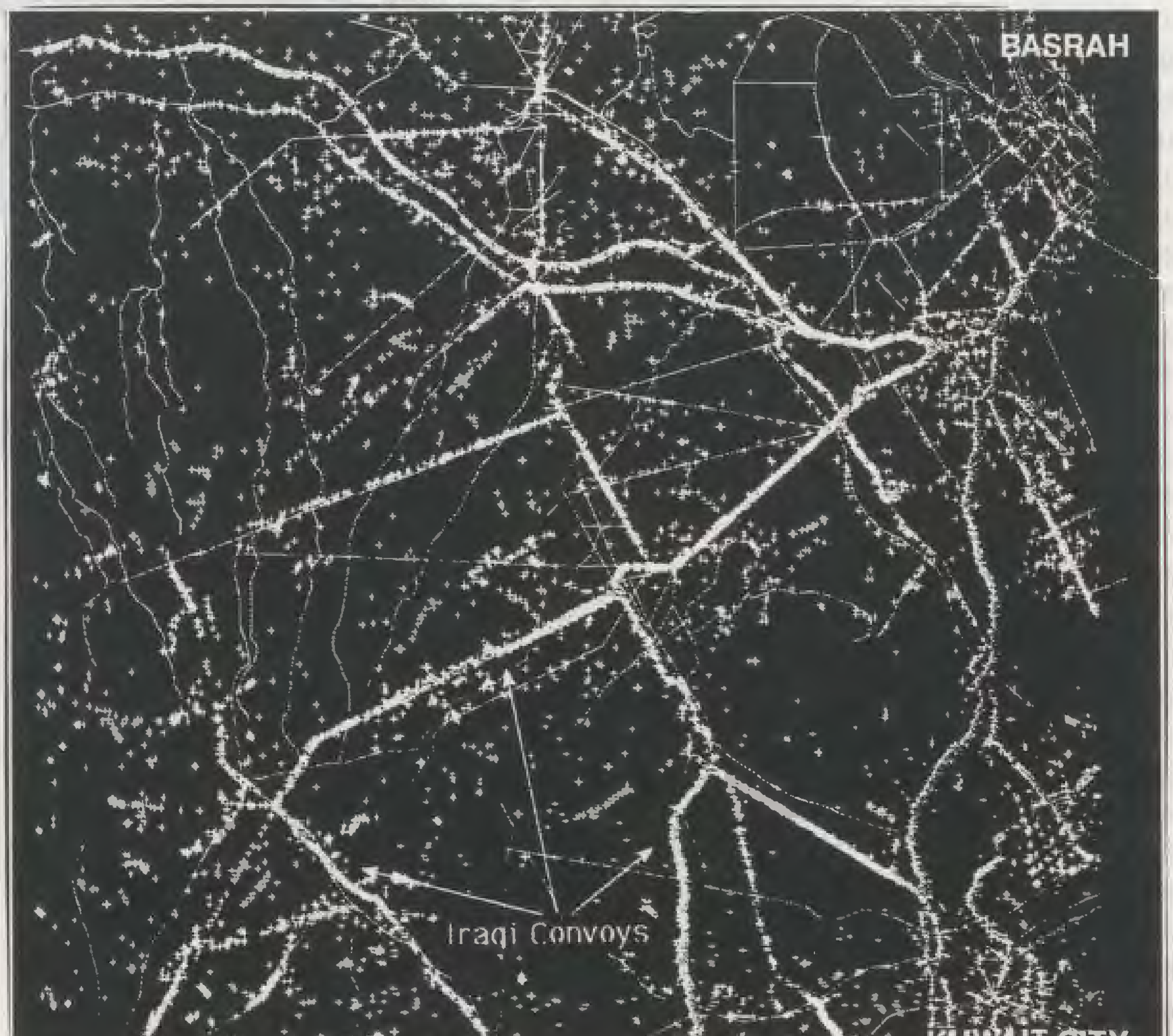
Col L. Gordon COOPER, USAF, Ret. '56;
Lt Col Virgil I. GRISSOM, '56 *;
Col Frank BORMAN, USAF, Ret. '57;
Brig Gen James A. McDIVITT, USAF, Ret. '59;
Lt Col Edward WHITE, '59 *;
Maj Gen William A. ANDERS, USAF, Ret. '62;
Capt Charles A. BASSETT II, (T-38) '60 *;
Maj Gen Michael COLLINS, USAF, Ret. '64;
Col Donn F. EISELE, '60 *;
Col David R. SCOTT, USAF, Ret. '62;
Col Edwin E. ALDRIN, Jr., USAF, Ret. '63;
LCDR Roger B. CHAFFEE (Navy) *;
Col Stewart A. ROOSA, USAF, Ret. '60;
Lt Col Alfred M. WORDEN, USAF, Ret. '63;
Col James B. IRWIN, '58 *;
Brig Gen Charles M. DUKE, Jr., USAF, Ret. '64;
Col William R. POGUE, USAF, Ret.;
Col Karol J. BOBKO, USAF, Ret. '70;
Col Guion S. BLUFORD, Jr., USAF, Ret. '74
& Ph.D. '78, AFIT/EN;
Col Mark N. BROWN, USAF, Ret. '80;
Col Richard M. MULLANE, USAF, Ret. '75;
Col John M. FABIAN, USAF, Ret. '64,
& Ph.D. '74, U. of Washington;
Col Donald H. PETERSON, USAF, Ret. '62;
Col Henry W. HARTFIELD, Jr., USAF, Ret.;
Col John E. BLAHA, USAF, Ret.;
Col Richard O. COVEY;
Col Guy S. GARDNER, USAF, Ret.;
Col Ronald J. GRABE;
Maj Gen Roy D. BRIDGES, Jr.;
Maj James D. HALSELL, Jr. '85;
Lt Col Ellison S. ONIZUKA *;
Maj Francis R. SCOBEE *.

The Apollo I tragedy claimed the lives of Grissom, White and Chaffee. The Challenger disaster took the lives of Onizuka and Scobee.

EDUCATOR Final Issue

1. Fabian, Dr. John M., Class of 1964
2. Constant, Dennis L., Class of 1973
3. Nauseef, John M., Class of 1979
4. Bluford, Guion S., Class of 1974
5. Anders, William A., Class of 1962
6. Teal, David J., Class of 1965
7. Herres, Robert T., Class of 1960
8. Goldfarb, Oscar A., Class of 1967
9. McCoy, Diann L., Class of 1978
10 Rankin, Robert R., Class of 1964
11 Hallin, William P., Class of 1968
12 Mullane, Richard, Class of 1975

Actual JSTARS image showing the Iraqi retreat from Kuwait
(cira February 1992).



CHAPTER 5

SIGNIFICANT EVENTS

5-1: AFIT Association of Graduates merger with The AFIT Foundation

The Air Force Institute of Technology Association of Graduates (*AFIT AOG*) was inaugurated on November 18, 1979, at the 60th anniversary celebration of the beginning of AFIT. The Commandant had formed a 15 member "founding" committee to survey the graduates and, if appropriate, develop an infrastructure to support such an organization. The committee was headed by General Lawrence A. Skantze and the Commandant appointed Mr. Richard H. Lee from his staff as the liaison to the committee. At the formation of the national chapter, General Skantze was elected the first president and Mr. Lee was confirmed as the Executive Director. The Mission of the AOG was to: foster a spirit of loyalty and fraternity among graduates of AFIT, exchange Air Force-related technical information, encourage graduate suggestions for modifying existing AFIT programs, and promote the interests of AFIT without attempting to influence legislation or participate in political activities related thereto. In 1987, the AFIT AOG was incorporated as part of the AFIT Foundation.

In 1989, the Association of Graduates (*AOG*) was dissolved as a separate not-for-profit organization and was formally incorporated into The AFIT Foundation.

On 25 January 1989, AFIT's Association of Graduates (*AOG*) became one of the major component committees comprising the Air Force Institute of Technology Foundation, a group of academic, civic, and business leaders who devote their time and talents for the betterment of the Institute. Established in 1986 to assist the Institute in accomplishing its mission to support national defense, the AFIT Foundation has been instrumental in helping with various memorial programs such as the recently created Demidovich Memorial Award and the future **Icarus Memorial** to commemorate AFIT students who have been listed as killed or missing in action, or killed while testing experimental aircraft. Through this merger, the AFIT Foundation now consists of a governing body and four major components: the Association of Graduates, the Friends of the Library, a committee to work with the various memorials the AFIT Foundation sponsors, and a committee which manages the Icarus Memorial fund-raising efforts.

In 1986, The AFIT Foundation, a not-for-profit corporation under the laws of the State of Ohio, was created by Dr. J. S. Przemieniecki who served initially as its first statutory agent and trustee, with two additional trustees, Lt Gen William E. Thurman and Brig Gen Richard J. Toner. Subsequently, Dr. Przemieniecki was elected to be the first Chairman of the Board of Trustees of The AFIT Foundation. Other elected officers of the Foundation were: Mr. James W. McSwiney, President; Lt Gen James T. Stewart (USAF Retired), Vice President; and Mr. Richard H. Lee, Secretary. The original purpose of the foundation was to raise funds for an AFIT memorial which was selected to be a twenty-foot bronze statue of *Icarus*. Through the symbol of Icarus the Foundation wanted to honor AFIT graduates who lost their lives

when they pressed to go beyond the capabilities of their equipment in quest of the mastery of flight or when they paid the ultimate price in combat. It is specifically for those airmen that this symbol of The AFIT Foundation is dedicated. The current plans are to complete the fund-raising campaign in 1994 and to start construction in 1995.

5-2: ACE

The Acquisition Enhancement (*ACE*) II Study Group found approximately 56,000 civilian and military men and women in the acquisition work force dedicated to contracting, quality assurance and program management activities. It determined that the training backlog of the work force, measured against the stringent training requirements contained in the General Accounting Office audit and subsequent directives, was awesome. It would require approximately 2.0 million student 'person-days' to overcome the backlog. The study group determined that this was within the capability of our education and training base if -- and only if -- all available resources were applied in a coordinated fashion. AFIT, and specifically, the contracting management department of the School of Systems and Logistics, stepped in to fill this breech. Nine of the ten courses taught by the department are under the auspices of the current Defense Acquisition University (*DAU*) oversight.

5-3: APDP

The Defense Acquisition Workforce Improvement Act (*DAWIA*) of 1990 formalized the need to provide a coherent, structured approach to the professional development of acquisition personnel. Prior to its passage, the Air Force had already initiated an effort to develop an acquisition professional development program based on the findings of the Defense Management Review (*DMR*) of 1989. The Air Force secretariat convened an Acquisition Professional Development Council (*APDC*) to upgrade the quality of the Department of Defense (*DOD*) acquisition workforce. With the first meeting of the APDC in April 1990, the Acquisition Professional Development Program (*APDP*) came into being.

The APDP is designed to provide the Air Force acquisition community with a structure that ensures its people get the necessary training, education, and experience to effectively progress into more responsible and demanding positions. Directives establish three certification levels and spell out the experience, academic/professional military education, and training requirements necessary for improving professionalism and certification in each of nine acquisition disciplines.

AFIT APDP focuses on educational initiatives that (1) deliver quality instruction to greater numbers of students at reduced costs, (2) provide more education experience opportunities with industry, (3) develop new courses to meet changing requirements, and (4) increase or maintain requisite levels of graduate and professional continuing education (*PCE*).

The APDP has funded increased enrollment in Master's and doctoral programs in both of AFIT's graduate schools, as well as in civilian institutions. The program has expanded opportunities in Education with Industry to enable mid-level managers to gain firsthand experience in working with defense contractors. The APDP has been the sole funding source in the development of a distance learning network. The APDP/AFIT partnership has played a vital role in ensuring that opportunities are made available in fulfilling the educational tenets of DAWIA.

5-4: DAU

The School of Systems and Logistics (*AFIT/LS*) is one of fifteen schools constituting the Defense Acquisition University (*DAU*) Consortium, and one of the major providers of acquisition education. The School is currently designated as course sponsor for eighteen DAU courses required at all three levels of

acquisition certification. Our responsibilities include curriculum development, faculty development, quality of course delivery, certification and support of course offerors, and effective, efficient utilization of DAU resources. In FY 93, 4,237 students from the Air Force, Army, Navy and other DOD agencies attended DAU courses taught in residence and on-site by AFIT faculty. An additional 1,124 students were taught by contractor faculty on contract to the School. Approximately 50% of AFIT/LS's total resources are committed to support this effort, and this commitment will continue to grow as the mission of providing education for the DOD acquisition community through DAU continues to increase in importance.

5-5: Distance Learning

Anticipating the increasing need for quality "distance education," a production of high-quality videotaped lessons for the Teleteach Program was pursued. The faculty developed videotapes for environmental and management lessons which have been extremely popular and have already been viewed by hundreds of students.

On 27 April 1989, at the Commandant's request, an AFIT Educational Technology Activities Meeting was held to develop a plan for exporting education and it became an attachment to the AU Satellite Delivery System Plan. Activities were discussed to complete the picture of what was going on at the Air Force Institute of Technology in the Education Technology arena and included the appointment of project officers for activities contained in AFIT's appendix 20 to annex C of the *AU Educational Technology Master Plan*. This meeting was the official beginning of researching the feasibility of AFIT conducting classes via satellite.

Throughout 1989, Maj Jolly T. Holden investigated satellite delivery systems at corporate, university, and military educational institutions to determine the feasibility of the Air Force Institute of Technology establishing its own satellite network Air-Force wide. Major Holden shared his knowledge through briefings that he conducted for the primary MAJCOM users of AFIT's education programs and obtained feedback on their acceptance and willingness to fund a portion of the cost associated with a satellite delivery system.

On 13 October 1989, a significant spin-off of Major Holden's briefing-feedback approach, the AFIT/AFLC Technology in Education Partnership was established. This partnership was a means for AFIT to obtain a low-cost start in the development of a satellite education program. The Air Force Institute of Technology would use time on AFLC's Video Teleconferencing Network (*VTCN*) systems/studios, the base Cable Television (*CATV*), and Local Area Networks (*LAN*) to implement a four-phase plan.

The AFIT watertower serves as a fitting background for the AFIT Satellite transmission antenna.

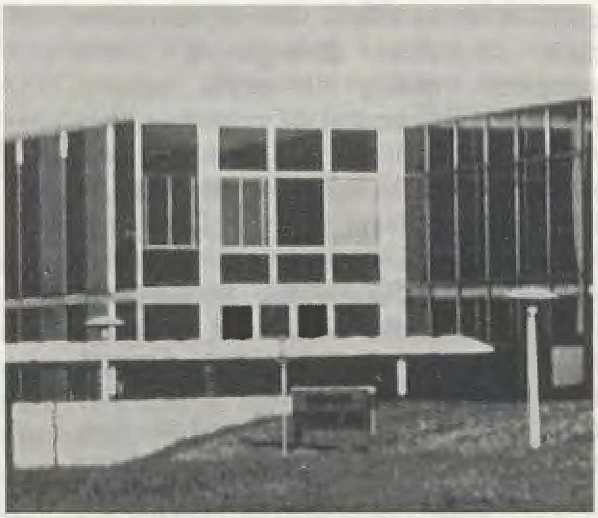
Phase I consisted of the AFIT, KAS-CATV, connectivity which was established on 1 November 1989. Phase II consisted of the connectivity of the AFIT building 640, KAS-CATV, and the Logistics Management System Center (LMSC)/SYCA LAN building 262 on 6 November 1989. Phase III incorporated General Boyd, AFIT Commandant, briefing the initiative to Lt Gen Robert P. McCoy, HQ AFLC Vice Commandant, with a test class simultaneously being conducted and transmitted from AFIT's video classroom. General McCoy approved Phase III on 16 November

1989. General Boyd conducted the AFIT/AFLC Technology in Education Partnership Briefing in December 1989, which culminated the year's efforts for updating AFIT's educational delivery system and provided a stepping stone to the future development of an AFIT Satellite Education Network. The final phase, Phase IV, which implemented command-wide capability to provide education to the Air Force Logistics Command using the AFLC Video Teleconferencing Network and VTC studios, was completed in October 1990.

