CHALLENGES TO UNITED STATES TACTICAL AIR FORCE AIRCRAFT MAINTENANCE PERSONNEL: PAST, PRESENT AND FUTURE

THESIS

Barbara L. Harris, Captain, USAF

AFIT/GLM/LSM/91S-28

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GLM/LSM/91S-28

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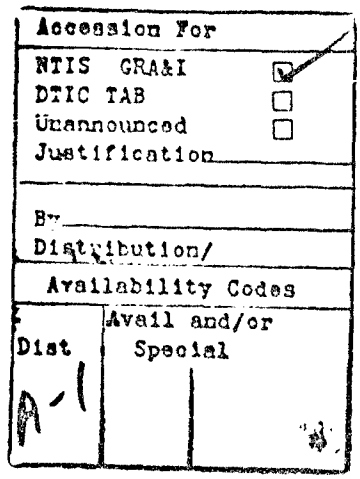

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THESIS

Presented to the Faculty of the School of Systems and Logistics

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

Barbara L. Harris, B.A.

Captain, USAF

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Preface

The purpose of this study was to assess the challenges Tactical Air Forces (TAF) aircraft maintenance personnel face as a result of organizational changes based on fiscal restrictions and dramatic changes in the Soviet Union and Eastern bloc nations.

When the study was originally conceived, it was not designed to cover the concepts of two-level aircraft maintenance and TAF Composite and Objective Wings and their impact on the maintenance organization. However, the TAF's rapid development of these two areas necessitated their consideration.

My success in completing this effort must be shared with several individuals. I offer my heartfelt appreciation to my thesis advisor, Major Dave Diener. His ability to pull seemingly unrelated ideas together was a continuing source of inspiration. I am eternally grateful to my reader, Mr. Jerry Peppers. He tactfully prevented me from making historical blunders, gently guided me to fill in the blanks, and kept me laughing when I really needed to.

For their assistance in providing me with critical historical information I would like to thank Ms. Bea Arthur from the TAC History Office; Mr. Paul Ferguson from the AFLC History Office; and Mr. Dave Menard from the Air Force Museum Archives. Each of these fine people provided me with the most prompt and courteous service anyone could ever hope for.

I would also like to thank several of my friends for helping me get through the hard times. Captain Steve (Ike) Eichenbrenner, his wife (and my friend) Angela, and their two children, Paula and Chester were

my "family" away from home. They were always there for me and showed me just how important family is to success. I must also thank Captain Rui Jorge G. Gomes, of the Portuguese Air Force, for putting up with a lot more than he got in return.

My mother, Carole Myers, also deserves a lot of the credit for my success. She always reminds me I can do anything I set my mind to and always she is right. Thanks Mom.

Finally, I owe the greatest debt to my husband Captain Richard A. Harris, Jr., for his love, tolerance, patience, support, and understanding. As an active duty officer, Rich was unable to accompany me to this school. Instead he had to put up with the long periods of separation, endless phone calls, and all the trials of running a home without my help. He showed me how important we are to each other.

Barbara L. Harris

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Abstract

The purpose of this study was to assess the challenges Tactical Air Forces (TAF) aircraft maintenance personnel face as a result of the TAF reorganization. The overall goal was to provide aircraft maintenance managers with a basis for evaluating and meeting those challenges. To accomplish this goal, emphasis was placed on documenting the concepts, events, and conditions which led to changes in military aircraft maintenance from the birth of aviation to the present. Current issues such as the proposed move to two-level maintenance and the formation of the TAF Composite and Objective Wings were also addressed. Research was conducted primarily through the review of available historical documents, complemented by current literature and personal interviews. The TAF reorganization results in a more centralized maintenance organization with a generalized workforce. History shows that when faced with comparable conditions--reduced threat and loss of defense dollars, the Air Force took similar action. The on-equipment aircraft maintenance technician will experience the least negative impact from the reorganization. Those most likely to experience the greatest changes in the structure of their career fields are the off-equipment aircraft avionics maintenance technicians. Furthermore, the TAF reorganization also eliminates many of the overhead supervisory positions held by intermediate-level officer and enlisted aircraft maintenance managers. Although it will take some time for the chaos to subside, if everyone focuses on doing their part to ensure the success of the mission the TAF Objective Wing will become another positive example in history.

CHALLENGES TO UNITED STATES TACTICAL AIR FORCE AIRCRAFT MAINTENANCE PERSONNEL: PAST, PRESENT, AND FUTURE

I. Introduction

It is fiscal year (FY) 1995, do you know where your force levels are? If you guessed close to the Air Force of 1950 you are correct! The 1990 Defense Authorization Bill proposes Air Force strength reductions of 100,000 airmen over the five year period, FY 91-FY 95--from 510,000 by the end of FY 1991 to 415,000 by the end of FY 1995. This level nearly matches Air Force strength levels just three short years after its birth in 1947 (1:36-37). Although this is not the first time the Air Force has taken major cuts, today there is a difference. In the past, manpower reductions have always followed a period of buildup in the force. Reducing the force simply equated to the immediate release of those individuals who had enlisted to avoid the draft, and who did not want to make a career out of the military in the first place. Today the circumstances are very different. (See Appendix A for a complete list of manning numbers.)

The latest round of cutbacks comes on the heels of a manpower reduction plan that began around 1986. The Air Force has lost 76,000 airmen over the past five years, and even before Congress called for deeper cuts this year the Air Force was cutting new accessions and accelerating retirements. The problem is there is no assurance the cuts

will end at the levels now planned. What will really happen hinges on future appropriations (1:37). If appropriation levels drop further, they could speed up the current drawdown rate, or even force final levels below the planned totals. Of course, the converse is true, but at this point it is highly unlikely the trend to slim down the military complex will reverse. The rapid changes in the Soviet Union and Eastern Europe have stretched to the United States. The reaction to these changes has been a call by Secretary of Defense Dick Cheney to "slash $180 billion from the defense budget by fiscal (year) 1994" (3:8). This large reduction in defense dollars equates to smaller United States military forces in the future.

Experience has taught the Air Force to be very careful how it carries out these reductions. When it sought to reduce the force following the Vietnam conflict, the Air Force did so at the cost of new accessions. Although this plan worked in the near term to rapidly reduce manning levels, in the long term it was a failure. Large gaps were created in the number of career-eligible airmen who had the necessary skills to maintain a combat ready force (1:37). It has been more than 15 years since the Air Force made that mistake, and the next five years may tell how well the Air Force learned the lesson.

The status of manning reductions has been explored, but what, if any, effect will the budget reductions have on planned readiness? As reported in the April 1991 issue of Air Force Magazine, "Air Force officials say they will try to hold it (readiness) at today's high levels" (6:74). As the number of aircraft is reduced, a fifteen percent reduction in the overall flying hour program is expected. Yet, the Air Force does not want to reduce its readiness level. It wants tactical fighter

pilots and strategic pilots to continue flying twenty hours per month. Though the Air Force's direct flying-hour budget for airlift crews has been cut, it will be supplemented by DoD-funded flying time (6:74). What this means is that the tasking level basically remains the same. In short, fewer people and fewer aircraft but the same expectations for a combat ready force. Is another chapter in the continuation of the ages old "more with less" concept of military operations being written?

The reduction in force to pre-Korean War levels will provide some interesting challenges to Air Force leaders and managers. It is the purpose of this research to identify those challenges Tactical Air Force (TAF) aircraft maintenance personnel face. (The term Tactical Air Force encompasses the Tactical Air Command, Pacific Air Forces, and United States Air Forces in Europe.) The study of aircraft maintenance issues is done in two phases. The first phase is a historical review of the development of aircraft maintenance, with the emphasis placed on the issues faced by aircraft maintenance during each period of development. Though this research focuses on TAF aircraft maintenance issues, the inclusion of additional material is necessary for several reasons. First, the review of early aircraft maintenance history provides a better understanding of its evolution. Maintenance managers will have an opportunity to view how these challenges were met in the past, and may be able to draw a parallel to today's issues. Second, TAC (and subsequently the TAF) did not exist in the early years of aircraft maintenance development; TAC was officially recognized in 1946. Finally, the first TAF maintenance manual--TAC Manual 66-1--was not published until 1957. The second phase of the study focuses on the most

recent changes faced by the TAF maintenance organization. The last chapter compares and contrasts the development of aircraft maintenance, with a focus on the constraints aircraft maintenance managers must face.

Why Today Is Different From Yesterday: The End of "Cold War"

Historically, the United States military has reduced its forces after every major war beginning with World War I and continuing to the present. Now, the longest running war has come to an end. It was not as concrete as past wars where there was a definable beginning and end to the hostilities. This war was a "cold war" with the Soviet Union which began just after World War II. The beginning of this war was marked by the Soviet support of post-war communist regimes which eventually took power in many Eastern European nations. Finally, in response to the Czechoslovakia coup of 1948, and the Berlin blockade from April 1948-September 1949, the North Atlantic Treaty Organization (NATO) was formed (7:512).

Although the cold war was a different war, it still represented a long period of ideological conflict where the known threat was the Soviet Union. In 1988, Soviet President Mikhail Gorbachev made a choice to end the cold war. He selected that year as the time to call for perestroika--the restructuring of the Soviet society, economy, and military. He made a choice to replace the "nyet" approach to foreign affairs with one of glasnost, or openness. The impact of his choice for the future of the Soviet Union has been felt worldwide and, in particular, by the United States.

Without the ever-present threat from the Soviet Union, the United States has been forced to rethink its military strategy. This has resulted in a shift in the foundation of United States national security policy and strategy. Maj Gen Charles G. "Chuck" Boyd, then Director of Plans for the Air Force Deputy Chief of Staff for Plans and Operations (XO), was one Air Force strategist not convinced the world is safe. In James W. Canan's article, "Global Power from American Shores," he said:

> Whether the Soviet threat diminishes or resurges, it seems obvious to Air Force strategists that even greater threats to US interests--and to US national security--will rise up elsewhere, especially in the increasingly well-armed Third World. (2:40)

What Now?

A perceived change in the posture of our main threat gave Congress all the impetus it needed to call for reductions in the defense budget. Lt Gen Thomas J. Hickey, Deputy Chief of Staff for Personnel, said "When all the dust settled (on the 1990 budget), the Air Force leadership faced a $600 million reduction in personnel dollars to manage our programs" (3:8).

This reduction in personnel dollars is leading to a broad spectrum reduction in force (RIF). In March 1991, assigned overseas manning levels were set to 100 percent for short tours, but they have been reduced from 100 percent to 90 percent of authorized levels for long tours. At the same time, stateside manning went from 95 percent to 85 percent (5). Air Force leaders and managers, accustomed to working with more personnel, are searching for ways to cope with these reductions while retaining capability.

Specific Problem

Manning reductions combined with little change in demands for sortie production causes a whole new set of challenges to emerge. The problem is, there is no clear statement of the effect these challenges have had, or will have, on the TAF aircraft maintenance organization. The first concern of this research is to determine if challenges exist. If they do, the next step will be to compare these challenges to those faced in the past. The overall goal is to provide maintenance managers a basis for evaluating and meeting those challenges.

To accomplish this goal, emphasis is placed on documenting the concepts, events, and conditions which led to changes in military aircraft maintenance from the birth of aviation to the present. This research includes a look at the circumstances surrounding the buildup and drawdown of the Army Air Service, the Army Air Corps, the Army Air Forces, and the United States Air Force over the same period.

Investigative Questions

The following questions are used to guide the research. The term "air force" is used to suggest the Army Air Service, Army Air Corps, Army Air Forces, and the United States Air Force. (See Appendix B for the chronology of Air Force development.)

1. What led to the periods of buildup of the air force from the birth of aviation to the present?

2. What was the overall structure of the air force prior to each buildup period? How was the aircraft maintenance organization structured?

3. What challenges did the aircraft maintenance organization face associated with each buildup period?

4. What was the overall structure of the air force after each buildup period? How was the aircraft maintenance organization structured?

5. How were the drawdowns of the air force accomplished?

6. What challenges did the aircraft maintenance organization face at the end of each drawdown period?

7. Do similar challenges exist today?

Scope and Limitations

This thesis is limited to examining the challenges facing TAF base-level aircraft maintenance career fields. Primary consideration is given the current 45XXX AFSCs*. They are: (4:29)

AFSC	TITLE
458X0	Machinists/Welders
458X2	Corrosion Control
452X1	F-15 Flightline Avionics
452X2	F-16 Flightline Avionics
452X3	F-111 Flightline Avionics
451X4	F-15 In Shop Avionics
451X6	F-16 In Shop Avionics
452X4X	Crew Chief/Hydraulics/Engines

* A listing of current TAF AFSCs is located at Appendix C.

Methodology

Two time-oriented areas form the perspective of this research--historical and current. The historical inquiry involved a comprehensive search of available historical documents. In addition, primary source data were gathered through interviews with Jerome G. Peppers, Jr., Professor Emeritus, School of Logistics, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. The investigation of the contemporary maintenance challenges was done through the review of current literature and applicable Air Force directives. Supplementary material was gathered by interview with Headquarters, Tactical Air Command personnel.

Preview of the Remaining Chapters

This study spans nearly a century of aircraft maintenance developmental history. It is organized by chapters, with each chapter representing a specific period of time. Chapters II through VIII begin with a section entitled "The United States in Perspective," and end with an "Aircraft Maintenance Issues In Summary" section. For ease of reference, a bibliography is located at the end of each chapter. A compilation of these chapter bibliographies is located at the end of the study.

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II. Beginnings 1900-1920

The United States In Perspective

The term connected with the late 19th and early 20th centuries is "scientific specialization." Scientific specialization refers to the advances in technological aptitude brought about by the geometric increase in the number of practitioners (13:510). It was an era of exploration, discovery, and growth that served to move science beyond popular grasp. These years were also a time of social growth in America. To lend some perspective, it is interesting to note some of the historical developments taking place in the United States at this time.

In 1910, the Boy Scouts of America were founded followed by the American Girl Guides (later the Girl Scouts) in 1912. In 1913, the Federal Reserve System was authorized which signaled a major reform of United States banking and finance. The first telephone talk from New York to San Francisco was made by Alexander Graham Bell and Thomas A. Watson, in 1915. The first United States Congresswoman, Jeanette Rankin (R-Montana), was elected in 1916. Finally, the 18th Amendment to the Constitution (Prohibition) was proposed by Congress in December 1917, and fully ratified by January 1919 (13:462).

In the years between 1885 and 1913 total American industrial production was increasing at an annual rate of 5.2 percent. This compared to increases in Germany of 4.5 percent, Great Britain of 2.11 percent, and Russia--on a lower base--of 5.72 percent. The American share in world manufactures jumped from less than 20 percent in 1880 to more than

35 percent in 1913. In 1870 American production was about 10 percent greater than German production; in 1900 it was over 100 percent greater, and in 1913 it was 150 percent greater (4:273).

During this time of industrial growth, the United States also conducted successful military campaigns to include; Cuba in 1898, Puerto Rico also in 1898, the Philippines during the Philippine Insurrection of 1899, China during the Boxer Rebellion of 1900, and Mexico during a period that spanned 1911-1917. It was within this framework that manned, powered, and controlled flight developed.

Air Power at the Turn of the Century--No War In Sight

The United States military had only limited experience with aviation prior to the turn of the century. Union forces had used observation balloons as early as 1861 in actions near Fort Monroe, Virginia (4:195). While these vehicles may have fueled the imagination, they could not measure up to the excitement generated by the Wright Brother's invention.

Though the Wrights made the first controlled, powered flight they were not alone in their quest. Many others, Octave Chanute, Glenn Curtiss, Samuel P. Langley, and Senhor Don Alberto Santos-Dumont to name but a few, were also making aviation history (4:9,53,11,41). These visionary pioneers--like the Wrights--were involved in a life-long pursuit of manned, powered, and controlled flight.

However, on a cold morning, 17 December 1903, the Wrights literally flew into history. In their own words they captured that moment:

> The first flight lasted only twelve seconds, a flight very modest when compared to that of birds, but it was, nevertheless, the

> first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in free flight, had sailed forward on a level course without reduction of speed, and had finally landed without being wrecked. (3:82)

The Military Takes Notice. Nearly four years after the Wrights' historic flight, 1 August 1907, the Aeronautical Division of the United States Army Signal Corps was formed. With a total strength of three men, the Division was created as the Government's tool for keeping in touch with aeronautical advances. Shortly after activation, the Division began advertising for a "practical means of dirigible aerial navigation" and subsequently set up a balloon facility at Fort Omaha, Nebraska (11:1).

By December 1907, the first bids for a heavier-than-air flying machine began arriving at the Signal Corps. The specifications for this aircraft were stringent.

> The airplane had to be capable of carrying two persons with a combined weight of 350 pounds, carry enough fuel for a 125 mile flight, remain in the air for one hour, and be able to return to the starting point without damage to the machine. The prospective airplane was to fly 40 miles per hour, plus or minus four miles per hour, and the design simple enough to permit the machine to be quickly and easily assembled and disassembled. (1:8)

This last specification was to be tested after the successful bidder was selected. That bidder had to disassemble the aircraft, pack it on Army wagons and transport it to the flight test site. Once it arrived, the aircraft was to be reassembled on-site and put into operating condition within an hour (1:8-9).