The cost effectiveness of distance learning via satellite stimulated Major Philip J.-L. Westfall, the director of the Center for Distance Learning, to acquire (with funds provided by the Acquisition Professional Development Program) an interoperative network based on digital technology which could be used by all governmental organizations. Downlinks were established at most Air Force bases. Following AFIT's success, the Army converted its analog system to the compressed digital network. Dr. G. Ronald Christopher served as the Deputy Director with primary responsibility for course development while Capt William Cramer served as the technical director. During its first full year of operation, the SYS 200 course, *Acquisition Planning and Analysis* reached over 3,000 students remote from Wright-Patterson AFB.

5-6: Four Facilities Erected

Graduate School of Engineering facility, Building 640 (Bane Hall). On 14 June 1962 the Senate Armed Services Committee included $4 million for AFIT construction in the authorization bill; it was reviewed by both houses, and signed by President John F. Kennedy on 28 July 1962. However, the appropriations bill still hung in the balance. General Combs and other friends of AFIT appeared before the Appropriations Committee, and the Bill passed the House on 14 August, with the money for AFIT construction included. The Senate passed it on 25 September, and President Kennedy readily signed it.



Bane Hall -- Engineering School

Bids were opened in early November and a contract awarded. On 18 December 1962, ground was broken for the new School of Engineering building, with General Curtis LeMay, Chief of Staff, as guest of honor. LeMay addressed the gathering and ended on a note of hope for the future:

> "As we break ground for this new school, all of us hope that from its graduates will come much of the sage counsel and many of the technological advances which will keep our nation strong. This will go far to maintain the canopy under which free men may continue to seek the way to a true and just peace."

The building was dedicated on 28 Aug 1964, and subsequently rededicated to Thurman Harrison Bane, [1879-1932] Colonel, Army Air Service who developed Dayton's McCook Field into the "crucible of aviation technology." He was also the first commandant of the AFIT school in 1919-1922. He had flight-tested the first Army helicopter, and was a visionary, aviator, leader and educator.

School of Systems and Logistics, Building 641, (Twining Hall). In 1970 Gen Ernest Pinson felt that one way to strengthen the Institute was to consolidate, and he wanted a new building for the School of Systems and Logistics, which was 'off by itself' in Area A. In the spring of 1970, the Air Force had announced tentative plans for a major building program to replace aging facilities. The plans included two new buildings for AFIT: one for the School of Systems and Logistics, one for the headquarters and Civil Engineering School. Both would be on the Area B hill, adjacent to the School of Engineering.

The issue of a new building for the School of Systems and Logistics became active again in late 1973, when the military construction program for FY 75 was submitted to Congress. This time the building was approved without the extraordinary and dramatic efforts that had been necessary for the Engineering building. The contract was awarded in June 1975, and the ceremonial groundbreaking took place in August.

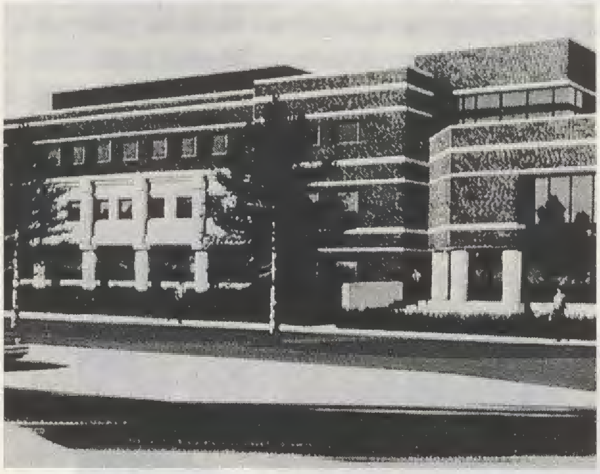
Twining Hall -- School of Systems and Logistics

The building was completed and dedicated 4 Oct 1977 and later rededicated to General Nathan Farragut Twining, [1897-1982] Chairman, Joint Chiefs of Staff 1957-60. He had formerly been WWII Chief of Staff for Allied Forces, Commander of 13th Air Force, Commanding General of Air Materiel Command, (from whence he instituted the logistics college in 1946), and then subsequently was Chief of Staff of the Air Force, 1953-57. He was renowned as: Aviator, Warrior and Leader.

Kenney Hall -- Science and Research Center

Science and Research Center, Building 642, (Kenney Hall). In 1989, construction was completed on the Science and Research Center. The new building, started in 1987, houses an extensive library, auditorium, faculty offices and laboratories, and the computer center. On 1 June 1989, the library portion of the Science and Research Center was turned over to AFIT. The centralized Academic Library facility was relocated within it and subsequently opened on 5 July 1989.

The building was dedicated to the visionary inventor of the parachute fragmentation bomb, General George C. Kenney, [1889-1977], first Commander and organizer of the Fifth Air Force (as well as organizer and first commander of Strategic Air Command), and subsequently commander of Air University, (of which AFIT became an official part on 1 April 1950). He was enshrined as an Engineer, Aviator, Leader and Visionary.



Artist's Rendering of Building 643,
School of Civil Engineering and Services

Civil Engineering and Services Facility -- Construction Underway in 1993/94 -- Building 643. The contract for construction was let in October 1992, with groundbreaking, Feb 1993, for the School of Civil Engineering and Services new facility. The 54,000 square foot, three-story structure is sited immediately west of Twining Hall, Bldg 641, Area B. The new facility will house an auditorium, eight general purpose classrooms, four technically-specific classrooms, three computer-oriented classrooms, student common areas, and administrative space for faculty and staff. This latest addition to AFIT's main campus will be completed in October 1994 at a cost of approximately $6.1 million.

5-7: Quality Air Force (QAF)

AFIT teaches Quality Circle class. The first AFIT Quality Circles course was offered in August 1981 and the program continues to expand. "Our role is not only educating Quality Circle instructors and practitioners, it's providing consultation for users of this management technique and conducting scientific research to determine the benefits of the program," according to an AFIT spokesperson.

To accomplish this three-fold mission of education, consultation and research, AFIT conducts courses on workshops, plans on publishing a Quality Circles newsletter, provides telephone consultation, and gathers research data to determine the program's effectiveness.

"Education is the first part of our mission. We offer a five-day course for circle facilitators and circle leaders. We introduce students to the history, concepts and philosophy of Quality Circle management. We also give them the tools and techniques necessary to teach others and to start circles at their installations." The 40-hour course includes a combination of lectures, discussions, case studies and workshops.

AFIT also offers a one-day course for general officers and senior executive service civilians. "This course is designed to give senior management an appreciation of the circle process so they can better understand how much to be involved, and how much not to be involved."

The AFIT Quality Circles staff provides consultation as the second portion of their mission. "It's not uncommon for circles to encounter issues for which they lack experience. AFIT has a commitment to work beside them and help them resolve these various issues. Most often we can do this telephonically but sometimes we do travel to the site."

As the third part of the AFIT mission for Quality Circles, the Department of Organizational Sciences is conducting systematic, wide-range research concerning the circle process. "In the past, no one really did a good job of vigorously researching the quality circle process. There are a lot of testimonials available about its success but this is all anecdotal evidence. The Department of Defense wanted AFIT to design a plan to collect empirical data from diverse functional units over a period of a few years. And, we're doing that now. We will be able to make scientific conclusions about the benefits of the circles process when more data is collected."

The Quality Circle effort at AFIT received its original impetus from Dr. John Demidovich and Professor Virgil Rehg, who was the course director.

An off-site Faculty Enhancement Workshop was conducted for the AFIT faculty on 21-23 March 1989, at the Marcum Conference Center, Miami University of Ohio. It was organized by a consultant, Mr. Jim Ott, of Organization Transformation Technologies, Inc., to improve the interaction among the faculty, from each of the three schools, and staff. The workshop was centered around three major objectives: (1) Understand and communicate the academic environment that exists at AFIT -- define the characteristics of each school and the internal and external environments in which AFIT operates, share how the faculty feels about their situation, and decide if any changes seem desirable; (2) Better understand Quality Management -- answer the question, "Where might the Air Force Institute of Technology use Quality Management to help the Air Force Institute of Technology do a better job?"; (3) Identify systems that need improvement, scope them out and make plans to involve the appropriate people in working on them.

1992 was marked by an across-the-board effort to insert Total Quality (*TQ*), now known as "Quality Air Force," or *QAF*, into all of Air University's schools, programs and processes. AFIT's effort in this area was patterned after AU's at Maxwell. Led by the AFIT Commandant, assisted by an Executive Steering Group, and facilitated by TQ experts from the School of Logistics and Acquisition Management, three off-site conferences were held to initiate a top-down quality approach for the Institute. These off-sites saw the formulation of a mission statement, strategic goals, and objectives. Then the Commandant led a series of awareness presentations to inform everyone at the Institute about the Quality program. In a parallel effort to educate the entire AFIT population on the tenets of QAF, and to begin applying QAF techniques to solving real-world problems, five individuals from AFIT attended a five-week facilitator training workshop at the Air Force Quality Center at Maxwell AFB. (These trained facilitators guided Process Action Teams (*PATs*) to tackle some of AFIT's most vexing problems.)

The Institute initiated a Total Quality Management (*TQM*) program. Three process action team studies were completed resulting in eliminating unnecessary tasks and improving student lesson appraisals, correspondence, and administrative support. A Center of Excellence was established for Total Quality Management. This center serves as a focal point to facilitate efforts to incorporate the TQ process throughout Air Force engineering and services.

5-8: DERA

In March 1989, groundwater contaminant modeling research commenced which was supported by the Defense Environmental Restoration Account (*DERA*) funds. Preliminary results were presented to the Environmental Protection Agency (*EPA*) and Air Force Engineering and Services Center scientists in September 1989. The research also earned the Air Force Scientific Achievement Award for the principal investigator.

5-9: DISAM

Effective with Defense Security Assistance Agency (*DSAA*) Letter of 17 Jan 92, Acting Director Glenn A. Rudd announced the appointment of Captain Jack E. Martin, USN, as the Commandant of Defense Institute of Security Assistance Management (*DISAM*), co-located in the AFIT Headquarters Building. AFIT Commandants, while of general officer rank, had been dual-hatted, with a second command responsibility for DISAM, ever since the latter school's founding in the 1970s. The new DISAM chain-of-command, per DOD Directive 2140.5, is a line directly from DISAM to DSAA, per authority of Army Lt Gen Teddy G. Allen, DSAA Commander.

5-10: Dayton Area Graduate Studies Institute: A Consortium of Federal, State, and Private Universities.

The Dayton Area Graduate Studies Institute (*DAGSI*) is an academic consortium operated jointly by AFIT, Wright State University (*WSU*), and the University of Dayton (*UD*). The Dayton Area Graduate Studies Institute was formed, on 13 January 1994, as a non-profit organization and AFIT is participating through the mechanism of the Cooperative Research and Development Agreement (*CRDA*). The main purpose of DAGSI is to improve local and regional educational and research opportunities in the masters- and doctoral-level study of engineering and computer science, by pooling faculty talents and research resources of the three participating institutions. DAGSI will place specific emphasis on enhancing doctoral-level studies in engineering and computer science, thereby fostering the kinds of collaborative research necessary to ensure the attractiveness of the local region as an internationally competitive, industrial, high-technology environment. DAGSI will help generate the additional 500 new science and engineering graduates needed by the local Air force laboratories and the many more needed by local industries during the next 10 years. The participation of AFIT in the proposed institute has been made possible through the Federal Technology Transfer Act of 1986. DAGSI will fulfill the spirit of this legislation by enhancing transfer of defense technologies to civilian economy.

The collaborative education and research effort in graduate engineering and computer science among AFIT, WSU, and UD will evolve around the following concepts:

- Member institutions would retain total control over their admission standards, program and degree requirements, and enrollment limits.
- Degrees would be granted by the individual universities, not the Institute.
- Graduate engineering courses taken at member institutions could be counted toward degrees in another member institution.
- The three institutions would charge a common tuition and the Institute would receive the state tuition subsidy from Ohio for courses taken under DAGSI (subject to state approval).
- Faculty from the three institutions would serve on each other's student research committees.
- The three institutions would form research teams to seek research funding.
- Laboratory facilities would be shared whenever possible.

The Air Force will derive significant benefits from DAGSI, such as:

- The combined faculties and facilities of the three schools would offer a stronger and more responsive graduate engineering and computer science programs and will satisfy DOD civilian educational requirements in the Wright-Patterson Air Force Base (*WPAFB*) area.
- The concept will enhance technology transfer in support of national policy.
- Funding from tuition, state tuition subsidies and research could make the AFIT program self supporting. Realistic estimates indicate annual revenues of about $40 million can be realized for AFIT in 3-5 years.
- WSU and UD engineering faculty will interact with AFIT students, thereby enriching their educational environment.
- Besides this, the AFIT Foundation is working hard to generate scholarships, chairs and centers of excellence. A $1.0-1.5 million academic chair donation is currently being actively pursued.

The Dayton Area Graduate Studies Institute will have over 230 Ph.D. faculty, and it will become one of the largest academic institutions in the country -- at a par with the top engineering schools, supporting national critical technologies areas and providing cross-

pollenization of ideas across different scientific and engineering disciplines. Thus the creation of DAGSI creates a national asset important to our economic growth and competitiveness. DAGSI will create an environment conducive to substantial economic development that can only be realized through improved local educational and research opportunities primarily at the doctoral-level study of engineering and computer science. DAGSI also represents a state and national prototype for similar consortia for the purpose of regional economic development.

5-11: Schedule *A* for AFIT Faculty

In 1985, Congress granted the Secretary of the Air Force authority to establish a new personnel procedure for AFIT civilian faculty. The arrangement is a Schedule A excepted service system. The implemented method is a merit system and is modeled after those widely used in civilian universities. Job grades are assigned to individuals, rather than positions, and are the four classical academic ranks. A unique salary schedule is produced each year and increases, other than Cost of Living Allowances (*COLAs*), are totally based on merit. Promotions are based on the classical university criteria of teaching, research, and service. Peer review forms a major component of the evaluation for promotion.

In 1991, Schedule A was expanded to include certain other Air University schools. In 1994, the system was further expanded to include the Air Force Academy.

5-12: Gifts

The Air Force Institute of Technology received approximately twenty two million dollars in software and services as a gift from the Digital Equipment Corporation (*DEC*). The Digital Equipment Corporation will provide the Institute with a set of partnership programs aimed at achieving a significant cost savings by sharing computing, management, support, and service responsibilities with AFIT.