In all, forty-one bids were submitted with only three qualifying for competition. The Wrights offered to produce a plane for $25,000 within 200 days, A.M. Herring bid $20,000 and asked for 180 days, and A.F. Scott offered the lowest bid of $1,000 and asked for 185 days.

Contracts were sent to all three bidders, but only the Wrights were able to meet their proposed delivery date. Scott never signed his contract. He knew the construction of an aircraft would far exceed his $1,000 bid, but he only had $100 for the ten-percent deposit required. He was unable to raise more funds and eventually withdrew from the bidding. Herring did sign his contract; however, when he arrived in Fort Meyer it was without an aircraft. He had crashed his entry on Long Island and was unable to repair it in time. Although he was given an extension it soon became clear he could not meet the demand. He asked the War Department to cancel his contract on 1 August 1909. This left only the Wright Brother's bid of $25,000 and the Army accepted their aircraft on 2 August 1909 (11:22). The rest, as is often said, is history.

In July 1909, the Wright Brothers arrived at Fort Meyer, Virginia to complete flight tests cut short by Orville's August 1908 accident. In that accident, Orville was seriously injured and the most qualified Army officer, Lieutenant Thomas Selfridge, was killed (11:1). These final test flights were not initially successful. Orville's unfamiliarity with the newly modified aircraft slowed his efforts at demonstrating its capabilities. "Orville soon succeeded in mastering the new plane. On 20 July he stayed in the air for one hour, twenty minutes, and forty-five seconds (unofficial timing), showing perfect control and making sharp turns at heights then considered great" (3:212). The final Army standard was met several days later.

On 30 July 1909, Orville Wright made the final official flight test for the government contract. With Lieutenant Benjamin D. Foulois as his passenger, he beat the final specification of flying 40 miles per hour with a speed of 42.25 miles per hour. As a reward for exceeding

the standard, the Wright Brothers received an additional $5000. Thus the military purchased its first successful airplane for a total cost of $30,000 (3:214).

The First Mechanic. The Wrights made their mark on history not only as fliers but also as mechanics. It was the mechanic and not the pilot who was first on the scene at the birth of aviation. The Wrights were mechanics first, inventors second, and pilots third. Thus it was normal practice for the pilot-owner to perform the necessary maintenance on his own aircraft. This practice continued until around 1911. As the aircraft became more complex and required more work the aircraft mechanic became more commonplace.

The first dedicated maintenance technician arrived aboard a train with the Wright Flyer at Ft Meyer, Virginia, in August 1908. When Orville Wright brought his aircraft there for flight testing, the first non-flying mechanic came with him (14:17.25). Charley Taylor's presence marked the beginning of the aircraft maintenance career field.

The Start of an Air Force

In 1911, Congress ended the Wright Flyer era with an appropriation of $125,000 for Army aviation. Five of the newest "tractor" aircraft were ordered which had the propeller in front of the crew rather than behind it as the Wright Flyer and early Curtiss "pusher" aircraft had. A permanent flying school was set up at North Island, San Diego, California where experiments with the aircraft continued. A low-recoil machine gun developed by Colonel Isaac Lewis was successfully fired from an aircraft by Captain Chandler, Chief of the Aeronautical Section.

Aerial photography, radiotelegraphy, and bomb sight trials were also carried out (11:2).

The First Aircraft Maintenance Technical Order. Prior to 1911, no forms or technical data (at least as they exist today) were used. In fact, there was no formal aircraft maintenance organization below the division level. Aircraft mechanics received on-the-job training, or OJT as it is called today. If the pilot experienced a problem with his aircraft he would simply debrief, or explain the problem, when he returned. The various mechanics then got together to decide on the most likely cause. Once they felt they had fixed the problem, the pilot would fly the aircraft again to check out the repair (10:6-7). This marked the time when the test flight and test pilots became an essential part of aircraft maintenance.

In April 1911, then Lieutenant Benjamin D. Foulois was assigned the task of creating a formal document to cover the care and maintenance of aircraft, and the training of pilots and mechanics. In July 1911, he completed the document called "Provisional Airplane Regulations for the Signal Corps, United States Army, 1911."

> It included information on the care, repair, and maintenance of an airplane, on the ground; inspection duties and responsibilities of pilots, crew chiefs, and mechanics; and the initial provisional organization of an Aero Company and its sections, including commissioned, enlisted, and civilian personnel initially required to repair, maintain, and operate assigned aircraft. (10:8)

Another important 1911 development was the deployment of two young Army officers--Lieutenants DeWitt Milling and Henry H. Arnold--to Dayton, Ohio, home of the Wright Brothers, for training on the Wright Flyer. They received flight training and were schooled in aircraft construction and maintenance as well. The goal was to make them capable

of instructing the aircraft mechanics when they went to their next duty assignments. To prepare themselves as instructors, the two took large photographs of the aircraft and labeled the individual parts. This is believed to be the first system of nomenclature for aircraft parts (10:8-9).

In May 1913, with the publishing of the US Army Aviation Section Technical Order 00-2A one of the first "official" versions of the crew chief system of maintenance was born. The crew chief system was described as

> a non-commissioned officer provided with several assistants. These assistants were responsible for such tasks as examining all control wires, connections, fittings, turnbuckles, pins, belts, engines, etc. Minor repairs were accomplished by the NCOIC of the airplane under the supervision of the officer (pilot) in charge. Major repairs were made by the chief mechanic. (14:17.25)

Organized Aircraft Maintenance Takes Root. On 18 July 1914, Congress authorized the creation of the Aviation Section of the Army Signal Corps with 60 officers and 260 enlisted men. The aircraft were given to the Signal Corps because "it had been customary to assign anything that was new and experimental to the Signal Corps, the army's scientific branch, for development" (2:315). Just after the start of World War I in Europe, August 1914, the First Aero Squadron was formed under Captain Foulois (11:2). As the squadron commander, he "was responsible for the upkeep and repair of the airplanes, engines, and equipment under his command." The squadron consisted of 20 pilots (officers) and 12 aircraft, divided into three companies of four aircraft each. Each company, headed by a captain, was further divided into four sections, each headed by a lieutenant (10:10).

The actual maintenance work was carried out by the sections. These sections consisted of a first lieutenant pilot, a crew chief, a sergeant, three first class privates, and one private. The officer was responsible for supervising all repairs done to the aircraft (10:10). Aircraft maintenance men came from the enlisted ranks and could be of any grade as long as they passed the Aviation Mechanician examination. This stringent, two-part test was developed by the Signal Corps Aviation School in 1915.

> The first part of the examination required the student to make fittings, ribs, spars, struts, skids and wires; assemble, disassemble and align an airplane; prepare the plane for shipping; stretch cloth on the wing frames and dope it; remove, repair and replace tires. The second part required the candidate to clean the engine, grind the valves, adjust the clearances, time valves and spark; clean magnetos; locate and repair firing systems; adjust the carburetor and locate and adjust ordinary troubles. In addition, the student had to pass a physical examination. (5:27)

In those early days of flying, there remained a close relationship between pilots and maintainers. Pilots were still capable of repairing both their engines and the basic airframe and they acted as their own test pilots as well.

> The early days of flight, in fact through the 1920s, were days of hazard. The aircraft, particularly the engine, was generally unreliable and frequent un-planned landings were made in meadows, or farm fields, and sometimes in trees. If the aircraft was still in flyable condition, the pilot made repairs and, often with local help, managed again to leave the ground and resume his flight. The pilot had to be maintenance capable or he would be unable to obtain charters or passengers--his income source. Nevertheless, the mechanic became more and more important as the pilot's duties (and paper work) became more demanding of his time. When World War I was fought the "mech" had become a positive and essential element of aviation. (9)

Trial By Fire--Unrest On the Mexican Border

In truth, the Army did not use its aircraft in a war until World War I. This is truth only in that the Punitive Expedition of 1916 was not a declared war. To most observers it was simply another border skirmish of the type that had been going on between Mexico and the United States since before the Civil War. For many years the northern part of Mexico and southern United States was haunted by outlaws, both Mexican and American, and Indians. These bands often raided across the border then fled back into their own country to seek refuge. Up until 1916 the Army's role in quelling these attacks was limited to small campaigns normally fought by platoons, troops, companies, and the occasional battalion or calvary squadron. These Army units were strictly forbidden from crossing the border into Mexico (2:xv).

With General Victoriano Huerta's fall from power in July 1914, Mexico again faced civil war. Two factions, one led by General Venustiano Carranza and the other by General Francisco (Pancho) Villa, split the country in half. On 15 October 1915, the United States officially recognized Carranza as the head of the Mexican government (2:186).

In support of the Carranzistas, President Wilson allowed them to reinforce their position against Villa through the United States at Agua Prieta, a small town located directly across the border from Douglas, Arizona. In the next several months, Villa's army suffered a series of shattering defeats at the hands of Carranza's army. Villa blamed his troubles on the United States. Soon he and his army began a number of savage attacks on United States citizens (2:186-211).

Following a particularly brutal attack by Villa on Columbus, New Mexico, 9 March 1916, President Wilson drew together his Cabinet. On the evening of 10 March 1916 a telegram was released to the press. The text was as follows:

> President has directed that an armed force be sent into Mexico with the sole object of capturing Villa and preventing further raids by his band, with scrupulous regard to sovereignty of Mexico. (2:214)

Although the enabling order which followed did not mention Villa by name, it was generally assumed his capture was the purpose of the expedition.

A Short Digression. It is important to mention that while the Punitive Expedition of 1916 saw the first use of American military aircraft outside our borders, it was not the first time the United States intended to use these aircraft. Earlier, in 1911, when the Mexican Revolution threatened American sovereignty, President Taft ordered some 30,000 troops to the border for large-scale maneuvers. The Army had no provision for any tactical organization larger than a regiment, so an improvised unit called the Maneuver Division, under the command of Major General William Harding Carter, was formed (2:146-147).

General Carter had within his command "the new and highly experimental airplanes--three or four airplanes, four or five pilots and a handful of mechanics and technicians." Not only did he use these aircraft for reconnaissance and as fast messengers, but he predicted their importance would increase (2:148).

The Maneuver Division was dissolved in early August 1911 without a shot being fired in battle. Yet, this short episode in American

military history set the initial standard for the use of aircraft in military operations.

Deploying The 1st Aero Squadron--The Punitive Expedition. The 1st Aero Squadron, under Captain Foulois' command, was at San Antonio, Texas, when the order was received to move at once to Columbus, New Mexico for duty with the Punitive Expedition. At that time, squadron personnel included eleven officers, eighty-four enlisted men, and one civilian technician. Its equipment consisted of eight Jennies--JN-2 airplanes, ten trucks (one of which was a mobile machine shop), and one passenger vehicle. As the squadron passed through El Paso two trucks were added by the quartermaster who had hired them locally. The squadron arrived by train in Columbus on 15 March 1916, and immediately began reassembling the airplanes. One was completed and actually took a short test flight that day, and the first actual reconnaissance mission was flown the next day (2:316). As in today's Air Force, the aircraft maintenance personnel were called upon to do more than just take care of the aircraft.

Transportation at Columbus was sorely lacking so the squadron's trucks and personnel were soon pressed into service. Captain Foulois was placed, temporarily, in charge of all transportation. The first shipment of motor trucks for the Expedition arrived several days later. It was made up of seventeen Jeffery "Quads" (four-wheel drive), with knocked-down wagons instead of truck bodies. The squadron, with its portable machine shop and soldier-mechanics, made the necessary conversions to the trucks. It is interesting to note that the members of the squadron were the only qualified military truck drivers at Columbus. The Army had not yet felt the need to teach this skill to any large

numbers because motor vehicles were almost as new as the aircraft and not yet readily accepted in military units (2:316).

In spite of these interruptions, the mechanics managed to assemble all eight aircraft and have them ready for flight by 19 March 1916. That day orders came from General John J. Pershing, Punitive Expedition Commander, to move the aircraft to Casas Grandes, Mexico for immediate service. All eight aircraft departed that afternoon, but it was several days before seven of the eight made it to the destination. One aircraft crashed en-route and was destroyed (2:316).

From Casas Grandes Foulois' squadron flew various reconnaissance and communications missions while the number of serviceable aircraft dwindled. "After one month of operation, only two of the eight planes taken to Columbus, N.M., were in commission and these were considered unsafe for further field service" (6:78). Foulois had foreseen this outcome and had submitted an urgent request for the immediate purchase of ten more aircraft along with enough spare engines and parts to make quick repairs.

Four Curtiss N8s arrived at Columbus in late April 1916. These were little better than the aircraft already in the field. They were eventually rejected and sent on to San Diego where they became trainers. Finally, in May 1916, 12 Curtiss R2s were delivered to Columbus. Although they required modification before they were sent into service, they eventually became the aircraft of the Expedition (6:78).

Many thought the air operation conducted during the Punitive Expedition was a failure; however, many important lessons were learned. First, it became clear that it was "definitely necessary to have a backlog or bunch of airplanes in reserve" to back up those being used in

the field. It was also critical to provide a channel for those actually using the equipment to communicate their needs (6:78). Foulois was adamant about the need to have a base fully equipped for the reception, assembly, test, repair, and alteration of the aircraft. He went on to recommend that planes be tested under field conditions, at varying altitudes, temperatures, and humidities (6:79). Armed with these recommendations, and more, the United States Army Signal Corps began preparing for the future.

A Prelude To War

In Europe, during this same time frame, there was trouble brewing. Germany, under Wilhelm II, sought a political and imperial role consistent with its industrial strength. This expansion was both a challenge to Britain's world supremacy and a threat to France, which still resented the earlier loss of Alsace-Lorraine to Germany. Austria was trying to curb Serbia's expansion (after 1912) and the threat it posed to its Slav lands. Russia feared both Austrian and German political and economic aims in the Balkans and Turkey. All this turmoil resulted in an accelerated arms race throughout Europe. By 1914, Germany had a standing Army of over 2 million men, Russia and France each had over 1 million men, and Austria and Britain had nearly 1 million men apiece (13:509).

The European War Begins

On June 28, 1914, Austrian Archduke Franz Ferdinand was assassinated by a Serbian. The European War had started. United States President Woodrow Wilson officially declared neutrality in the war on

August 4, 1914. World War I was first called the European War because it was based on European alliances. For example, when Germany invaded Belgium to outflank France, Britain entered the war. After declaring war, Britain blockaded Germany. In response to the blockade, Germany began conducting unrestricted submarine warfare against the neutrals (13:509).

After a warning to Britain by Germany, the British ship Lusitania was sunk, 7 May 1915, by a German submarine. Included in the 1,198 passengers killed were 128 Americans. As a result of a campaign by the United States, Germany issued an apology and a promise to make payments. Yet Germany continued the campaign against neutral shipping. Seven months to the day the Lusitania was sunk, President Wilson asked Congress for an increase in military funds. On February 3, 1917, the United States cut diplomatic ties with Germany and officially entered the War on April 6, 1917. The Conscription Law was passed May 18, 1917 and the first United States troops arrived in Europe on June 26, 1917 (13:508-509).

The Development of Pursuit Aviation

During the Punitive Expedition air power proponents proved that the aircraft was a useful vehicle for both reconnaissance and communication. The same was true from the very outset of World War I. Used for reconnaissance, the airplane permitted rapid and efficient detection of enemy troop movements. As battles became stalemates, "each side sought to learn the layout and depth of enemy trench fortifications and the location of gun emplacements." The airplane essentially became the

eyes of the armies. The key to success of reconnaissance missions was freedom of movement (11:28).

As reconnaissance took hold as a powerful tool, the battle to deny the enemy use of the air accelerated. "There is no clear record of who first tried to intercept an enemy reconnaissance aircraft, but it is fairly certain that the attempt was by pistol fire." By the end of 1914 everything from pistols to grenades was employed in the effort to down enemy aircraft. The next step was to provide interceptor escort for reconnaissance aircraft. Soon hostile packs of interceptors fought for control of the skies. The "dogfight" became a standard feature of the aerial landscape above the front lines (11:28-29).

Under the stimulus of these dogfights, pursuit aircraft and tactics rapidly advanced. Initially there were two schools of thought as to what the proper tactics should be for these pursuit aircraft. Observation and bomber aircraft commanders preferred the "convoy," or close protection approach, where the fighters would accompany the formation in close ranks. Ground commanders preferred the "aerial barrage" approach, where friendly fighters would set up a "barrage," or overwhelming quantity of aircraft over friendly front lines. This, they hoped, would deter enemy aircraft from approaching. The Air Service did not agree with either of these approaches (11:29).

They saw these fighters cast not in a defensive role, but rather as offensive weapons. The Air Service decided these pursuit aircraft should "provide indirect protection by means of flexible offensive action in which the pilots could take full advantage of the elements of surprise, position, initiative, and aggressiveness." It was felt that these fighters could be far more successful in a broad offensive role

than in a purely defensive one (11:29). This was the doctrine that pursuit aviation followed throughout the remainder of the war. "In their postwar appraisals of the air experience of World War I, airmen agreed that the first and foremost principle emerging from the war was that air supremacy is the primary aim of an air force" (11:29).