The Campuswide Software License Grant Program gives AFIT the right, at no cost, to use operational systems such as VMS and ULTRIX, as well as more than one hundred and sixty other products. These programs can be used on any VAX system at the Institute. The Air Force Institute of Technology will also implement DEC's Education Software Library for use with software maintenance and telephone support, which will establish a central day-to-day software distribution and support capability for AFIT campus users.

Following the guidelines of Air Force Regulation (*AFR*) 11-26, *Gifts to the Department of the Air Force*, final details were worked out by Lt Col Richard J. Nissing, Deputy Director, Directorate of Operations and Plans, for the Air Force Institute of Technology to receive two point two million dollars in computer gifts from these six different corporations: (1) Sun Microsystems, Inc., (2) the Integrated Virtual Systems Company, (3) Texas Instruments Inc., (4) Symbolics, Inc., (5) the ELXSI company, and (6) the Intergraph Corporation.

On 19 July 1989, the Sun Microsystems, Inc.'s donation of an Interactive Computer Graphics/Very Large Scale Integration (*VLSI*) system to support Forecast II, Tactical Mission Plan System in the School of Systems and Logistics was approved for acceptance by the Secretary of the Air Force. On 12 June 1989, the Integrated Virtual Systems Company's donation of one thousand dollars of VAX/VMS Emulation Software to be used in the operation of the ELXSI System 6400 computer was accepted by Brigadier General Boyd. Texas Instruments, Inc. donated two Explorer Computers with software in support of software intelligence research which request was approved by the Secretary of the Air Force. Symbolics, Inc., offered to donate ninety-five thousand three hundred dollars worth of Symbolics 3600 Systems hardware and software to support artificial intelligence research in the School of Engineering. Also, Intergraph Corporation offered to donate ten AutoCad Microsoft software packages valued at sixteen thousand dollars to support the School of Engineering's ENG 495 course.

The largest single gift received by the Institute to date, valued at nearly two million dollars, was the offering from ELXSI Company to donate seven M6420 Central Processing Units, with supporting hardware. This gift will enhance the capability to complete physics research and work additional data management applications. The Air Force Institute of Technology is not obligated to any future activities with the corporations who donated these tremendous gifts. Gifts such as these enabled AFIT to significantly further the Institute's research and educational capabilities.

Gifts to AFIT. The AFIT Foundation, as a non-profit entity, may accept gifts including cash and checks that can be used in the betterment of AFIT. Moneys for Memorials; endowments, such as faculty chairs; scholarships; and Centers of Excellence may also be sent to the AFIT Foundation, P.O. Box 33646, WPAFB OH, 45433-0646.

5-13: The AFIT Forum

Periodically, AFIT brings speakers to present lectures to students and faculty on a variety of topics of current interest. For example, Dr. Robert R. Barthelemy, Director, National Aerospace Plane (*NASP*) Joint Program Office, spoke on the NASP program. Mr. Gary Vest, Deputy Assistant Secretary of the Air Force for Environment, Safety, and Occupational Health, spoke on "Environmental Issues for Air Force Systems." Mr. Norman R. Augustine, Chairman and CEO of Martin Marietta Corporation, gave a presentation titled, "Defense Acquisition: The Tunnel at the End of the Light." Dr. Robert Carothers, President, University of Rhode Island, spoke on "Quality Management" in a university environment.

5-14: Military Faculty Tenure

After being endorsed by AFIT's Board of Visitors (*BOV*), the Air Force Institute of Technology submitted a proposal for a new tenure program to Air University. Upon the Command's recommendation, the Air Force Military Personnel Center approved the request concerning the new program.

In September 1989, AFIT supplemented its new tenure program which allows officers to extend their assignments as professors. Previously, extensions of assignments had been allowed but not extensively used. The new tenure program allows up to twenty-five percent of the military faculty to extend for an additional four years at the Institute. Selection for the new program is based upon outstanding performance, appropriate education, and professional experience which will allow AFIT to maintain the finest faculty possible. Retention of officer faculty ensures that the current needs of the Air Force are reflected in the content of the courses and curricula offered.

Norman R. Augustine, chairman and chief executive officer for Martin Marietta Corporation, right, talks with MajGen Kenneth Eickmann, chief of staff for AFMC, and Col Robert C. Helt, vice commandant of AFIT, left, following Augustine's speech on Defense Acquisition given during the "AFIT Forum."

CHAPTER 6

AWARDS

6-1: Institute Awards

Outstanding Unit Award for Meritorious Service

General B. L. Davis, commander, Air Training Command (*ATC*), awarded AFIT the Air Force Outstanding Unit Award for exceptionally meritorious service, from April 27, 1978 through November 17, 1979. During that period many new and innovative accomplishments in the area of university-level education were accomplished, AFIT maintained the highest academic excellence, made important strides in modernization, and moved into areas of new and unique usefulness to the Air Force.

In 1978 the Air University Board of Visitors commended AFIT for "recognizing and articulating the manpower problem confronting the Air Force and Department of Defense; that is, the unavailability of adequately trained personnel in sufficient numbers to meet Air Force requirements" and noted "AFIT is the major resource of the Air Force in response to these problems."

Significant and unique research on Air Force and DOD problems yielded diverse new knowledge and financial savings. Major research completed during the period included discovery of two new molecules which hold high promise as excimer materials for lasing; design of a ram-air ejection system for cruise missiles; and design of a data structure and access program that enabled Strategic Air Command (*SAC*) to integrate the cruise missile into the Single Integrated Operational Plan; and provided a breakthrough in interactive graphics allowing display of worldwide geographical locations in map form, electronically and in real time.

In 1978, the School of Engineering theses alone saved the Air Force an estimated $5,674,000 in research and development funds through cost offset; however, cost avoidance could be far greater: a single School of Systems and Logistics thesis of 1978 was expected to yield a cost avoidance of $13 million in FY 80.

New programs developed by the Institute include such advanced degree programs as Strategic and Tactical Sciences, Maintenance Management, Environmental Health Nursing, and Space Operations Management. The latter prepared operations and support personnel to fill management positions in space operations.

AFIT's high standards and capabilities were clearly recognized by the Deputy Secretary of Defense, the Secretary of the Air Force, the Air Force Chief of Staff, the military organizations which use AFIT graduates, the AFIT Subcommittee of the Air University Board of Visitors, the National Association of Colleges and Schools, and the Engineers' Council for Professional Development. Additionally, as a result of student research and faculty professional activities, AFIT made significant contributions to the Air Force across a broad spectrum of research and development.

Air Force Organizational Excellence Awards

The Air Force Institute of Technology was presented an Air Force Organizational Excellence Award for the period from 1 Jun 1986 through 31 May 1988. The award was presented on 16 Aug 1988.

AFIT won another Air Force Organizational Excellence Award for the period from 1 Jun 1989 to 31 May 1991, with the award presented 22 Jul 1991.

Air Force Association Award

One of Maj Gen Stuart H. Sherman's first official acts as commandant of AFIT in 1980 was to receive the Air Force Association's Hoyt S. Vandenberg Award for education on behalf of the Institute. AFIT was named the year's recipient of the award for its accomplishments in 1979.

Air Training Command and Air Force Systems Command submitted AFIT as a joint nomination for the award which is annually awarded to the individual or organization making the most outstanding contributions, directly or indirectly, in the field of aerospace education or training. As a part of ATC's Air University, AFIT provides university-level education to meet Air Force and Department of Defense needs in science, engineering, logistics, technical management, medicine and other fields.

Through AFIT's resident schools and contracts with civilian universities, 1,549 people received undergraduate and graduate degrees and 13,728 attended professional continuing education courses. During 1979, AFIT integrated and realigned its schools to better anticipate and more quickly respond to future requirements -- a management action which allowed AFIT to make their programs not only available to more users but to develop new programs in response to requirements.

To aid in the fight against the critical short-fall of engineers, AFIT initiated several programs. A 'crossflow' program identified officers with quantitative backgrounds and prepared them in a three-month program for systems acquisition management positions, freeing engineers in those positions for other jobs. AFIT also began a program to allow officers with technical, but non-engineering, degrees to convert to undergraduate electrical engineering degrees at the resident school, and expanded the concept to offer conversion programs in aeronautical and astronautical engineering.

To eliminate a backlog of students and to provide more continuing education, the Institute expanded its electronic education delivery system (teleteach). This system used two-way electronic blackboards and voice communications to reach students at distant locations, increasing up to five-fold the number of students reached.

Research by AFIT-sponsored students enabled the USAF to avoid research costs of an estimated eleven million dollars in 1979; research by AFIT resident students alone, in terms of cost avoidance, offset the O&M cost of the Institute's graduate resident program. One example of this research was the design by six systems engineering students of the ram-air ejection system for the cruise missile.

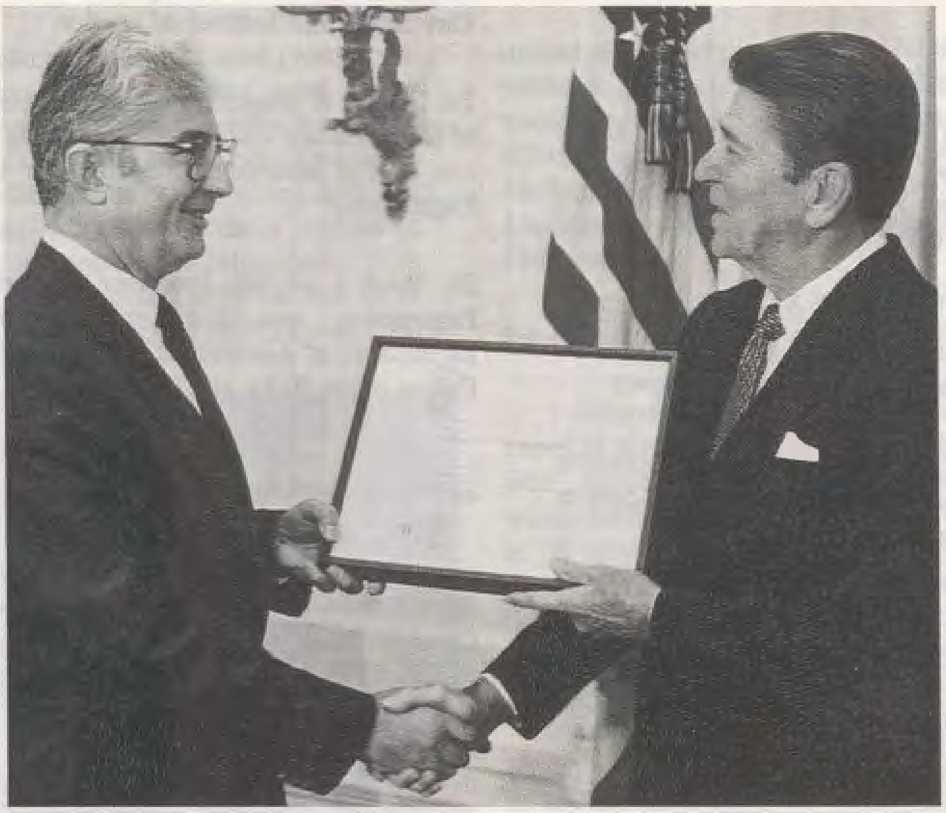
Equally important in 1979, its 60th anniversary year, was AFIT's vigor and persistence in gaining support to articulate the need for technical education and institutionalizing that support by establishing an *AFIT Association of Graduates.*

Silver Anvil Award for active PR program

The highly coveted Silver Anvil Award was presented to the Air Force Institute of Technology in 1980 in recognition of AFIT's outstanding achievements in public relations. The Public Relations Society of America made the presentation at its 36th annual awards banquet in Philadelphia in May 1980. AFIT's commandant Maj Gen Gerald E. Cooke accepted.

There was a distinct effort to reverse the downward trend in advance technical education, with AFIT conducting an aggressive campaign in 1979 to obtain key leadership support; thus the reason for the award. Through talks with leaders in and out of the Air Force, targeted publicity, speeches, a two-day 60th anniversary celebration, initiation of a national association of graduates, a quarterly professional journal, a monthly newspaper, and a film, AFIT documented and gained that support.

Nearly 50 public relations and media executives judged 419 entries in 1979-80 with an average of 22 entries in each of the 9



Dr. Janusz Przemieniecki and President Ronald Reagan

categories. The Air Force Academy was the only other military winner. The judges commented that AFIT's PR program included precisely-defined objectives, effective research, thorough planning, good judgement and consistent follow-through.

The Silver Anvil symbolizes that validity, quality, and achievement of any public relations activity is ultimately measured on the anvil of public opinion.

6-2: Presidential Recognition by President Reagan for an AFIT Dean

In the 1980s, Dr. J. S. Przemieniecki who in 1969 became the Dean of the resident School of Engineering, received two presidential recognitions. In 1981, he received the Presidential Rank Award of Meritorious Executive in the Senior Executive Service for "sustained superior accomplishment in management of programs of the United States Government and for noteworthy achievement of quality and efficiency in the public service." In 1982, he was honored with the highest recognition an individual can receive in government service -- the Presidential Rank Award of Distinguished Executive -- for "sustained extraordinary accomplishment in management of programs of the United States Government and for leadership exemplifying the highest standards of service to the public, reflecting credit on the career civil service." This award was personally presented to him by President Reagan at a White House ceremony.

6-3: Professional Recognition of Faculty

The Pendray Medal For Aerospace Literature. Dr. J. S. Przemieniecki, Institute Senior Dean and Scientific Advisor, received the Pendray Medal from the American Institute of Aeronautics and Astronautics 7 Jan 92 for his contributions to aerospace literature. He was also recognized in May 92 by the Ohio Senate, which acknowledged his "ceaseless crusade to expand the frontiers of human knowledge and winning international renown in his area of expertise."

Faculty Fellows

Lt Col Joseph H. Amend III, Associate Dean, School of Civil Engineering and Services -- Fellow of the American Society of Civil Engineers (*ASCE*)

Dr. Charles J. Bridgman, Professor of Nuclear Engineering and Associate Dean for Research -- Fellow of the American Nuclear Society

Dr. Yupo Chan, Professor of Operations Research, Department of Operational Sciences -- Fellow of the ASCE

Dr. John J. D'Azzo, Professor and Head, Department of Electrical and Computer Engineering -- Fellow of the Institute of Electrical and Electronic Engineers (*IEEE*)

Dr. Milton E. Franke, Professor of Aerospace Engineering; Department of Aeronautics and Astronautics -- Fellow of the American Society of Mechanical Engineers (*ASME* and Associate Fellow of the American Institute of Aeronautics and Astronautics (*AIAA*)

Dr. Constantine H. Houpis, Professor, Department of Electrical and Computer Engineering -- Fellow of the IEEE

Dr. Shankar Mall, Professor of Mechanics and Head, Department of Aeronautics and Astronautics -- Fellow of the ASME

Dr. Peter S. Maybeck, Professor, Department of Electrical and Computer Engineering -- Fellow of the IEEE

Dr. Anthony N. Palazotto, Professor of Aerospace Engineering, Department of Aeronautics and Astronautics -- Fellow of the ASCE and Associate Fellow of the AIAA

Dr. J. S. Przemieniecki, Professor of Aerospace Engineering and Institute Senior Dean -- Fellow of the AIAA, Fellow of the Royal Aeronautical Society, and Fellow of the City and Guilds Institute of London

Dr. Steven K. Rogers, Professor, Department of Electrical and Computer Engineering -- Fellow of The International Society for Optical Engineering

Dr. Peter J. Torvik, Professor of Aerospace Engineering and Engineering Mechanics, Department of Aeronautics and Astronautics -- Fellow of the AIAA and Fellow of the ASME.