"The Air Service had little to do with the (early) development of pursuit aviation and tactics in World War I. The first American combat unit did not begin active operations until April 1918, a year after the United States entered the war" (11:30). The Air Service adopted the doctrine, training methods, and tactics the Allies had developed and tested and then adapted them to their needs. Even though early doctrine was created mostly by the Allies, it is important to understand the basis of pursuit aviation in the Air Service. In time, this facet of air operations would be joined together with another, tactical air operations, to form what the United States Air Force now calls the Tactical Air Force (TAF).

The Development of Tactical Air Operations

> Tactical airplanes or units are those which carry out operations against (or in the presence of) a hostile force, especially in respect to engaging ground forces or attacking ground targets. Tactical air operations include close air support of ground forces, interdiction or cutting off enemy supplies and reinforcements from the battlefield, and attacks on enemy air installations and forces. (11:31)

Depending on the type of operation, tactical targets might include enemy troops and their weapon systems, light fortifications, rail centers and storage depots, and air strips and aircraft on the ground. To be

considered tactical targets, they would be located in or near the immediate zone of operations (11:31).

In the European War this type of operation gradually emerged as a separate category of aerial warfare. The bombing of tactical targets evolved as a normal part of warfare. Since the aircraft were rather cumbersome, pilots found it safer to carry out this type of tactical operation at night. By late 1915 both the Germans and the British were carrying out night bombing raids on an everyday basis (11:31).

Tests at the Battles of St. Mihiel and Meuse-Argonne. The scale of tactical air operations continued to grow as the war went on. Mass bombings grew in size and intensity as the British took the offensive and pushed the Germans westward. During this time, the greatest concentration of tactical air power took place under the command of General William (Billy) Mitchell (11:32).

At St. Mihiel, on the Meuse River in western Europe, General Mitchell had command of 1,481 aircraft. These were corps and army observation, army artillery, pursuit, day and night bombers, and reconnaissance aircraft. His plan for using these aircraft was simple. He assigned to the ground troops only what aircraft were necessary to carry out their operations. All the rest were put into a "central mass" which was then assigned to "independent" counter-air action until air supremacy was gained. On the day of the attack, General Mitchell positioned two mixed brigades of bombers and pursuit aircraft on either side of the St. Mihiel salient. (A salient is an outward projection, or bulge in the battle line.) These brigades took turns striking the salient, driving off and destroying enemy planes, and attacking all

possible surface targets. This "concentration of force" gave the Allies virtual freedom from the possibility of German air attacks (11:32).

This same tactic, with a slight variation, was used by General Mitchell at the battle of Meuse-Argonne. The only difference was that now the Allies were attacking from the salient instead of against it. General Mitchell took the same tact. He concentrated his air forces on the main axis of the ground advance. By doing so he sought to clear the way and at the same time protect the ground troops. The sheer numbers of German aircraft allowed their air force to enjoy some success against the Allied air force. However, when all the dust had settled Mitchell's use of air power had insured the defeat of the German forces (11:32-33).

Air Doctrine at the Close of the War. General Mitchell's experience and success in the use of air forces were the basis for his generalizations about the best use of tactical aviation. Although these battles clearly illustrated the value of concentrated force, the use of air power was still dependent on the ground mission. Many leaders in the air power arena, including the chief of the Air Service, would jump on General Mitchell's bandwagon. In the spring of 1919 the Tentative Manual for the Employment of Air Service was published. It stated that "in the future, as in the past, the final decision in war must be made by men on the ground, willing to come hand to hand with the enemy. When infantry loses the Army loses. It is therefore the role of the Air Service, as well as that of the other arms, to aid the chief combatant, the Infantry" (11:33) This was the doctrine the Air Service carried with it into the next war.

Aircraft Maintenance in the European War

The entry of the United States into war, in 1917, rapidly increased the need for aircraft mechanics. Pilots were now more concerned with learning aerial tactics and maneuvers than they were with maintaining their aircraft. As the aircraft became even more complicated a new type of mechanic emerged--the specialist.

Specialized Maintenance Takes Hold. In that first year of the War the United States made some big strides in aircraft technology. The basic pre-war aircraft now included several new systems. The armament system consisted of machine guns synchronized to fire through the propellers, "swing" guns on rails in the rear cockpit that could be manually swung to shoot enemy aircraft, and an elementary bombing system. Radiotelegraphs and cameras had also been added. A collection of airplane mechanics from various disciplines, or specialists, was needed to maintain these modern aircraft. These specialists included blacksmiths, cabinetmakers, carpenters, coppersmiths, electricians, fabric workers, sail makers, instrument repairmen, metal workers, motor mechanics, machinists, propeller makers, vulcanizers, and welders (1:12).

Training. In these early days of the Air Service all technicians, regardless of whether they worked on aircraft or not were considered airplane mechanics (1:12). Remember this concept of maintaining airplanes was as new and perplexing as the aircraft themselves. In an effort to "train" these airplane mechanics a plan entitled "Instruction Course for Enlisted Men, Aviation Service" was published in August 1917. The course involved ten weeks of instruction in such areas as electrici-

ty, airplanes, gasoline engines, magnetos, motorcycles, motor trucks, office work, and telegraphy (10:11). Eventually, "the term 'airplane mechanic' came to be applied only to those men who maintained airframes, aircraft engines, and accessories which are an integral part of the plane." The other areas such as armament systems, photography, and radiotelegraphy repair were separated from the basic mechanic's career field and were taught in separate courses (1:12).

The actual training turned out to be the least of the Air Service's problems. The biggest problem by far was recruiting enough mechanic candidates from the civilian sector. The average American mechanic was unfamiliar with the detailed and delicate type of work demanded of aviation mechanics. Many of those civilians possessing the needed skills had been drained off by the draft, enlistments, and war industries. To counter this, the Air Service launched an aggressive two week recruiting drive early in December 1917. Approximately 50,000 recruits signed up, only one-half of the total that would be needed for the War (10:11). The United States had hoped to recruit these mechanics as relief forces for the Allies.

As early as July 1917 American students were filling openings at French flying schools (where mechanics were trained), others had been sent to Italy, and still others to Britain. On 1 June 1918, 16,732 men were training in England. Hundreds of these trainees relieved English mechanics who were then sent to the front for duty (7:202). Training was also conducted by Army technical schools, aircraft factory operated schools, civilian technical schools, colleges, and universities. Of course, OJT was conducted at air bases both in the classroom and on the flightline. The bulk of the Air Service training took place at either

Camp Kelly, San Antonio, Texas or in a rented building in St. Paul, Minnesota (1:13).

Aircraft Maintenance Organization. When the United States entered the War, the Aviation Section consisted of "131 officers, 1087 enlisted men, 5 balloons, and fewer than 250 aircraft" (8:3) of which only 55 were serviceable (4:325). By the end of 1918, the Air Service had grown to 195,023 personnel (12:40) and American manufacturers had produced some 11,700 aircraft (4:327). This rapid growth forced some changes in the maintenance structure.

The Air Service chose to divide maintenance work into four echelons. They were: (14:17.25-17.26)

> First echelon - Maintenance was performed by the aircrew; e.g., servicing the aircraft, performing pre-flights and daily inspections, making minor adjustments and repairs.
>
> Second echelon - Maintenance was usually performed by the ground crew of operating units, air base squadrons, and aircraft detachments; e.g., servicing aircraft and equipment, performing periodic preventive maintenance inspections, making minor adjustments and repairs.
>
> Third echelon - Maintenance was performed by specialized mechanics from base shops and sub-depots; e.g., removal and replacement of major unit assemblies and all minor repairs to aircraft structures and equipment.
>
> Fourth echelon - Maintenance was performed by highly specialized mechanics in air depots; e.g., major repairs, modifications, and overhauls. These depots were located at Dallas, Texas; Montgomery, Alabama; and Indianapolis, Indiana (10:13).

Although each echelon was clearly defined on paper, in practice maintenance sometimes went a little differently. "The amount and kind of work accomplished by each echelon was limited primarily by the available equipment and supplies, and the experience and initiative of the personnel" (1:13). It was a view that Brigadier General Mason M.

Patrick set out to change when he took over the Air Service in May 1918. (10:14).

In August 1918, General Patrick issued Memorandum No. 37. It established a plan for the supply, salvage, and repair of airplanes in the overseas theater. It called for a network of Groups, Mobile Parks, Air Depots, Intermediate Depots, Depots, Acceptance Fields, and Production Centers (10:14). The following paragraphs present a brief description of the different organizations with some exceptions. The Intermediate Depots, Depots, and Acceptance Fields had no repair or maintenance responsibilities directly related to the operational units (10:16).

The lowest level was the Group. It was made up of squadrons which performed maintenance at the local level. Each squadron was designed to operate as independently as possible. The scope of maintenance was limited to minor aircraft repair and engine replacement. The emphasis was on rapid aircraft repair with limited downtime. Maintenance procedures in the squadron were informal. Recall there were no aircraft forms, so the pilot verbally debriefed any malfunctions to the crew chief. "There was no maximum operating time for engines; they were replaced only after failure, if possible" (10:15).

The next echelon was the Mobile Park. These were located a convenient distance from the group(s) they serviced. The Mobile Park consisted of a supply, repair, and salvage unit. It used mobile machine-shop trucks and the equipment needed for some heavy repair (10:15).

If the required work was beyond the capabilities of the Mobile Park it was given to the Air Depot. These depots serviced three or more Mobile Parks with a 30 day stock level. They also did the major

airframe repairs and salvage, but only handled minor engine repairs.

The most important link to maintenance was the Production Center. "These centers assembled the aircraft parts received from the United States into complete aircraft, and were responsible for the overhaul and repair of the aircraft engines." The Production Centers were also capable of some aircraft repair and salvage, although the bulk of the salvage work was done by the Air Depots (10:16).

"This maintenance echelon system proved very effective throughout the remainder of the war. This organizational structure was able to provide the Air Service with a significant increase in combat ready aircraft under the most adverse supply and parts conditions" (10:16).

War Comes To An End

President Woodrow Wilson proposed peace on 8 January 1918. The Germans accepted the armistice on 11 November 1918. What came to be called World War I had ended (13:434).

In less than a year the Air Service drew down to 25,603 personnel and approximately 2000 aircraft. This was 21 times the size of the force before the war but only 13 percent of its peak in 1918 (12:40). It had been only 10 years from the time the Signal Corps had accepted the first airplane from the Wright Brothers. Yet in this short time, the airplane had proved its worth. The Air Service had developed from three men to a highly developed flying and maintenance organization. The Air Service had wanted to maintain their status on par with their Army counterparts--the infantry, calvary, and artillery divisions. This was not to be. When the 1920 budget request of $55 million was trans-

lated into an allocation of only $25 million, plans to maintain and expand the Air Service came to a halt (10:17).

Aircraft Maintenance Issues In Summary

This chapter presented an overall look at the period from the birth of aviation to the end of World War I. It is a combination of the significant events that shaped aviation, tactical operations doctrine, and most importantly aircraft maintenance. The following paragraphs provide a brief summary of the basic aircraft maintenance issues.

Pre-World War I. This period must be considered not only the birth of aviation, but the birth of maintenance as well. This list captures the steps of the development of aircraft maintenance prior to World War I.

1. In the early years the pilot-owner performed his own aircraft maintenance. With his arrival at Ft. Meyer, Virginia in 1908, Mr. Charley Taylor became the first dedicated aircraft mechanic.

2. The recruiting of potential aircraft mechanics was difficult. The aircraft, not to mention mechanization in general, was still quite new to the American scene. This resulted in a shortage of mechanics skilled in maintaining these systems.

3. The learning curve for those first entering the aircraft maintenance career field was steep. It was 1915 before aircraft mechanics were tested for the skills needed to maintain an aircraft.

4. Minimal documentation was available to serve either for reference or historical reporting. Aircraft discrepancies were reported to the mechanics through oral debriefing with the pilot.

5. Initially the task of training mechanics rested with the pilot. It took some time to train enough of these mechanics so they could teach the new recruits through on-the-job training.

6. The mechanic did all the work on the aircraft. There was no specialist support to speak of.

7. Retaining these trained mechanics was difficult.. Once they had been trained they became more valuable to the civilian market.

World War I. The war brought with it a host of new challenges to the aircraft maintainer. The following lists some of the new, and not so new, challenges World War I brought to maintenance.

1. As pilots faced the learning of new aircraft, maneuvers, and tactics they lost their skills as mechanics. This placed much more emphasis on the mechanic and his qualifications.

2. The complexity of the aircraft--adding radiotelegraphy, armament, and photographic systems--created a new breed of mechanic, the specialist. These specialists required training apart from the basic crew chief, so new training courses had to be developed.

3. Recruiting again presented a problem. Most of the skilled civilian mechanics had been drained off by the draft, or enlistments.

4. In the early years, the "airplane mechanic" was lumped into a group that maintained just about any mechanical device the army owned. Eventually, the airplane mechanic became identified separately from other maintenance people.

5. The four level maintenance system brought several changes to training, facilities, the supply pipeline, and even the type of work designed for the mechanics. However, what was on paper did not necessarily reflect the actual maintenance being done.

6. Maintenance forms were just beginning to take shape. This meant the mechanics also had to begin doing paperwork as well as "real" work.

Afterword

The preceding paragraphs sum up the challenges faced by early aircraft maintainers. The following chapter will explore the period after World War I. It begins with a look at conditions in America following the war. The chapter then goes on to explore the changes in the Air Service structure. It concludes with an examination of the effect of peace on the aircraft maintenance career field.

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III. The Interwar Years 1920-1938

The United States In Perspective

The nearly two decades between the World Wars were exciting, challenging, and sometimes frightening times in America. The changes and events that shaped this period spanned the political, social, economic, and scientific arenas; often crossing the boundaries of each. It became increasingly more difficult to separate events into specific categories. For example, what category does the first licensed radio broadcast, 20 August 1920, fit into? Was it a scientific, economic, or social event (8:444)? While this may be hard to classify, determining where America stood on world politics was not. That same year the United States refused to join the League of Nations. In doing so, it signaled to the rest of the world America's intentions to stay out of global affairs. The general feeling was that there was plenty going on at home to keep the country interested.

The 1920s were filled with an amazing array of developments. On 26 August 1920, the 19th Amendment was ratified giving women the right to vote. The Ku Klux Klan began a revival of violence against blacks in the North, South, and Midwest in 1921. In 1923, the first sound-on-film motion picture was shown in New York. The John T. Scopes trial concluded on 24 July 1925. He was found guilty of teaching evolution in a Dayton, Tennessee high school and fined $100. Captain Charles A. Lindbergh left Roosevelt Field, New York on 20 May 1927 alone in his aircraft, the Spirit of Saint Louis. He made the first New York to Paris nonstop flight of 3,610 miles in 33 1/2 hours. Amelia Earhart

followed on 17 June 1928 becoming the first woman to fly solo across the Atlantic. The Stock Market crash, 29 October 1929, closed the decade with disaster. The end of post-war prosperity was marked by an estimated $50 billion loss in the stock market between 1929 and 1931 (8:445).

Following the "crash" America experienced the worst period of depression in the nation's history. Yet even this could not stand in the way of progress in the 1930s. On 1 May 1931, the Empire State Building was officially opened in New York. President Roosevelt appointed Frances Perkins as Secretary of Labor in 1933 as the first woman cabinet member. In an effort to calm the nation, President Roosevelt ordered all banks closed on 6 Mar 1933. In the next 100 days Congress met in special session finally passing New Deal social and economic measures on 16 June 1933. Although in 1933, the United States had some troops stationed outside of its borders it foreswore armed intervention in Western Hemispheric nations that same year. An engineering marvel, the Hoover Dam, was completed in the United States in 1936. It remains one of the highest dams in the world. In July 1937, a little over nine years after her historic flight, Amelia Earhart and co-pilot Fred Noonan were reported lost near Howland Island in the Pacific. To this day their disappearance remains an unsolved mystery. Eighteen years after the first licensed radio broadcast Orson Wells created a nationwide panic with his 30 October 1938 radio dramatization of War of the Worlds (8:445-446).

Status of the Force

The years between the wars was also a time of turmoil and triumph for the Air Service. It faced low budget allocations, reduced manning, and non-acceptance every step of the way. Only a small nucleus of airmen and air leaders saw the great potential of the airplane in future conflicts. The limited American experience in World War I did little to support "their conviction that air power would be the dominant weapon of the future" (5:40). That lack of backing was compounded by the overwhelming American support of isolationism.

Aircraft and Manning. "We practiced isolationism--a separation from the activities of the rest of the world" (2:39). The oceans bordering the continent made the United States feel protected from invasion by potential enemies in the East and West. Relations with Canada and Mexico were stable, so no threat was expected from these neighbors.

> Thus, military forces were small and were charged primarily with the defense of the continental United States. With small manpower authorizations from Congress came small budgets and little or no new equipment. (2:39)

"The total aircraft inventory was less than 2000 aircraft, and they were not very complex machines" (4:19). Manning in the Air Service reached an interwar low of 9,050 by the end of 1920 and an interwar high of 21,089 in 1938 (6:40). Unfortunately, many of those men who left the service following World War I were the mechanics who had been so carefully recruited and trained.