6-4: Faculty Awards

Outstanding Engineer and Scientist Awards. Since 1971, the Affiliate Societies Council of the Engineering and Science Foundation of Dayton has been recognizing outstanding engineers and scientists in the Dayton Area through special awards presented during the Engineers Week in February of each year. The following faculty members from the Graduate School of Engineering received this prestigious recognition:

Dr. Thaddeus L. Regulinski, 1972
Dr. Peter S. Maybeck, 1979
Dr. Robert E. Fontana, 1980
Maj Joseph W. Carl, 1981
Maj Salvator R. Balsamo, 1982
Capt Pedro L. Rustan, 1983
Dr. Matthew Kabrisky, 1984
Dr. Peter J. Torvik, 1984
Capt Stephen E. Cross, 1985
Dr. John J. D'Azzo, 1986
Dr. Janusz S. Przemieniecki, 1986
Lt Col Edward S. Kolesar, 1990.

USAF Research and Development Awards. Maj Edward S. Kolesar and Capt Steven K. Rogers, both Associate professors of Electrical Engineering, were among eight Air Force personnel recognized for their scientific efforts and achievements through the research and development program in 1989. Major Kolesar was recognized for his research on

microchip electronic sensors used primarily in the detection of nerve agents used during chemical warfare. Captain Rogers was recognized for his research in the development of "smart munitions," or bombs which seek and destroy enemy vehicles without assistance from those responsible for firing them. Both professors are associated with the School of Engineering's Department of Electrical and Computer Engineering.

Gen Bernard A. Schriever

General Bernard A. Schriever Award. This award is given in recognition of a person who advances aerospace power, technology, doctrine, or the Air Force as a profession. It is sponsored jointly by the Wright Memorial Chapter of the Air Force Association and the Air Force Institute of Technology.

Co-recipients in Nov 1993 were Dr. Milton E. Franke of the Graduate School of Engineering, and Major Philip J-L Westfall, Director of the Center for Distance Education, a division of the School of Systems and Logistics.

Professor Ezra Kotcher Award. This award is given in recognition of an individual who has made a significant, substantive contribution to curriculum or instruction development within AFIT. Contributions may be a student text; simulation exercise; bibliographic publication; symposium; or a new approach to leadership, professionalism, or aspects of officer education. It is sponsored jointly by the Wright Memorial Chapter of the Air Force Association and the Air Force Institute of Technology.

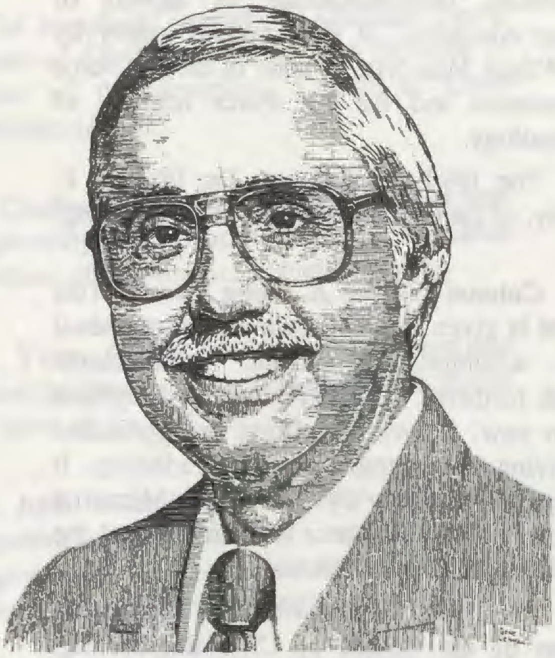
The 1993 recipient was Dr. William F. Bailey, of the Graduate School of Engineering.

Colonel Charles A. Stone Award. This award is given in recognition of an individual who accomplished specific achievements which furthered the AFIT mission. Emphasis is on new, innovative efforts or approaches involving demonstrated personal leadership. It is sponsored jointly by the Wright Memorial Chapter of the Air Force Association and the Air Force Institute of Technology.

The 1993 winner was Dr. Charles R. Fenno of the School of Civil Engineering, MWR and Services.

Lt Col Jacob Simons, Jr. received the **Graduate Logistics Educator Award** from the Society of Logistics Engineers. Lieutenant Colonels Jacob Simons and Richard Moore shared the **Most Significant Article Award** from the *Air Force Journal of Logistics* for Fall 1992.

Dr. John D'Azzo



Dr. John W. Demidovich

John W. Demidovich Award. In 1988, the Air Force Institute of Technology established an award in honor of the late Dr. John W. Demidovich. Sponsored by the AFIT Foundation, this award recognizes professors in logistics for Professional Continuing Education. Some of the criteria for the award are research and consultation accomplishments, teaching promise and effectiveness, participation in non-resident Professional Continuing Education, innovations and revision of courses and teaching, published material, and participation in academic and faculty affairs.

On 25 April 1989, Professor Virgil R. Rehg, a professor of quantitative methods, became the first recipient of the John W. Demidovich Award. Professor Rehg had taught at the School of Systems and Logistics for eighteen years and is a course director for five Professional Continuing Education courses in quality, quality management and reliability.

There have been two other winners awarded. Dr. Doug Goetz, AFIT/LSP in 1990; and, in 1992, Captain Gregory Garrett received the John Demidovich Award as the Outstanding PCE Professor (as well as the 1992 DOD Value Engineering) Award.

The names of all recipients of the John W. Demidovich Award are engraved on a permanent plaque which is displayed within the School of Systems and Logistics.

Other Awards

Mr. Jean Jines received the 1992 DOD Value Engineering Award (with Capt Garrett) as well as the 1992 Army Materiel Command Value Engineering Award.

Maj Albert T. Stoddard received the Air University Outstanding Individual Mobilization Augmentee of the Year Award. Major Stoddard has taught the Airfield Pavement Engineering course and on his training days, he has contributed to the USAFA's Air Base Design and Performance course. Maj Stoddard has helped design a five million dollar MILCON project and coauthored three papers.

The Honorable Mr. Donald Atwood, Deputy Secretary of Defense; The Honorable Ms. Ann Foreman, Under Secretary of the Air Force; Mr. Jean S. Jines, Assistant Professor, Department of Contracting Management, AFIT; Captain Gregory Garrett, Assistant Professor, Department of Contracting Management, AFIT; The Honorable Mr. Don Yockey, Under Secretary of Defense for Acquisition; Mr. Colin McMillan, Assistant Secretary of Defense (Production and Logistics).

Lieutenant Colonel Mark Goltz was selected as the Air Force Military Engineer of the Year by the National Society of Military Engineers. He also received the 1989 Air Force Scientific Achievement Award for his groundwater contaminant modeling research.

Dr. Steven K. Rogers

6-5: Emeritus Awards and Personnel Changes

Harold E. Lillie

Mr. AFIT: Harold E. (Hal) Lillie, Director of Admissions

Mr. Harold E. Lillie was the Director of Admissions from time of his leaving USAF active duty in 1958, until he retired from Civil Service in 1980.

Hal Lillie knew the educational system, backwards and forwards, and helped his technicians learn it well, too. But, he could still work rings around anyone -- give him a batch of O-95s, with transcripts attached from various schools, and he would screen the potential eligibility of these students at the rate of a box of 250 records per hour. Not only was he quick -- he rarely made a mistake. On the rare occasion when he wasn't sure of a student's potential for the AFIT resident engineering school, he'd ask Dr. Pedrotti or John D'Azzo for their inputs.

His military record included a commission via Aviation Cadets in the early part of WW-II, and he flew cargo over the 'Hump' in the China, Burma, and India Theater. After the war, he obtained his BS and MS from University of Denver, the latter degree in 1951. He was recalled for Korea, and assigned to AFIT. He stayed on, after active duty, and became the Director of Admissions, helping the Military Personnel Center fill the pipeline with academically eligible students for AFIT, both in residence as well as for Civilian Institutions Programs. When he retired, in May 1980, Hal left a legacy of thousands of students who owed their education, as well as proper follow-on assignments, to his good judgement.

Hal wasn't retired long, before he was back part-time as a consultant, since he was already a civil service retiree. He continued to accomplish the vast amount of record-screening necessary to keep the academic pipeline filled, under several O-6 Air Force Directors of Admissions. This ended in April 1993, when the reorganization of AFIT caught up the part-time job Hal had enjoyed for twelve additional years. This time there was no gala, and no retirement ceremony -- just a word of thanks from all his colleagues who had grown to know and respect him.

Longtime faculty member Dr. Matthew Kabrisky retired in January 1992. He continues a full-time interaction with students and faculty as Professor *Emeritus*. He was, and continues to be a prolific researcher. He is renowned for his pioneering research in motion sickness in which it was found to be related to epileptic seizures, and can be relieved by use of drugs used for epilepsy. He is also a pioneer in pattern recognition and the reverse engineering of microelectronic integrated circuits.

Dr. Charles J. Bridgman

Personnel changes. There has been a significant change in physics departmental personnel over the last 15 years. The civilian faculty has seen several retirements. Dr. Leno Pedrotti, Department Head from 1962 to 1983, Dr. Donn Shankland, Dr. Bernard Kaplan and Dr. George John, all Full Professors, retired during this period. All were appointed as *Emeritus* Professors and Dr. John still remains active in his laboratory on a daily basis. Two military faculty retired and were reappointed to civilian faculty positions. These were Dr. William Bailey, (who served as Deputy Department Head), retired from the Air Force as a Lt Col, and Dr. Kirk Mathews who retired from the Navy as a LCDR. In addition, Dr. Charles (Jim) Bridgman left the department (as an active faculty member) and moved to the position of Associate Dean of Research in the School of Engineering, and Dr. Robert Hengehold was selected to succeed Dr. Pedrotti as Department Head in 1983. Not to be forgotten, Mr. Robert Hendricks, a physical science technician who has served the department in the nuclear science area for over 35 years, retired in 1993.

Upon retirement of Colonel Don Caughlin, Associate Dean, Colonel Jay DeJongh was elevated from Assistant to Associate Dean. Colonel Tom Schuppe, former head of the Department of Operational Sciences, was appointed as the new dean for LA. The math department head position was vacant and candidates for that position were interviewed; Dr. Alan Lair was appointed. Several faculty members were also recognized for outstanding contributions to their profession.

Prof. Johnson

Professor J. Richardson 'six-pack' Johnson tipped up his career with a final chug-a-lug at the delightful retirement staged in his honor in February 1992, after a long and renowned association with both the Schools of Systems and Logistics, and for many years, with the School of Civil Engineering and Services. 'Rich' left a host of friends and colleagues as Major General Joseph A. 'Bud' Ahearn [USAF, now retired] warmly toasted the Johnson years. Rich and his wife Mary Ann were instrumental in both local and national channels toward getting the *Aviation Heritage Trail*, including the Wright Brothers Bicycle Shop, Carillon Historical Park (museum resting place of the third Wright-B Flyer produced), the Huffman Prairie on Wright-Patterson Air Force Base, and the Wright homestead in Oakwood placed in the *National Register. Professor Emeritus* Johnson also has produced an extensive series of management videotapes entitled "20/20."

Professor Albert Moore, Department of Mathematics and Statistics was appointed Professor Emeritus, upon retirement from the School of Engineering.

Professor William Elrod, Department of Aeronautics and Astronautics was appointed Professor Emeritus from the Engineering School, upon retirement.

Jerome G. Peppers, Associate Dean of the School of Systems and Logistics and author of *The History of Military Logistics*, was appointed Professor Emeritus.

Donald G. Benoit became Professor Emeritus. He had been Department Head and Associate Professor of Contracting Management, and founded as well as implemented the Graduate Labor Relations course.

Professor Emeritus, (the late) James O. Mahoy, was founding father of the Government Contract Law course, the most highly attended course in the Institute.

Lt Col Terry L. Caipen was named the Assistant Dean for EN in November 1992, replacing Colonel Jay DeJongh.

6-6: Student Awards

Edwin E. Aldrin, Sr. Award

Presented to a member of the graduating class who has demonstrated strong personal leadership and who has accomplished the education objectives of the Institute in an outstanding manner. The award is named in honor of Lt Edwin E. Aldrin, Sr., member of the Institute's first graduating class of 1920 and first Vice Commandant, and is sponsored jointly by the Wright Memorial Chapter of the Air Force Association and the Air Force Institute of Technology.

American Defense Preparedness Association Management (Louis F. Polk) Award

This award is given annually in recognition of outstanding student performance to a graduate student from the graduating classes in the School of Engineering and in the School of Systems and Logistics. Particular attention will be given to identification of student accomplishment related to the goal of ADPA's interest in strengthening the industrial defense base. Specific criteria will include: Evidence of outstanding academic performance as demonstrated by a high cumulative grade point average in all graduate courses taken in AFIT resident programs. Evidence of professional comprehension and ability as reflected in response to academic and professional challenges and relation of these opportunities to the development of a cohesive comprehensive education and research program. Demonstration of ability to apply academic and professional theory to the solution of a significant problem of direct value to national defense through research and thesis accomplishment.

Commandant's Award

Presented to the graduating students who have demonstrated the most exceptional individual master's thesis research. This research represents an outstanding contribution to scientific, management and engineering knowledge with consideration given to the originality, resourcefulness, completeness, scope and level of difficulty of the work.

George K. Dimitroff Award

Presented to the graduating student(s) whose thesis is outstanding in research methodology, written presentation, and contribution to the Civil Engineering career field. The award memorializes the legacy of excellence established by George K. Dimitroff as the editor of the *Air Force Engineering and Services Quarterly* and as a faculty member at AFIT.

Graduate Engineering Management Peer Award

Presented to a Graduate Engineering Management (GEM) student for excellence in leadership and contributions to the success of the Graduate Engineering Management program. The award recipient is selected each year by the students in the GEM program based on criteria established by the students. The Director of Engineering and Services established and sponsors the award to recognize the outstanding contributor to each GEM class.

Mervin E. Gross Award

Presented to a student graduating from the School of Engineering, in recognition of exceptional scholarship and high qualities of character, initiative and leadership. The award is named in honor of Brigadier General Mervin E. Gross who, following World War II, was responsible for reorganizing the Air Corps Engineering School as the Air Force Institute of Technology. He also served as the first Commandant of the Institute.

General Edwin W. Rawlings Award

Presented by the faculty of the Graduate School of Systems and Acquisition Management to one student in each class who is selected as most deserving due to exceptional scholarship and high qualities of character. Criteria include high academic achievement, minimum grade point average of 3.75, expressed leadership, and ability to work with faculty and fellow students.

Society of American Military Engineers (SAME) Award

Presented to a Graduate Engineering Management student for exceptional scholarship and outstanding qualities of character, initiative, and leadership. The minimum cumulative grade point average for the award is 3.50; however, the selection is based on the student's overall performance and ability to work with faculty and fellow students. Student and faculty inputs are used in the selection process. The award is sponsored annually by the Society of American Military Engineers.

Society of Logistics Engineers (SOLE) Excellence in Logistics Award

Presented by the faculty of the Graduate School of Systems and Acquisition Management to one student in each class who is selected as most deserving due to exceptional scholarship and contributions to the field of logistics. Criteria include high academic achievement, minimum grade point average of 3.75, judged superior, and possessing the ability to work with faculty and fellow students.

CI Hero Saves Float. On 1 January 1992, Capt Andy Rogers, a CI student at the University of Arizona, was attending the Tournament of Roses Parade in Pasadena CA. On a downhill portion of the parade, a rather large float pulled by a team of mules experienced braking problems and picked up speed, spook-

ing the mules. Before any serious injury resulted to the float attendants or spectators, Capt Rogers jumped from the crowd, grabbed the harness of the lead mule, and wrestled the float to a stop. As a result of his heroism, Capt Rogers was awarded the AF Achievement Medal.

6-7: Association of Graduates Awards

Distinguished AFIT Graduates

The AFIT AOG sponsors an award to AFIT graduates who are judged to be worthy of the title of *AFIT Distinguished Graduate.* Nomination and selection of the Distinguished Graduates occurs every two years or so by a group of outstanding Americans representing industry, education, military, and public life. Criteria for selection is based on the following guidelines: "Must be an AFIT graduate who has made significant contributions to our nation and who, through their inquisitive minds' and extraordinary achievements, exemplifies the AFIT ideal of excellence through knowledge".

Gen James H. 'Jimmy' Doolittle

Gen Lew Allen, Jr.

Name **Year Award Presented**

Col Buzz Aldrin -- 1983

Gen Lew Allen, Jr. -- 1987

Maj Gen William A. Anders -- 1990

Col Frank Borman -- 1979

Gen Mark E. Bradley -- 1985

Gen Benjamin W. Chidlaw -- 1987

Lt Gen Laurence C. Craigie -- 1981

Lt Gen James H. Doolittle -- 1979

Gen Muir S. Fairchild -- 1993

Brig Gen Harold R. Harris -- 1983

Col George V. Holloman -- 1979

Gen George C. Kenney -- 1981

Lt Gen Donald L. Putt -- 1990

Gen Bernard A. Schriever -- 1979

Lt Gen Ralph P. Swofford, Jr. -- 1993

Lt Gen Kenneth B. Wolfe -- 1985

Dr. William A. Mauer

6-8: Civilian Awards

Upon retirement from AFIT, Dean William A. Mauer was honored with the **Outstanding Civilian Career Service Award** for service from 17 Jul 65 through 31 Mar 92. He came to AFIT in October 1984, after 15 years at the Naval Postgraduate School, and two years of service as a Distinguished Visiting Professor at the Army War College. His efforts at AFIT significantly reduced administrative workloads and helped smoothly transition AFIT from a General Manager to a Schedule A Pay Plan. In addition, his efforts were the principal Air Force contributions that produced a viable and cost-effective Acquisition Enhancement (*ACE*) program. His inspiration in ACE led to a proposal for Defense Acquisition University (*DAU*), a primary provider for education, training, and research opportunities for all acquisition personnel.

Dr. Mauer was also cited for his visionary efforts on behalf of the transportable Acquisition Planning and Analysis course, making distance learning a reality through the use of self-paced computer instruction, text and videotape. He introduced new curriculum review processes emphasizing greater customer interface and spearheaded the reorganization and fee-for-service studies, typifying his commitment to higher education and better service. Dr. Mauer brought recognition to the Institute and contributed immeasurably to its reputation as a national resource.

The **Exceptional Civilian Service Award** was presented in 1991 to Dr. Peter J. Torvik, Professor of Aerospace Engineering, for service as Head of the Aeronautical Engineering Department from 1 Jan 86 through 30 Sept 1990. During this period of outstanding service as an educator, Dr. Torvik's leadership and exemplary performance led to the development of new and revised engineering educational and research programs which contributed significantly to the technological superiority of the United States Air Force.

The **Meritorious Civilian Service Award** was presented to Dr. Rita L. Wells, Associate Professor of Contract Management, for service from 1 Feb 86 through 30 Sep 91 for, among other efforts, her work in the Executive Contract Administration course. The course was conceived, developed and implemented by her, to bring the expertise of students to the fore. Within the course, students are provided extensive resource documents and assigned problems that require analysis, synthesis and group problem-solving skills, all adroitly managed by Dr. Wells. The course is actively sought by senior managers in contracting, program management and quality assurance.

The **Meritorious Civilian Service Award** was presented to Dr. G. Ronald Christopher, Chief Courseware Development Division Supervisory Education Specialist, for service from 20 Aug 90 through 7 May 93 for his leadership and expertise in the successful development of a computer-based version of Acquisition Planning and Analysis, SYS 200.

He was responsible for developing a non-resident multimedia self-paced version of the course, and worked closely with subject-matter experts and contractors to ensure the course's development and testing. The course was initially deployed to 14 sites, including one in Saudi Arabia, which made it possible for the Air Force to avoid over $4.8 million in educational costs over the next five years.

The **Meritorious Civilian Service Award** was presented to Mr. Robert R. Bergseth, Assistant Professor of Systems Acquisition Management, for service from 24 Aug 90 through 7 May 93 for his expertise in the successful development of a computer-based version of the critically important professional education Acquisition Planning and Analysis SYS 200 course. As course director for the project, Mr. Bergseth provided subject-matter expertise to instructional designers and coordinated course development issues with other faculty to ensure the course's successful development and testing. He guided the development of over 60 computer-assisted lessons supported by videotaped lessons, developed the 20 modules of instruction in the HyperText medium and reviewed the final product prior to deployment to 14 world-wide sites.

Dr. George John, Professor of Nuclear Engineering, was awarded the **Outstanding Civilian Career Service Medal** at retirement in May 1992, and appointed Professor Emeritus.

CHAPTER 7

THE VISION

The dramatic collapse of the Soviet Union and the spread of democracy and freedom throughout the former Soviet block has transformed the world, removing the old East-West confrontation and ending the Cold War. This change in the strategic environment gives the United States the opportunity to reduce the size of its armed forces while still retaining the military capability to protect its interests. The end of the Cold War, however, has not removed all threats to security and vital interests of the U.S., as evidenced by the invasion of Kuwait in 1990. Of particular concern is the proliferation of highly sophisticated weapons, which could be used in regional crises and conflicts involving US forces. In response to these changes, however, we must continue to proceed with modernization of our forces, reshaping our military structure and maintaining a technological edge over our adversaries, albeit at a more deliberate pace than during the Cold War era when pressures forced allies to move new technology weapons quickly to production in order to stay ahead of the Soviet modernization effort. Defense must now be planned for a new era in a rapidly changing world. This means that AFIT programs will have to be adjusted to the post Cold War requirements and expectations.

The role of AFIT is expressed succinctly within its mission statement "to support national defense through graduate and professional education and research programs." The rationale for resident education at AFIT is equally valid for this new era as it was in 1919 when AFIT's antecedent school was established at McCook Field in Dayton, Ohio, and when it became apparent that the progress in military aviation depended on special education in the new science of flight. The requirements for education in the Air Force today are not limited just to the science of flight; they now include both technical and management sciences, all of which are needed to develop new weapon technologies and systems and to manage increasingly complex Air Force operations. The rationale for AFIT as the graduate school of the United States Air Force will remain valid as long as we have the need to maintain a superior defense posture in response to our commitments to national defense.

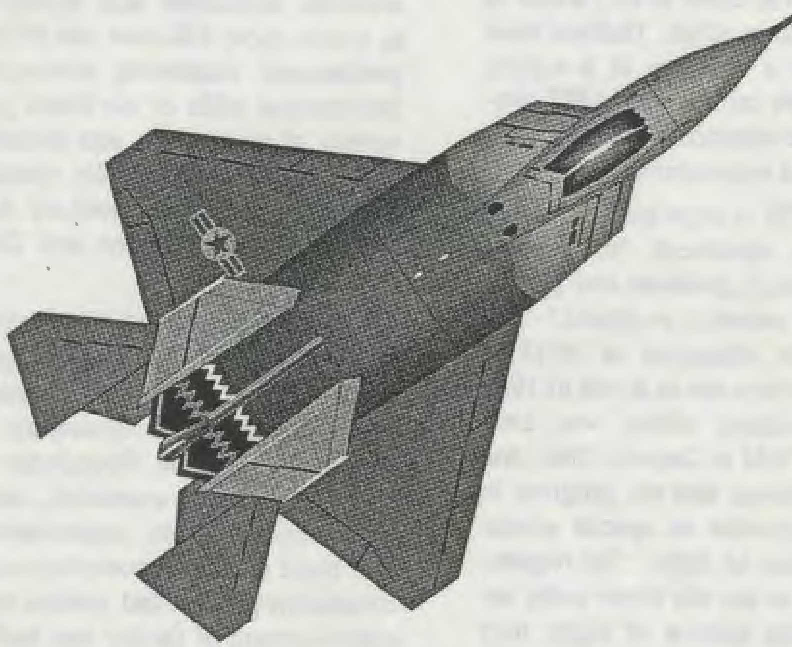
The overall goal for AFIT is to maintain AFIT as a world-class institution of higher education in defense science, technology, and management. This goal is reflected in the Air University motto "Strength Through Knowledge" and in AFIT's motto "Prepared In Mind," both of which affirm AFIT's vital role in the Air Force and its commitment to quality education. As we adjust to the new era and new defense requirements, our programs will undergo some changes guided by the emerging needs for the 21st century: graduate education in defense science and engineering to ensure technology pre-eminence for US air and space forces; graduate management education to ensure efficient and cost effective acquisition processes for new systems; operations research, simulation and modeling education to ensure more effective use of our resources; professional continuing education to update professional skills of Air Force personnel in a variety of disciplines; and distance education to provide an economically viable educational delivery system throughout the Air Force, and even for other Services and Department of Defense agencies.

The Institute is firmly committed to the concept of Total Quality. The quest for quality in AFIT is more than a concept; it is our credo demanding a leadership commitment and operating style throughout the Institute that inspire trust, teamwork, and continuous improvement. This commitment embraces four basic elements: complete customer focus, continuous product and process improvements, empowerment of faculty and staff, and leadership. In a related activity, the Institute has introduced the concept of "better business practices," where appropriate ideas from the commercial sector are being introduced into

AFIT operations, such as the "fee-for-service" concept.

Another area offering a potential for improved quality in education and research is the transfer of AFIT technologies and knowledge into the civilian economy, made possible through the Federal Technology Transfer Act of 1986 authorizing Cooperative Research and Development Agreements (*CRDAs*). The Institute has already signed several CRDAs for joint projects involving AFIT faculty and private companies and organizations, and AFIT is now receiving royalties and fees from these agreements. It is expected that this activity will grow. Interestingly enough, AFIT is even receiving royalties from Japan for one of the CRDAs. The most recent CRDA is with the Dayton Area Graduate Studies Institute (*DAGSI*) --- an academic consortium operated jointly by AFIT, Wright State University, and the University of Dayton. The main purpose of this consortium is to improve local and regional educational and research opportunities in the Masters- and doctoral-level study of engineering and computer science by pooling the faculty talents and resources of the three participating institutions. DAGSI will help to generate an additional 500 new science and engineering graduates needed by the local Air Force laboratories and the many more needed by local industries during the next ten years.

The education we provide today for men and women in the Air Force will form the foundation upon which the 21st century Air Force will be built. And AFIT is ready to take on this important challenge. As a concluding comment, we quote the words of the former AF Chief of Staff, General Charles A. Gabriel: "AFIT today is the Air Force's tomorrow."



ACRONYMS

AACSB	-American Association of Collegiate Schools of Business
AAD	-Advanced Academic Degree
AADMS	-Advanced Academic Degree Management System
AB	-Airbase
AECP	-Airman Education and Commissioning Program
AF/CE	-Air Force Civil Engineer
AF/CV	-Air Force Vice Commander
AF/DP	-Air Force Director of Personnel Resources
AF/DPPE	-Air Staff
AFB	-Air Force Base
AFBDA	-Air Force Base Disposal Agency
AFCEE	-Air Force Center for Environmental Excellence
AFCESA	-Air Force Civil Engineering Support Agency
AFIT	-Air Force Institute of Technology
AFIT/ACF	-Finance Division
AFIT/CI	-Civilian Institution Programs
AFIT/CIM	-Health Care Education Division
AFIT/DE	-School of Civil Engineering and Services
AFIT/EN	-School of Engineering
AFIT/IM	Information Management Directorate
AFIT/IM	-Directorate of Information Management
AFIT/LD	-AFIT Academic Library
AFIT/LD	-Academic Library
AFIT/LSL	-Department of Government Contract Law
AFIT/PA	-Directorate of Public Affairs
AFIT/RM	-Directorate of Resource Management
AFIT/RMIG	-Graphic Arts Branch
AFIT/RMIS	-Presentation Services
AFIT/RMS	-Logistics Support Division
AFIT/RR	-Admissions/Registrar Directorate
AFIT/RR	-Directorate of Admissions/Registrar
AFIT/SC	-Communications-Computer Systems Directorate
AFIT/SC	-Directorate of Communications-Computer Systems
AFIT/SCOM	-Microcomputer Support Branch
AFIT/SCU	-Computer Customer Support Center
AFIT/XP	-Directorate of Operations and Plans
AFIT/XP	-Operations and Plans Directorate
AFITNET	-AFIT Local Area Network
AFITSIS	-AFIT Student Information System
AFLC	-Air Force Logistics Command
AFMEA	-Air Force Management Engineering Agency

AFMPC	-Air Force Manpower and Personnel Center
AFNEWS	-Air Force TV News
AFOSR	-Air Force Office of Scientific Research
AFR	-Air Force Regulation
AFSAT	-Air Force Security Assistance Training
AFSC	-AF Systems Command
AFSC	-Air Force Specialty Code
ALCs	-Air Logistics Centers
AMC	-Air Materiel Command
AOG	-Association of Graduates
APDC	-Acquisition Professional Development Council
APDP	-Acquisition Professional Development Program
AR	-Headquarters Air Force (*AF-ACC*) Annual Report
ARPA	-Advanced Research Projects Agency
ARPA/CSTO	-Advanced Research Projects Agency/CSTO
ASC	-Aeronautical Systems Center
ASD	-Aeronautical Systems Division
ATC	-Air Training Command
AU	-Air University
B.S.	-Bachelor of Science
BAR	-Broad Area Review
BEAMS	-Base Engineering Automated Management System
BOV	-Board of Visitors
CAC	-Curriculum Advisory Council
CADD	-Computer-Aided Drafting and Design
CATV	-Cable Television
CBPOs	-Consolidated Base Personnel Offices
CC	-AU/Commander
CCQ	-Orderly Room
CDE	-Center for Distance Education
CDERS	-Command Derived Educational Requirements System
CE	-Civil Engineering
CE	-School of Civil Engineering and Services
CEMARS	-Civil Engineering Management Applications Regional Seminar
CESMARS	-Civil Engineering and Services Management Applications Regional Seminar
CEV	-Department of Environmental Management
CF	-Director of Academic Affairs
CFD	-Computational Fluid Dynamics
CI	-Civilian Institution Programs
CIF	-Financial Management Division
COIL	-Chemical Oxygen-Iodine Laser
CPD	-Center for Professional Development
CPU	-Central Processing Units
CRDA	-Cooperative Research and Development Agreement