Reorganization. During the interwar years a sometimes vocal and other times subtle battle was being waged for autonomy of the Air Service. In small steps, the air arm began to see some changes. The first was the Army Reorganization Act of 1920. In simple terms this Act

made the Air Service a combatant arm of the Army. While it was not the radical change many air officers sought, it did give the Air Service more autonomy in many areas: research and development, procurement, aircraft supply, support equipment, personnel policies, and training functions. The Air Service also retained some previous concessions in the form of flight pay and the requirement that tactical units be commanded by rated aviators (5:48-49). The passage of this act led to a continued quest for a separate air force.

On 2 July 1926, Congress passed the Air Corps Act. The name of the Air Service was changed to the Air Corps. The new title carried with it a suggestion that the Corps was "capable of independent as well as auxiliary operations." This act again fell far short of the desires for a separate air force, but it did provide the Air Corps with a very important commitment. That commitment was to a five-year expansion and modernization plan for the Air Corps (5:49-50).

As a part of that plan a General Headquarters (GHQ) Air Force was established in 1935. The original GHQ concept called for an air force command organized apart from the support aviation normally assigned to Army units. This concept was not exactly what the Air Corps got. The GHQ, comprised of only tactical units, was formed under the command of Lieutenant Colonel Frank M. Andrews. As the commander, he was to report to the Army Chief of Staff in peacetime and the theater commander in time of war. The Chief of the Air Corps remained responsible for the supply, procurement, and training functions of Army aviation. Although the creation of the GHQ fell short of the desired goal for independence it did "recognize the idea that there was a category of military aviation which need not necessarily support the infantry" (5:51-52).

Pursuit and Attack Aviation Take A Back Seat

Until 1926, pursuit was the basic branch of the Air Corps but the passage of the Air Corps Act changed that. Separating the tactical units from the other units of the Air Corps gave the proponents of bombardment more power in the Air Corps hierarchy.

> In World War I, pursuit aviation was the glamour mission for the pilots. Attack aviation was appreciated also by the ground commanders for its contribution to the harassment of enemy formations. But during the interwar years, both of these missions went into eclipse as doctrinal thinkers established the primacy of bombardment as the chief mission of the Air Corps and the one likely to be of most value in the next war. Although neglected, pursuit and attack aviation were nonetheless represented at the Air Corps Tactical School and had some strong proponents. (%:46)

These changes in the structure of the air arm led to changes in the structure of maintenance throughout the 1920s and 1930s.

The Pendulum Swings Back--The Crew Chief System Revisited

It was a trend toward generalization that replaced specialization in maintenance in the 1920s. The mechanic was again being trained to maintain his entire aircraft. The only exceptions remained the armament, radio, and photographic systems. This, of course, was not a new concept. In fact, it smacked of the crew chief system first introduced in 1913.

By the time a mechanic reached the top skill level he was capable of doing most of the maintenance on his aircraft. When he reached this point he was called a master mechanic. Under this concept, teams of mechanics were formed to work on a specific aircraft. Each team was headed by the master mechanic or "crew chief."

The crew chief was the center of the team. He was solely responsible for the overall condition of his aircraft. "His team maintained the airframe, engine, control systems and accessory systems." The few remaining specialists accomplished any work beyond the crew chief's capabilities (1:16). This system of crew chief maintenance stayed in place until World War II when aircraft complexity, an extraordinary increase in the number of aircraft possessed, and mechanics required to maintain those aircraft forced another shift in the balance between specialization and generalization.

Technical Training--A Casualty of War

Another reaction to the reduced number of mechanics was the immediate closing of all technical schools. To stem the loss of mechanics a 1920 Air Service study recommended four schools, similar to one located in Saint Paul, Minnesota during World War I, be set up in various parts of the country. No action was taken on the recommendation. The only training available remained at Kelly Field, Texas in the "Enlisted Mechanics Training Department." This was eventually moved to Chanute Field, Illinois and was renamed the "Air Corps Technical School."

It was a very informal organization, with a hit or miss schedule. Classes started any time a large enough group of students arrived to take them. The course length was also flexible. The maximum course length was six months, although students were allowed to move through the program more rapidly. The students graduated as soon as they could complete the course work (1:15). This was not as easy as it may sound.

Graduates had to be proficient in aircraft welding, wood working, dope and fabric, sheet metal, hydraulics, electric, propeller, engines, flight controls, and accessory systems (4:18). Money was a real problem for the technical school. The Air Service budget was small and little effort was made at expanding the technical training. "As a result, the training of aircraft mechanics suffered tremendously" (1:15).

By 1930 the Army was only sending veterans to technical schools. A new recruit in the Army Air Corps was made a private in the Regular Army and assigned to an Air Corps station. There he received his basic training on being a soldier. After completing basic training he made application to attend a technical school of his choice and was given aptitude tests. If he was selected to attend a mechanics course his name was placed on a waiting list until a vacancy occurred. This waiting period usually extended anywhere from one to three years. Often the soldier's term of enlistment expired prior to the completion of his training, since the term of enlistment was only three years. Once he completed school he could either elect to reenlist, or separate and return to the civilian sector (1:17).

The mid to late 1930s saw the dawning of a renewed prosperity, so many soldiers opted not to remain in the service. The expanding commercial aviation industry lured these men away with higher wages and the promise of greater opportunities. From 1929 to 1937 the Air Corps lost 15.6 percent of its enlisted corps through failures to re-enlist. Three-quarters of those lost were the trained aircraft mechanics (1:17). This period of peacetime induced other changes in the maintenance structure and policy.

Squadron Level Maintenance

The typical post-war air service squadron maintenance organization was made up of "one engineering officer, who worked for the squadron commander; an engineering section; a shop section consisting of aero repair, engine repair, machine shop, final assembly, and parachute; and an inspector" (4:18). These service squadrons were the forerunners of today's off-equipment maintenance squadrons. They were usually located at the flying fields and performed any maintenance beyond the capability of the crew chief and his crew (4:18).

The air service squadrons initiated another practice still used today--aircraft maintenance record keeping. Aircraft status was documented through several reports. These included "an airplane condition record, the record of receipt of an airplane, the daily crew report, the daily aircraft report, the engine running time, and others" (4:17). Using these forms was quite a departure from World War I where oral debriefing of malfunctions was the standard (4:6). Squadron maintenance was not the only area which experienced change during these interwar years.

Depot Maintenance

During the 1930s the Air Corps was also busy enacting changes in the basic structure of depot maintenance. Recall that during World War I the Air Service had established three depots. They were located at Dallas, Texas; Montgomery, Alabama; and Indianapolis, Indiana (4:13). In the interwar years these depots were reorganized at four new locations. They were San Antonio, Texas; Fairfield, Ohio; Rockwell, New

York; and Middletown, Pennsylvania (1:18). These depots serviced approximately 166 aircraft and 500 engines per year (4:19). Along with this change of location went a change of policy.

In past years, aircraft were sent to the depot for overhaul whenever the station engineering officers felt it necessary. In this context overhaul meant that the aircraft went to the depot regardless of condition. "In 1930 a definite overhaul period was set for each model of airplanes and engines." This interval was first set at 12 months. Over the next six years it gradually crept up to 24 months (1:19). Under current policy, in 1936, this meant that every aircraft went to the depot at 24 month intervals regardless of condition. This system, the Air Corps decided, was not prudent.

So in 1936 the Air Corps reverted to the older method of overhauling the aircraft. This change was a result of the manufacture of all metal, monocoque aircraft. These aircraft were considered superior to the all wood models (7:5). Technical Order 00-25-4, dated 12 December 1936, stated that an aircraft was grounded for reconditioning only when visual inspection revealed the need for repair beyond the capability of lower echelon maintenance. Thus, although time interval was not the driving factor, the technical order did include a list of flying hours and normal elapsed time in months between overhauls for each of the more common aircraft (1:19).

Another change to inspection policy was made about this same time. The inspection process in past years was isochronal, i.e., carried out at specific intervals of days, weeks, or months. This change called for a phased concept of maintenance, one where the inspections were based on hours of operation. The basic schedule included a daily preflight

inspection, 20-hour, 40-hour, 80-hour inspections plus a weekly maintenance inspection (7:5). Preventive maintenance also received a great deal of attention. The emphasis was placed on anticipating and preventing system failures and malfunctions. These actions combined to produce a flexible maintenance inspection system which could be quickly adjusted to meet changing demands (1:19).

Aircraft Development and Maintenance Policy

Aviation research and development, on a limited scale, continued through these years. From 1919 through 1924 the center of this activity was McCook Field, Dayton, Ohio. Between 1919 and 1922 Air Service engineers designed and built 27 experimental aircraft. These activities declined after 1923 for lack of funding and a desire to give private enterprise encouragement in developing aircraft. Despite these cuts, a small nucleus of officers and civilians continued their work at McCook Field. Over the years they made significant progress in the development of bombsights, aircraft cannon, all metal planes, and engines (5:55).