CSIRF	-AFIT Controls/Structure Interaction Research Facility
DA	-Directorate of Administration
DA	-Information Administration
DARPA	-Defense Advanced Research Project Agency
DAU	-Defense Acquisition University
DCS	-Deputy Chief of Staff
DEC	-Digital Equipment Corporation
DEE	-Department of Engineering Applications
DEH	-Department of Housing and Services
DEM	-Department of Management Applications
DERA	-Defense Environmental Restoration Account
DES	-Academic Support Division
DISAM	-Defense Institute of Security Assistance Management
DL	-Distance Learning
DNA	-Defense Nuclear Agency
DOD	-Department of Defense
DOE	-Department of Energy
DP	-Directorate of Personnel Resources
DP	-Personnel Resources
DPs	-Directors of Personnel
DRA	-Data Research Associates
DSAA	-Defense Security Assistance Agency
E-Mail	-Electronic Mail
ECAMP	-Environmental Compliance Assessment and Management Program
ECPD	-Engineers' Council for Professional Development
EEC	-Environmental Education Center
EEIC	-Element of Expense Investment Code
EN	-School of Engineering
EPA	-Environmental Protection Agency
ERA	-Eigensystem Realization Algorithm
ESC	-Electronic Systems Center
ESIMS	-Engineering and Services Information Management System
EWI	-Education With Industry
FM	-Financial Management
FMB	-Financial Management Board
FMS	-Foreign Military Sales
FORSIZE	-Support Force Sizing Exercise
GEEM	-Graduate Engineering and Environmental Management [Program]
GEEM	-Graduate Environmental Engineering Management Program
GEM	-Graduate Engineering Management Program
GEMS	-Graduate Education Management System
GPA	-Grade Point Averages
GPSC	-Graduate Programs Steering Committee
GSP	-Graduate School Program

HPSP	-Health Professions Scholarship Program
HQ	-Headquarters
IDEA	-Industrial Development Education in Acquisition
IG	-Inspector General
IHPTET	-Integrated High Performance Turbine Engine Technology
ILS	-Integrated Library System
IM	-Information Management
IM/DP/CCQ	-Mission Support
IOs	-international students
IPE	-Information Processing Equipment
IRP	-Installation Restoration Program
JA	-Judge Advocates
JAG	-Judge Advocate General
JCS	-Joint Chiefs of Staff
JMASS	-Joint Modeling and Simulation System
JSTARS	-Joint Surveilance and Target Attack Radar System
LA	-Graduate School of Logistics and Acquisition Management
LA	-School of Logistics and Acquisition Management
LAC	-Office of Research and Consulting
LAG	-Graduate Programs Director
LAN	-Local Area Networks
LCC	-Large Computing Capability
LD	-Academic Library
LS	-School of Systems and Logistics
LSA	-Department of Academic Operations and Support
LSE	-Center for Distance Education
LSI	-Director of Information Resources
LSL	-Department of Government Contract Law
LSM	-Department of Logistics Management
LSP	-Department of Contracting Management
LSQ	-Department of Quantitative Management
LSR	-Department of Communication and Organizational Sciences
LSY	-Department of System Acquisition Management
M.A.	-Master of Arts
M.S.	-Master of Science
MAC	-Management Applications Course
MAJCOM	-Major Commands
MANREQ	-Manpower Requirements Exercise
MASAR	-Multiple Arrested Synthetic Aperture Radar
MB	-Megabytes
MEA	-Master of Engineering Applications
MIFFS	-Management Information Financial Forecast System
M.I.T.	-Massachusetts Institute of Technology
MMA	-Merchant Marine Academy

MOS	-Minimum Operating Strip
MOU	-Memorandum of Understanding
MPC	-Military Personnel Center
MS-DOS	-MicroSoft's Disk Operating System
MWR	-Morale, Welfare and Recreation
NASA	-National Aeronautics and Space Agency
NASP	-National AeroSpace Plane [program]
NCA	-North Central Association of Schools and Colleges
NPS	-Naval Post Graduate School
NRL	-Naval Research Lab
NSA	-National Security Agency
NTU	-National Technological University
O&M	-Operations and Maintenance
OFE	-Officer Field Education
OMB	-Office Management Bulletin
ONEE	-Office for Nonresident Environmental Education
OPAC	-Online Public Access Catalog
OPR	-Office of Primary Responsibility
OSU	-Ohio State University
OTH-B	-Over-The-Horizon-Backscatter
PA	-Directorate of Public Affairs
PA	-Public Affairs
PACOSS	-Passive and Active Control of Space Structures
PATs	-Process Action Teams
PCE	-Professional Continuing Education
PCs	-personal computers
PDP	-Program Decision Packages
POM	-Program Objective Memorandum
PR	-Programs and Resources
PRC	-Program Review Committee
PRCs	-Program Review Committees
PSE	-Professional Specialized Education
Ph.D.	-Doctor of Philosophy
QAF	-Quality Air Force
R&M	-Reliability and Maintainability
RCS	-Reporting Control Symbol
RCS	-Radar Cross-Section
RIF	-Reduction in Force
RL	-Rome Laboratory
RM	-Resource Management
RM	-Resource Management Directorate
RMF	-Model Fabrication
RMI	-Instructional Media Support
RMS	-Logistical Support and Research Equipment

RP	-Financial Management Directorate
RP	-Resources Directorate
RR	-Admissions/Registrar Directorate
RR	-Registrar/Admissions
SAF/AAD	-Directorate of Information Management and Administration
SARA	-Service Academy Research Associates
SBIR	-Small Business Innovative Research
SC	-Communications-Computer Support
SC	-Communications-Computer Systems Directorate
SCO	-Operations Division
SCP	-Resource Management Division
SCU	-Small Computer Support Center
SCV	-Systems Development Division
SDI	-Space Defense Initiative
SDIO	-Strategic Defense Initiative Office
SOA	-Separate Operating Agencies
SOCES	-School of Civil Engineering and Services
SOW	-Statement of Work
SQL	-Structured Query Language
SSN	-Social Security Number
TQ	-Total Quality
TQM	-Total Quality Management
UECP	-Undergraduate Engineering Conversion Program
UMD	-Unit Manning Document
USAF	-United States Air Force
USAFA	-United States Air Force Academy
UTHSC	-University of Texas Health Science Center
V-T	-Vibrational-to-Translational
VHDL	-VHSIC Hardware Description Language
VHSIC	-Very High Speed Integrated Circuits
VLSI	-Very Large Scale Integration
VLSI/VHSIC	-Very Large Scale Integration / Very High Speed Integrated Circuits
VSI/SSB	-Voluntary Separation Incentive/Special Separation Bonus
VTCN	-Video Teleconferencing Network
WIMS	-Work Information Management System
WL	-Wright Laboratory
XO	-Plans and Operations Directorate
XP	-Operations and Plans
XP	-Operations and Plans Directorate

Alphabetical Arrangement (by Surname) of Individuals and Events (or photographs) cited within this publication

NAMES	Page Number(s)
Col Gerald R. Adams	2-8
Capt Elmer E. Adler ('25)	1-7
Maj Gen Joseph A. 'Bud' Ahearn	6-9
Col Edwin E. 'Buzz' Aldrin, Jr. ('63)	1-72, 4-19, 6-11
[Lt] Edwin E. Aldrin, Sr. Award	6-9
Buzz Aldrin and father Edwin Aldrin invited back to AFIT for the fiftieth anniversary of the Institute	1-82
Lieutenant [then Col] Edwin Aldrin, Sr.	1-4, 1-23, 6-9
[Photo]: Astronaut Edwin E. Aldrin, Jr. ('63) was the first military man to walk on the moon.	1-87
[Photo]: The Aldrins, father and son, with General and Mrs. Haugen at the 47th Anniversary celebration.	1-80
[Photo]: The Class of 1925 (Aldrin, as Assistant Commandant, is seated second from left).	1-9
[Photo] Maj Joe Alleca	3-12
USArmy Lt Gen Teddy G. Allen	5-7
[Photo] Gen Lew Allen, Jr. ('57) &	1-91, 6-11
Lt Col Joseph H. Amend III	6-4
Col Roy W. Amick	2-7
William A. Anders, Class of 1962 [*Educator* cover drawing]	1-72, 4-19, 6-11
William A. "Bill" Anders ('62) of Apollo 8, now executive secretary of NASA	1-82
[Photo]: Apollo 8 launch from Kennedy Space Center.	1-87
Col John J. Apple	2-7
Dr. Henry A. Armsby, Chief of Engineering for HEW	1-57
Apollo 11 -- Neil Armstrong, Buzz Aldrin ('63), and Mike Collins ('64)	1-72, 1-81
Col Robert H. Armstrong	2-8
Gen Henry H. ["Hap"] Arnold, Chief of the Air Forces	1-18, 24, 25
[Photo] Honorable Mr. Donald Atwood	6-6
[Photo] Norman R. Augustine, CEO Martin Marietta Corp [AFIT Forum speaker] &	5-9, 5-10
Dr. William Bailey	6-5, 6-8
Maj Paul D. Bailor	4-9, 4-14
Mr. George H. Baker	4-13
Maj Salvator R. Balsamo	6-4
Col Thurman H. Bane [Award], head of the Technical Section	1-2, 1-3, 1-52, 2-1, 2-5, 5-4
[Photo], Col Thurman H. Bane, -- 1919-22	2-11
Col Paul Bard	2-7
Barling bomber, [the earliest U.S. "heavy" aircraft] was designed and tested at McCook	1-5, 11
Dr. H. W. Barlow	4-2
Dr. Robert R. Barthelemy	5-9
Mr. Leroy Baseman	3-8
Capt Charles A. Bassett II	4-19
Capt Hosea Battles, Jr.	3-22, 3-28
Col Frederick C. Bauer	2-10, 3-21
[Photo] Col Frederick C. Bauer, -- 1991-1992	2-27
Lt Col Kenneth W. Bauer, Jr.	4-17
Lieutenant Eugene H. Beebe ('37)	1-14
Ms. Lisa M. Belue	4-17
Professor Donald G. Benoit	6-9
Dr. Philip S. Beran	4-6
Mr. Robert R. Bergseth	6-13
First doctorate: in Chemical Engineering, to Captain James Bierlein	1-54
Mr. Winfield S. Bigelow	4-13
Col John E. Blaha	4-19

Mr. Douglas C. Blake 4-6
Guion S. Bluford, Class of 1974 & [*Educator* cover drawing] 4-19
[Photo]: Astronaut candidate Maj Guion S. Bluford, Jr. (MS '74, Ph.D. '78), with Space Shuttle model 1-97
Mr. Robert M. Blythe 4-17
Lt Col [then Col] Karol J. Bobko ('70) training in shuttle simulators 1-89, 4-19
Col Frank Borman (CIP-'57) 1-71, 1-72, 1-80, 1-82, 4-19, 6-11
Brig Gen Stuart R. Boyd 2-10, 5-4, 5-9
[Photo] Brig Gen Stuart R. Boyd, -- 1987-1991 2-27
Maj Gen Mark E. Bradley, Jr. ('38), Assistant Deputy Chief of Staff for Material 1-61, 1-82, 6-11
[Photo]: Gen Mark E. Bradley ('38). 1-80
Maj [Maj Gen; then General] Follett Bradley of the 1922 class 1-5, 15, 20, 23
Maj Gen Charles A. Branshaw, Commanding General, Materiel Command 1-28, 2-8
[Photo] Maj Gen Charles A. Branshaw, -- 1944-45 2-13
Mr. Charles Brennan 4-12
[Photo] Capt Dave Brescia 3-12
Maj Gen Roy D. Bridges, Jr. 4-19
Dr. Charles J. Bridgman .... vi, 1-84, 2-5, 4-12, 6-4, 6-8
[Photo] Dr. Charles J. Bridgman 6-8
Captain Wendell H. Brookley 1-5
Representative Clarence J. Brown 1-67
Capt Jim Brown 4-6
Col Mark N. Brown 4-19
Donald L. Bruner, ('23) night flying possible through a series of experimental flights 1-6
[Photo]: Capt Donald L. Bruner ('23) 1-8
[Photo] Capt Tim Burkes 3-12
Capt Tom Burns 4-16
Lt Col Terry L. Caipen 6-9
LTC (Army) Daniel J. Caldwell 4-17
Dr. Ronald C. Calgaard 3-30
Dr. [Dean] Robert A. Calico, Jr. 2-7
Maj Gen James T. Callaghan 2-9
[Photo] Maj Gen James T. Callaghan, -- 1983-1986 2-25
[Photo] Maj John Calvin 3-12
Col George E. Cannon, Jr. 2-8
Maj Joseph W. Carl 6-4
Dr. Robert Carothers 5-9
Brig Gen John W. Carpenter III, assistant vice commander of ARDC; commander, AU 1-62, 1-79
Col Richard S. Cammarota 2-7
Brig Gen Frank O. Carroll 1-25
Albert B. Carson 1-36
[Photo] Maj Castanon Castanon 3-12
Col Don Caughlin 6-8
[Photo] Capt Joe Cavallaro 3-12
Mr. Jeffrey R. Cavins 4-15
Navy LT (then LCDR) Roger E. Chaffee, Engineering at AFIT: astronaut: completed studies correspondence-style 1-72, 4-19
September 1938 Neville Chamberlain's trip to Munich: seek peace with Hitler 1-15
Dr. Yupo Chan 6-4
Brig Gen Benjamin W. Chidlaw ('31) 1-25, 1-26, 2-8, 2-17, 6-11
[Photo]: Class of 1931 (Chidlaw is second from left in the front row) 1-9
[Photo]: Lt Gen Benjamin W. Chidlaw ('31) 1-51
[Photo] Maj Gen B. W. Chidlaw, -- 1946-47 2-17
Dr. Lung Chien, [post doctoral] 4-15
[Photo] Maj Steve Chimelski 3-12
Dr. G. Ronald Christopher .... vi, 5-4, 6-12

Churchill and Roosevelt ... 1-20
Maj John M. Clark ... 1-79
Capt Virginius E. Clark ... 2-1
Clements Committee ["Excellence in Education"] never published a final report ... 1-85
Deputy Secretary of Defense William P. Clements, Jr. ... 1-85
Col Ernest L. Clough ... 1-52
Capt Rich Cobb ... 4-8
Maj Gen Michael Collins ('64) ... 1-72, 1-80, 4-19
Mrs. Fran Collinsworth ... vi
Mr. Jose E. Colon ... 4-15
Brig Gen Cecil E. Combs ... 1-61, 2-8, 4-1, 5-4
[Photo] Maj Gen Cecil E. Combs, -- 1957-65 ... 2-21
Col Phil V. Compton ... 2-8
Col William G. Comstock ... 2-7
Dennis L. Constant, Class of 1973 [*Educator* cover drawing] ... 4-19
General Orval R. Cook ('30) ... 1-38
Cook-Cragie concept known as the Cook-Craigie Procurement System [with modification] ... 1-38, 59
Maj Gen Gerald E. Cooke, Commandant, AFIT ... 1-86, 1-91, 2-9, 6-2
[Photo] Maj Gen Gerald E. Cooke, Commandant ... v
[Photo] Maj Gen Gerald E. Cooke, -- 1978-1980 ... 2-23
Capt [then Col] Leroy G. ("Gordon") Cooper ('56) [made orbital flight lasting over 34 hours] ... 1-70, 1-71, 1-72, 4-19
[Photo]: Astronaut L. Gordon Cooper, Jr. ('56) with Mercury spacecraft model. ... 1-69
Col Howard H. Couch ('30) ... 1-24
Lieutenant [then Col] Don Coupland ('42) ... 1-18, 34, 36
Coupland and Gustafson ('42) ... 1-43
Richard C. Coupland ('24) ... 1-6
Col Richard O. Covey ... 4-19
Lieutenant [then General] Lawrence Craigie ('35) ... 1-11, 1-13, 1-18, 1-26, 1-33, 1-38, 1-82, 2-8, 6-11
[Photo]: Maj Gen Laurence C. Craigie ('35) ... 1-45
[Photo] Maj Gen Laurence C. Craigie, -- 1948-50 ... 2-19
Capt William Cramer ... vi
Captain Carl J. Crane, first automatic landing in aviation history ... 1-14
Dean William H. Crew ... 2-7
Carl E. Crockett ... 4-11
Col Gage H. Crocker ... 2-7
Capt Stephen E. Cross ... 6-4
Lt Megan Curran ... vi
Lt Col John F. Curry ... 2-8
[Photo] Lt Col John F. Curry, -- 1924-27 ... 2-11
Dr. Timothy J. Dakin ... 3-9
Burnie R. Dallas ('24) ... 1-7
Maj Herbert A. Dargue ('20) ... 1-7
Gen Bennie L. Davis, Commander Air Training Command ... 1-1, 6-1
Col [then Brig Gen] Leighton I. Davis, commandant, pinned on a star in April 1951 ... 1-51, 1-52, 1-53, 2-8
[Photo] Brig Gen Leighton I. Davis, -- 1951 ... 2-19
Dr. John J. D'Azzo ... vi, 6-4
[Photo] Dr. John D'Azzo ... 6-5
Capt Doug DeHart ... 4-8
Col Jay DeJongh ... 6-8, 6-9
Capt Scott Deloach ... 4-10
Dr. John W. Demidovich [Award] ... 5-1, 5-6, 6-6
[Photo] Dr. John W. Demidovich ... 6-6
Maj Scott Dennis ... 4-15
[Photo] Capt Mark DiPadua ... 3-12

George K. Dimitroff Award 6-10
Jimmy Doolittle ('23) in Reserve status and Vice President of Shell Oil 1-5, 1-6, 1-18, 1-48, 1-70, 6-11
Jimmy Doolittle, a brigadier general with a Medal of Honor 1-20
[Photo]: On the USS Hornet: Lt Col Doolittle ('23), with Rear Adm Marc A. Mitscher. 1-31
[Photo] Lt Gen James H. 'Jimmy' Doolittle 6-11
son of Capt James H. Doolittle, Jr. 1-52
Hugh Downey ('25) 1-6, 11
Dean Reginald H. Downing 2-7
Col Eldon W. Downs 2-8
Charles Stark Draper Laboratories, Cambridge, Massachusetts 1-92
[Photo]: Project DAWG: Dr. Charles Stark Draper 1-51
Brig Gen Drewes 3-7
Mark A. Driver 4-6
Brig Gen Charles M. Duke, Jr. 4-19
Deputy Secretary of Defense Charles W. Duncan, Jr. 1-91
Capt Ira Eaker stayed aloft for 151 hours by refueling in mid-air 1-7
General Ira Eaker, Deputy Commander, Army Air Forces 1-39
Maj Gen Oliver P. Echols ('27) 1-14, 25, 27
Col C. A. Eckert 2-8
Col Donald R. Edwards 2-8
[Photo] Maj Gen Kenneth Eickmann, AFMC Chief of Staff 5-10
Capt [then Col] Donn F. Eisele 1-63, 4-19
[General Dwight D.] Eisenhower 1-22
President [Dwight D.] Eisenhower 1-58
Professor William Elrod 6-9
David W. Elsaesser 4-15
Maj Gen Herbert L. Emanuel 2-9
[Photo] Maj Gen Herbert L. Emanuel, -- 1982-1983 2-25
Lt Col Larry Emmelhainz 2-5, 4-17
Lt Col Eugene L. Eubank ('30) 1-18
Col John M. Fabian ('64) 4-19
Dr. John M. Fabian, Class of 1964 [CIP Ph.D. '74] [*Educator* cover drawing] 4-19
Dr. Robert N. Faiman, Director of Academic Affairs [1974-1990] 2-5
General Muir L. Fairchild [Award] ('29) 1-16, 1-23, 1-35, 1-39, 6-11
Major General James Fechet, long-range bomber proponent, became Chief of the Air Corps in 1927 1-11
Dr. Charles R. Fenno 6-5
Capt Ken Fielding 4-16
[Photo] Maj George Flake 3-12
Dr. Robert E. Fontana 6-4
Col Thomas S. Ford 2-8
[Photo] Honorable Ms. Ann Foreman 6-6
Lieutenant Benjamin D. Foulois 1-2, 2-8
[Photo] Maj Gen Benjamin D. Foulois, -- 1929-30 2-15
Dr. Milton E. Franke 6-4, 6-5
David A. Fulk 4-11
Gen Charles A. Gabriel 7-2
Maj Yuri Gagarin, of the Soviet Air Force, traveled in space, making a single orbit of the earth 1-70
Capt Mark Gallagher 3-6
Lt Col Charles J. Gandy, Jr. ('62) 1-72
Maj Gen Grandison Gardner ('27) assumed command of USAFIT 1-51, 1-52, 2-8
[Photo] Maj Gen Grandison Gardner, -- 1950-51 2-19
Col Guy S. Gardner 4-19
Trevor Gardner, Assistant Secretary of the Air Force for Research and Development 1-58
Capt Gregory Garrett 6-6

[Photo] Capt [Gregory] Garrett 6-6
Dr. John Garrett 3-13
Capt Michele Gaudreault 4-8
Lt Col Edward M. Gavin ('39) 1-24, 26
Lt Col Walter H. Gerden 2-8
Capt Mark Gerken 4-10
Brig Gen William E. Gillmore 2-8
[Photo] Brig Gen William E. Gillmore, -- 1927-29 2-13
Col Otto Glasser ('47), project officer for the Atlas 1-59
Col Edwin M. Gleason 2-8
Maj John Glenn of the Marine Corps 1-71
Dr. Doug Goetz 6-6
Oscar A. Goldfarb, Class of 1967 [*Educator* cover drawing] 4-19
Lt Col Mark Goltz 6-6
[Photo] Maj Bill Goodwin 3-12
Col Ronald J. Grabe 4-19
Dean Gunther G. Graetzer 2-7
Capt Robert Graham 4-10
Col Walter Grande 2-8
Capt Kevin Grant 4-17
Col Donald J. Green 2-7
[Maj] Carl F. Greene ('26) had been working with pressure cabins 1-7, 14, 18, 24
[Photo]: Major Carl Greene (left) with early pressure cabin airplane 1-9
Col Frederick D. Gregory 3-30
Lt Col Virgil I. Grissom 4-19
Capt [then Maj] Virgil I. ("Gus") Grissom ('56) [pilot of Gemini 3] 1-61, 1-70, 1-72, 1-80
Brig Gen Mervin E. Gross, Commandant, AFIT 1-36, 2-8, 6-10
[Photo] Brig Gen Mervin E. Gross, -- 1946 2-17
[Col] Mervin E. Gross Award 6-10
Maj Paul I. Gunn 1-22
Lt Col Roy W. Gustafson ('42) 1-36
Col William B. Haidler 2-7
William P. Hallin, Class of 1968 [*Educator* cover drawing] 4-19
Maj James D. Halsell, Jr. 4-19
Dr. Harry P. Hammond, dean emeritus of engineering, Pennsylvania State College 1-55
Capt Ernest P. Hanavan, Jr. ('64) 1-72
Col Richard M. Hanes [Dean, School of Civil Engineering and Services] vi
Col Leonard F. Harman ('32) 1-15, 16, 18, 19, 24
Lt Gen Hubert R. Harmon ('25) 1-60
Maj Gen Robert W. Harper 1-44
Lieutenant [then Brig Gen] Harold R. Harris ('22), use of the parachute 1-5, 11, 6-11
Dr. E. Frank Harrison 3-30
Col Henry W. Hartfield, Jr. 4-19
Dr. Thomas Hartrum 4-9, 4-13
Col Vernon L. Hastings 2-8
Maj Gen Victor R. Haugen assumed command 1-76, 2-8
[Photo] Maj Gen Victor R. Haugen, -- 1965-67 2-23
Col James H. Havey 2-8
Maj William I. Havron 3-30
Lt Col Michael Heberling 3-7
[Photo] Col Robert C. Helt 5-10
Mr. Robert Hendricks 6-8
Professor Robert L. Henghold .... vi, 4-14, 6-8
Robert T. Herres, Class of 1960 [*Educator* cover drawing] 4-19

Maj Gen John K. Hester 4-2
Lt Gen Thomas J. Hickey 3-28
Capt Dan Hicks vi
Lt Col William C. Hobart 4-6, 4-13
Col John Hoff 3-14
Maj Jolly T. Holden 5-3
Captain [then Col] George V. Holloman ('35) 1-14, 1-18, 1-41, 6-11
[Photo]: Left: Capt George Holloman with his Q-2 radio-controlled target drone. 1-9
Mr. Courtney D. Holmberg 4-7
Mr. Arthur T. Hopkins 4-13
Dr. James M. Horner, Director of Academic Affairs 2-6
Dr. Constantine H. Houpis 6-4
Col Clinton W. Howard (Engineering School class of 1921) 1-11, 14, 32
Icarus Memorial 5-1
Col James B. Irwin 4-19
[Photo]: Apollo 15 crew: Astronauts James B. Irwin ('58), David R. Scott ('62), Alfred M. Worden, Jr. ('63). 1-88
[Photo]: Irwin with the Lunar Rover 1-88
Col Lewis M. Israelitt [School of Logistics Dean] 1-96, 2-7
[Photo] Track of JSTARS in Iraqi desert 4-20
Mr. Vincent J. Jodoin 4-13
Mr. Mark P. Jelonek 4-11
Thomas Jeter ('27), a Navy man, commanded aircraft carrier USS Bunker Hill 1-23
Mr. Jean Jines 6-6
[Photo] Mr. Jean Jines 6-6
Professor Emeritus George John 6-8, 6-13
Professor J. Richardson Johnson 6-9
[Photo] Professor Emeritus J. Richardson Johnson 6-8
Rich and Mary Ann Johnson 6-9
Mr. Ray O. Johnson 4-7
President Lyndon B. Johnson ordered retaliatory strikes [against Viet Nam] 1-75, 1-77, 4-1
Capt Dustin Johnston 4-8
Capt Frank Jones 3-25
Dr. Matthew Kabrisky 6-4, 6-8
Dr. Roland Kankey 3-7
Dr. Bernard Kaplan 6-8
Mr. Timothy G. Kearns 4-14
Mr. Kevin J. Keefer 4-15
Col Donald J. Keirn ('37) 1-25, 34, 42
Keirn's Resident Committee 1-35
Col Robert H. Kelley 2-8
Lieutenant Oakley Kelly, first non-stop coast-to-coast flight 1-5
Kelly Field, Texas 1-6
President John F. Kennedy signed [Bldg 640 authorization bill] on 28 July 1962 .... 1-67, 5-4
Captain George C. Kenney ('21) 1-5, 1-15
Gen George Kenney ('21) was commanding general of Strategic Air Command (SAC); commander of AU 1-42, 1-44, 5-5, 6-11
[Photo]: Lt Gen George C. Kenney ('21) in 1943. 1-31
Dr. Edward Keshock 4-17
Ernest R. Keucher vi
Mr. Daniel King 4-14
Capt James L. Klaus 1-79
Col [then Maj Gen] Hugh Knerr, had promoted the concept of a low-wing, multi-engined bomber 1-11, 1-14, 1-32, 1-33
General Knerr Committee 1-33
[Photo] Maj Gen Hugh Knerr, -- 1945 2-17
Maj William J. Knight ('58), flew the X-15 to world speed record of 4,520 mph, August 1966 .... 1-70, 72

Lt Col Edward S. Kolesar 6-4
Professor Ezra Kotcher [Award], Wright Field July 1928 Jr. aero engnr; Engnrg School Math Instructor 1-11, 1-16, 1-52, 6-5
Col Joseph P. Koz .... v, vi, 2-5, 2-10
[Photo] Col Joseph P. Koz, Commandant v
[Photo] Col Joseph P. Koz, -- 1993 to the Present 2-27
Col Jimie Kusel 2-8
Lt Gen Laurence S. Kuter, Air University commander 1-60
[Photo] Maj Gen J. K. Lacey, -- 1955-57 2-21
Maj Gen Julius K. Lacey 1-60, 2-8
Dr. Alan Lair 6-8
Dr. Bernard J. LaLonde 3-30
Professor Gary B. Lamont 4-6, 4-13
Maj Robert L. Landry 3-23
First Lieutenant Harold C. Larsen 1-29
Capt Sanders A. Laubenthal : Author 1-1
Ohio Senator Frank J. Lausche 1-66
Mr. Richard H. Lee 5-1
Eugene J. Lehman : Graphics 1-1
Dr. William L. Lehmann, assumed the role of Assistant Dean for Research 1-74
General Curtis LeMay, Chief of Staff 1-63, 1-67, 5-4
[Photo] Capt Brenda Lewis 3-12
Lieutenant Burton F. Lewis, aerial torpedoes & new aircraft: McCook Field 1-5
Professor Brad S. Liebst 4-7
Mr. Harold E. 'Hal' Lillie 6-7
[Photo] Mr. Harold E. Lillie 6-7
David G. Lingle ('26) 1-7
Col Clarence B. Lober 1-37
[Frank Borman ('57) and] Jim Lovell 1-72, 82
[Photo] Maj Rich Lucas 3-12
Maj David Luginbuhl 4-9
Dr. Theodore Luke 4-8
General [Douglas] MacArthur 1-20, 21
MacKay Trophy 1-5, 14
Col James S. MacKenzie, Jr. 2-8
Lieutenant [then Col] John A. Macready ('23) 1-5, 1-18, 1-23
[Photo]: 1st Lt John A. Macready ('23) 1-8
[Photo]: Macready with Orville Wright 1-8
Col Eugene R. Magruder 2-7
Dr. [Professor Emeritus] James O. Mahoy 3-13, 6-9
Dr. Shankar Mall 4-9, 6-4
Col Charles R. Margenthaler 2-7
Lt Col Wayne Maricle vi
Under Secretary of the Air Force, the Honorable Hans M. Mark 1-86
Dr. John R. Markham 2-2
Gen Robert T. Marsh 3-29
Army Chief of Staff, Gen George C. Marshall 1-17
CAPTAIN Jack E. Martin, USN 5-7
Dr. Floyd H. Marvin, GWU President; Secretary-Treasurer: National Commission on Accreditation 1-55, 1-58
Professor Kirk Mathews 4-11, 4-12, 6-8
Dr. [Dean] William A. Mauer 2-7, 6-12
[Photo] Dr. William A. Mauer 6-12
[Photo] Capt Jeff Maxwell 3-12
Dr. Peter S. Maybeck 6-4
Col John A. McCann, Deputy Commandant 1-74, 76, 2-8

Col McCann assumed command 21 Apr 64; Combs: Korea: Military Armistice Commission 1-75
[Photo] Col John A. McCann, -- 1964 2-21
[Photo] 'The Civil Engineering Team' painting, by Mrs. Eleonora McCann 2-10
McCook College 1-7
General Anson McCook (Civil War - fightin' McCooks) 1-3
[Photo]: McCook Field 1-9
Diann L. McCoy, Class of 1978 [*Educator* cover drawing] 4-19
Lt Gen Robert P. McCoy 5-3
[Brig Gen] James A. ("Jim") McDivitt (CIP-'59) 1-72, 1-81, 4-19
Jim McDivitt and Ed White, - the first all-AFIT team -- White first American to walk in space 1-72
[Photo]: James A. McDivitt ('59) and Edward White ('59) 1-72
Col Robert H. McIntire 2-8
Col Lawrence McIntosh, the only other [then] living member of the Class of 1920 .... 1-82, 2-8
[Photo] Maj Lawrence W. McIntosh, -- 1922-24 2-13
[Photo] Honorable Mr. Colin McMillan 6-6
Gen Joseph T. McNarney 2-2
Gen McPeak 2-7
Mr. James W. McSwiney 5-1
Maj Gen Edward P. Mechling 1-67
Mr. David W. Melton 4-7
Mr. Laurence D. Merkle 4-14
[Photo] Maj Rod Metcalf 3-12
Lt Col Willard R. Middleton 2-8
Mr. Dennis Miller 4-12
Lt Col Phil Miller vi
Capt Russel Miller 4-5
Mr. Bryan Minor 4-12
Maj Gen Augustus M. Minton, director, Air Force Civil Engineering 1-67
Billy Mitchell's bombers had sunk the Ostfriesland in 1921 1-11
Billy Mitchell's prediction: war would come in the Pacific 1-15
Professor Carlos Montestruque 4-17
Lt Col Richard Moore 6-5
Professor Albert Moore 6-9
Mr. Kenneth J. Moran 4-6
Mr. Scott A. Morton 4-7
Mr. Lloyd K. Moseman 3-8
Col Glynn O. Mount 2-7
Col Steven C. Mugg 2-8
Col Richard M. Mullane 4-19
Col Richard Mullane, Class of 1975 [*Educator* cover drawing] 4-19
Ms. Sharon Mullins 3-28
Col A. M. Musgrove 2-7
John M. Nauseef, Class of 1979 [*Educator* cover drawing] 4-19
Col Marshall W. Nay, Jr. 2-8
Col Albert M. Nemetz 2-8
Capt David Neumann 4-11
Lt Col Richard J. Nissing 5-8
President [Richard M.] Nixon 1-82
Lt Col Ellison S. Onizuka 4-19
Professor M. Pachter 4-5
Col Edwin R. Page ('25) 1-7, 18
Dr. Frank Pai, [post-doctoral] 4-15
Professor Anthony N. Palazotto 4-15, 6-4
Col Miles R. Palmer 2-8

Col Eugene C. Parkerson 2-7
Gen Mason M. Patrick, Chief of the Air Service 1-10
Patterson Field, [named for] a test pilot killed in a crash in 1918 1-13
Lt Col Norman Paulsen 2-8
Dr. Leno Pedrotti 6-8
Peer Award 6-10
Professor Jerome G. Peppers 6-9
Dr. Frank E. Perkins 3-29
Mr. John J. Pernot 4-9
Maj Glen Perram 4-7
Col Donald H. Peterson 4-19
Capt Odell Reynold 4-5
Maj Gen Ernest A. Pinson; former commander, OAR, Washington 1-78, 1-82, 2-8
[Photo] Maj Gen Ernest A. Pinson, -- 1967-1973 2-23
Gen Bryce Poe II 2-6, 3-29
Col William R. ("Bill") Pogue 1-89, 4-19
Louis F. Polk Award 6-9
Mr. Gernot S. Pomrenke 4-15
Maj Gen C. H. Pottenger 4-2
Brig Gen Henry C. Pratt 2-8
[Photo] Brig Gen Henry C. Pratt, -- 1930-35 2-13
Capt Kevin Priddy 4-16
Dr. Janusz S. Przemieniecki, design work: supersonic transport Concorde 1-79
Dr. Janusz Przemieniecki, Dean, School of Engineering .... vi, 1-86, 2-4, 2-5, 4-5, 5-1, 6-3, 6-4
[Photo] Dr. Janusz Przemieniecki 6-3
Lt [then Lt Gen] Donald L. Putt ('37) -- who convinced Air Corps to go ahead with B-17 .... 1-14, 1-23, 1-26, 1-59, 6-11
Professor Dennis W. Quinn 4-10
[Photo] Maj Steve Rakel 3-12
Robert R. Rankin, Class of 1964 [*Educator* cover drawing] 4-19
Dr. Raouf Raouf, [post-doctoral] 4-15
Gen Edwin W. Rawlings [Award], headed Air Materiel Command 1-60, 6-10
[Photo] President Ronald Reagan 6-3
Dr. Dorothy D. Reed 3-30
Lewis R. P. Reese ('25) 1-7
Dr. Thaddeus L. Regulinski 6-4
Professor Virgil R. Rehg 5-6, 6-6
Dr. Louis N. Ridenour 1-47
Lt Col R. Riggins 4-6
David D. Robertson 4-9
Col Pearl H. Robey ('36) 1-25
Brig Gen A. W. Robins, Commandant 1-13, 2-8
[Photo] Brig Gen Augustine Robins, -- 1935-39 2-15
Capt Andy Rogers 6-10
Professor Steven K. Rogers 4-15, 6-4
[Photo] Dr. Steven K. Rogers 6-7
Capt Michael Roggemann 4-8, 4-16
Professor Won B. Roh 4-11
Col Stewart A. Roosa ('60) 1-88, 4-19
President Franklin D. Roosevelt 1-15
[Photo] Mr. Leo Rose 3-12
Maj Mark Roth 4-9
[Photo] Maj Tom Rubin 3-12
Capt Dennis Ruck 4-16
Acting Director Glenn A. Rudd 5-7

Maj Robert A. Rushworth ('54), flew the X-15 on more flights than anyone ... 1-70
Capt Pedro L. Rustan ... 6-4
[Photo] Maj Kevin Sabicer ... 3-12
Col Charles W. Sampson ... 2-8
Brian P. Sanders ... 4-9
Dr. Eugene Santos ... 4-10
Representative Paul Schenck, of Dayton ... 1-64
Capt Scott A. Schimmels ... 4-15
Wally Schirra and Tom Stafford as crew ... 1-72
Wally Schirra, Donn Eisele ('60), and Walt Cunningham -- piloted Apollo 7 ... 1-80
[Photo] Lt Col Bill Schneider ... 3-12
Maj Gen Carl G. Schneider ('60), chief of staff at AFLC ... 1-95
Greg R. Schneider ... 4-11
Brig Gen Bernard A. Schriever ('41) [Award], Asst to Cmdr, ARDC; then Cmdr, AFSC . 1-16, 1-58, 1-59, 1-63, 1-66, 6-5, 6-11
[Photo]: Gen Bernard A. Schriever ('41). ... 1-68
[Photo] Gen Bernard A. Schriever ... 6-5
Col Thomas F. Schuppe ... 2-7, 3-6, 6-8
Maj Francis R. Scobee ... 4-19
Col David R. Scott ('62) ... 1-72, 1-88, 4-19
[Photo]: Scott salutes the U.S. flag during Apollo activity on the lunar surface. ... 1-88
Dr. Roy A. Seaton, Dean Emeritus, School of Engineering and Architecture, Kansas State College ... 1-60
Ms. Becky Semler ... vi
Maj Alexander P. de Seversky, authority on airpower ... 1-63
Dr. Donn Shankland ... 6-8
Gen John A. Shaud ... 3-29
[Photo] Maj Scott Shaw ... 3-12
Lt Col Dan Shell ... 3-13
Alan Shepard and Ed Mitchell descended to the lunar surface ... 1-88
Alan Shepard -- suborbital flight in Mercury capsule called "Freedom 7" ... 1-70
Maj Gen Stuart H. Sherman, Jr. ... 2-9, 6-2
[Photo] Maj Gen Stuart H. Sherman, Jr., -- 1980-1982 ... 2-25
Dr. A. J. Shine ... 4-2
Lt Col John Shishoff ... 4-17
Mrs. Maxine Shroyer ... vi
Maj Jerrold S. Shuster ... 4-4
Capt Robert M. Silva ('62) ... 1-72
Mr. Jeffery A. Simmers ... 4-14
Maj Gen Frank J. Simokaitis ... 2-9
[Photo] Maj Gen Frank J. Simokaitis, -- 1973-1978 ... 2-23
Brig Gen Frank J. Simokaitis, [Commandant], JD. degree (CIP-'50) ... 1-84
Lt Col Jacob Simons, Jr. ... 6-5
Mr. Glenn Sjoden ... 4-12
Gen Lawrence A. Skantze ... 5-1
General Alton H. Slay, commander of AFSC ... 1-94
Mr. Greg Smith ... vi
Col Larry L. Smith ... 2-7
Lt Col Randy Smith ... 4-15
Capt Ronald E. Smith, Air Force Cross & 12 other combat medals ... 1-84
Brig Gen Edgar P. Sorenson ('23) ... 1-38, 2-8
[Photo] Brig Gen Edgar P. Sorenson, -- 1947-48 ... 2-17
Maj Carl Spaatz ... 1-7, 16
Col Marvin F. Stadler ... 2-8
Tom Stafford and Navy Lt Eugene A. Cernan ... 1-72
[Photo] Mr. Nick Steiner ... 3-12

Mr. Todd D. Steiner 4-15
Ms. Jean M. Steppe 4-17
Lt Gen James T. Stewart 5-1
Maj Albert T. Stoddard 6-6
Col Charles A. Stone [Award] 2-7, 6-5
Lt Gen W. S. Stone 4-2
Capt Jim Stright 4-16
Col Oren G. Strom 2-8
Lt Col Mary J. Strong, enrollment in the School of Business 1-64
Lt Gen Dean C. Strother, commander of Air University 1-62
[Photo] SMSgt Andy Stubblefield 3-12
Col [Brig, then Lt Gen] Ralph P. Swofford, Jr. ('36), AU Commander 1-25, 1-25, 1-48, 1-54, 1-74, 2-8, 6-11
[Photo] Brig Gen Ralph W. Swofford, -- 1951-55 2-19
Mr. Robert Sydenstricker 4-15
Capt Greg Tarr 4-16
Assistant Secretary, Air Force, Manpower & Reserve Affairs, Curtis W. Tarr 1-82
David J. Teal, Class of 1965 [*Educator* cover drawing] 4-19
Col Clyde B. Thompson 2-8
[Photo] Capt Kirby Thompson 3-12
Dr. Paul Y. Thompson 3-30
Lt Gen William E. Thurman 5-1
Lt Gen Walter E. Todd, AU commander 1-64
Brig Gen Richard J. Toner 2-10, 5-1
[Photo] Brig Gen Richard J. Toner, -- 1986-1987 2-25
Dr. Peter J. Torvik 4-17, 6-4, 6-12
Capt Steven Troxel 4-8
President Truman: National Security Act of 1947, established Department of Defense: separate Air Force 1-38
Dr. C. T. Tsai, [post-doctoral] 4-15
Gen Nathan Farragut Twining Commander, ATSC 1-34, 2-2, 5-4
Col John Tyler 2-8
[Photo] Col John Tyler, -- 1957 2-21
Col [then Lt Gen] Stanley Umstead, Commander, AU -- had flown [B-17B] from LA to New York in under 9-1/4 hours 1-1, 1-16
[Photo] Mr. Dick Urrutia 3-12
Chief of Staff, General Hoyt S. Vandenberg 1-52
Mr. Jamie Varni 4-15
Capt Thomas R. Vermillion 3-22, 3-28
Mr. Gary Vest 5-9
Mr. George Vogel 4-16
Wernher von Braun [and team at Redstone Arsenal] 1-42, 71
von Karman Committee, or Markham Committee, after Dr. John Markham of MIT 1-35
Dr. Theodore von Karman, Special Consultant to Commanding General, AAF 1-34, 2-2
Ralph L. Wassell 1-16
Capt Gregg Wears 4-18
Major [then Lt Col] William R. Weems, an MIT man 1-28, 32
Dr. Bob Wehrle-Einhorn 3-13
[Photo] Lt Col Dave Welch 3-12
Gen Larry D. Welch 3-22
Col Paul T. Welch 2-7
Dr. Rita L. Wells 6-12
Dr. Byron Welsh 4-8
Maj Philip J-L Westfall .... vi, 5-4, 6-5
Lt Col Edward White (CIP -'59) 1-72, 4-19
Brig Gen Ennis Whitehead ('26) [took over Fifth Air Force June '44] 1-22, 23, 60
Col David C. Whitlock 2-8, 2-10, 3-21, 3-28

[Photo] Col David C. Whitlock, -- 1992-1993 2-27
Frank Whittle 1-25
Whittle engine, a jet-propulsion power plant 1-25
Mr. Edward Williams 4-14
Col Bennie J. Wilson, III .... vi, 2-8, 3-21
President Woodrow Wilson 1-3
Maj [Gordon] Wishon 3-26
Dr. Lynn Wolaver 2-5
Brig [then Lt Gen] Kenneth B. Wolfe ('31) [Commander Fifth Air Force] 1-24, 1-26, 1-33, 6-11
Maj James W. Wood ('56) 1-72
[Photo] Capt John Wood 3-12
Capt Clinton F. Woolsey ('26) 1-17
[drawing]: Model of Woolsey Bomber 1-17
Lt Col Alfred M. Worden 4-19
Orville Wright was the official observer 1-6
Orville and [the late] Wilbur Wright 2-1
Wilbur Wright Field 1-8, 1-13, 2-1
Dean C. Ray Wylie, Jr. 2-7
Ridley sealed [Chuck] Yeager into the X-1; worked closely with Yeager 1-43
Professor Yung Kee Yeo 4-14
[Photo] Honorable Mr. Don Yockey 6-6
Capt Frank Young 4-10
John Young and Charlie Duke ('64) explored the *Descartes* region of the moon 1-88
Navy Lt Cmdr John Young as co-pilot: spacecraft, nicknamed the "Molly Brown" 1-72
Secretary of the Air Force Eugene M. Zuckert 1-66, 1-75, 4-1

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United States Air Force Institute of Technology	1948 — 1955
Institute of Technology, USAF	1955 — 1956
Air Force Institute of Technology	1956 — 1959
Institute of Technology	1959 — 1962
Air Force Institute of Technology	1962 —

THE SYMBOLISM BEHIND THE COAT OF ARMS

The shield is blue, the principal color of the United States Air Force; the atomic symbol for oxygen representing the atomic age and scientific progress as well as the element which furnished life to both personnel and power plants of aircraft; the gear wheel representing engineering and the inception of the Institute within the aegis of the Air Materiel Command; the lightning rays representing the striking force, above and below, of science and engineering. The lower third of the field, broken by stylized cloud forms, is representative of the element which science is conquering and is therefore shown subordinate to the oxygen atom. The motto is indicative of the mission of the Air Force Institute of Technology, "Prepared in Mind."