In 1924, the Engineering Division was combined with the Supply Division and Industrial War Plans Division to form the new Material Division. The new division moved just down the road from McCook Field to a new area called Wright Field. Part of the Material Division's duty was to establish maintenance criteria, policies, and procedures. In addition, it was responsible for "exercising authority over all maintenance performed at flying units throughout the Continental United States" (4:19).

The Material Division took a two-step approach to the formulation of maintenance policy. First, maintenance information was gathered and analyzed. "Maintenance information reached Wright Field in any of five ways: (1) Airplane Flight Reports; (2) Maintenance Inspection Reports; (3) Unsatisfactory Reports; (4) Annual Engineering and Supply Conferences; (5) Depot Cost Accounting Reports." Then, based on this analysis, maintenance policy and procedure was established and published. Maintenance policies "were published in Air Corps Circulars, Technical Orders, Technical Letters, correspondence, memorandums, and as policy statements in the cumulative Digest of Air Corps Policies" (4:19). This system, created nearly 70 years ago, forms the basis of the maintenance policy system the Air Force uses today.

Aircraft Maintenance Issues In Summary

This chapter presents a look at the time period immediately following World War I until the buildup of forces for World War II. It was a period of change for the air force and for aircraft maintenance. The following list provides a brief summary of the aircraft maintenance progress and issues from 1920-1938.

1. Generalization again replaced specialization in maintenance in the 1920s. The mechanic was trained to maintain his entire aircraft. The only exceptions remained the armament, radio, and photographic systems.

2. Technical training suffered. The new Air Corps Technical School at Chanute Field, Illinois was a very informal organization, with a hit or miss schedule. Although the maximum course length was six

months, students had to be proficient in many complex tasks to graduate.

3. With the dawning of prosperity in the late 1930s many soldiers opted not to remain in the service. The expanding commercial aviation industry lured these men away with higher wages and the promise of greater opportunities. From 1929 to 1937 the Air Corps lost 15.6 percent of its enlisted corps through failures to re-enlist. Three-quarters of those lost were trained aircraft mechanics.

4. The service squadrons initiated the use of aircraft maintenance record keeping. Aircraft status was documented through several reports. The use of aircraft forms was quite a departure from World War I when oral debriefing of malfunctions was the standard.

5. The introduction of the all metal, monocoque aircraft resulted in a change in depot overhaul procedures. In 1936 the Air Corps issued Technical Order 00-25-4. It stated that an aircraft was grounded for reconditioning only when visual inspection revealed the need for repair beyond the capability of lower echelon maintenance.

6. The interval for inspections was changed from an isochronal concept to a phased concept of maintenance, based on hours of operation.

7. Preventive maintenance also received a great deal of attention. The emphasis was placed on anticipating and preventing system failures and malfunctions.

These changes brought on by peacetime would soon be challenged by war. In the next World War, mechanics would face many more challenges to their abilities.

Setting the Stage For War

Events in Europe and East Asia once more threatened to disrupt peace in the United States. In Germany, years of agitation by violent extremists came to a head with the Depression. A credit crunch caused international bankruptcies and unemployment of some 5.6 million persons in Germany. Nazi leader Adolph Hitler was named Chancellor by German President Paul von Hindenburg in January 1933. He was given dictatorial power by the Reichstag, the lower house of the German parliament, in March. Immediately following all opposition parties were disbanded, strikes banned, and all aspects of economic, cultural, and religious life were brought under the central government and Nazi party control. Severe persecution of the Jews began in 1935. Many of these Jews, along with political opponents and others, were sent to concentration camps where thousands died or were killed. Hitler's expansionism began with the re-incorporation of the Saar in 1935, occupation of the Rhineland in 1936, and annexation of Austria in March 1938 (8:511).

Italy was fast becoming identified with the fascist bloc. "Despite propaganda for the ideal of the Corporate State" the government sought few domestic reforms. An entente, or agreement, was made with both Hungary and Austria in March 1934, followed by a pact with Germany and Japan in November 1937. During the three-year civil war in Spain, 1936-1939, Italy sent between 50,000-75,000 troops in support of General Francisco Franco's extreme right rebellion. Aided by Nazi Germany and Fascist Italy, Franco succeeded in his grab for power. As a final fascist gesture, Italy enacted anti-Semitic laws after March 1938 (8:511).

Events in East Asia were similar to those in Europe. "After a period of liberalism in Japan, nativist militarists dominated the government with peasant support." Manchuria was seized, by February 1932, and a puppet government was established. Inner Mongolia (Jehol) was occupied in 1933. Japan then invaded China proper in July 1937 and was able to take large portions of the country by 1938. The invasion was made easier by the on-going Kuomintang-Communist civil war. The Chinese suspended the civil war in the face of threatening Japan (5:511).

American isolationist sentiment drove Congress to pass the Neutrality Act of 1935. This law forbid the United States from providing financial aid to any country involved in war. It also stated that no protection would be offered to American citizens who entered a war zone. In 1937 this law was modified by the War Policy Act which gave the President some discretionary power. However, this act also reaffirmed American neutrality and forbade the sale of any war materials to any hostile nation (3:10). Several more years would pass before the nation would find itself caught up in the business of war.

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IV. From Isolationism To World Power 1939-1945

The United States In Perspective

Throughout most of the 1930s, the United States was busy with its own internal problems. The country, still reeling from the effects of the Depression, was indifferent to the affairs of other nations. In affirmation of these feelings, President Roosevelt officially declared neutrality in the European War on 5 September 1939 (14:446). This was to be a short lived proclamation.

War was breaking out all over. In Europe, the Nazi-Soviet non-aggression pact of August 1939 freed Germany to attack Poland in September. Britain and France then declared war on Germany. By July 1940, Russia had seized East Poland, attacked Finland, and taken the Baltic states. From April-June 1940, mobile German forces staged "blitzkrieg," or lightening war (9:144), attacks in which they conquered Denmark and Norway, and defeated France. Italy joined Germany as the "Axis" in late 1937 and German-Italian campaigns took the Balkans from Russia by April 1941. Three million Axis troops then invaded Russia in June and kept marching until they reached the outskirts of Moscow and occupied Leningrad, but were defeated there by a combination of winter, logistics,and Soviet determination. A similar picture was taking shape in Asia.

When war broke out in Europe Japan announced it would not get involved in the European struggle. However, the events in Europe gave Japan a freer hand in the East. The West, occupied by its own problems, paid little attention to Japan's growing demands. Japan took advantage of this Western preoccupation to improve both its strategic and economic

position. In March 1939, the Japanese army began pressing Germany for a full alliance. Germany was only too glad to oblige the Japanese, knowing an alliance would strengthen its own position in Europe. Once the Tripartite Pact was signed (to include Italy), in September 1940, Japan was able to turn its attention to courting the Soviets. On 3 April 1941, the Soviet-Japanese Nonaggression Pact was signed eliminating the Soviet Union as a rival in China. The only threat to Japan's plan to take over China was the United States (2:360-361).

"Meanwhile the United States was moving cautiously away from neutrality" (2:361). The first year of the new decade, 1940, bore witness to these changes. Congress repealed the 1937 War Policy Act, clearing the way for weapons sales to Britain and France. Fifty over-age destroyers, still useful for anti-submarine patrols and convoy duty, were transferred to Britain in return for the rights to maintain American military bases in certain Atlantic British territories. This was quite a departure from America's declared neutrality stance. Further evidence of United States preparation for war came with the Congress' 1940 approval of the first peacetime draft in American history.

During President Roosevelt's third term, in 1940, "he called for making the United States the 'arsenal of democracy'." The Congress agreed and passed the Lend-Lease Act on 11 March 1941 (2:361). The Lend-Lease Act gave the president the power to "...sell, transfer title to, exchange, lease, lend, or otherwise dispose of any defense article to any country whose defense the president deemed vital to the defense of the United States" (6:21). At this same time, British and American military leaders were discussing how the forces would be used "when the United States might enter the war" (2:361).

On 14 August 1941, President Roosevelt and British Prime Minister Winston Churchill issued the Atlantic Charter, an 8-point proclamation of the goals of the free world (14:446). The United States and Britain sought (7)

1. No new territories.
2. No territorial changes without the consent of the people involved.
3. The right of self-determination.
4. Free trade.
5. Joint economic development.
6. Freedom from fear and want.
7. Freedom of the seas.
8. Abandonment of the use of force.

Japan began to believe that America's commitment to the Atlantic war would further distract her from the East. Japan was mistaken. "The United States policy of aid to Britain in Europe was accompanied by a growing resolve to resist Japanese aims in the Pacific" (2:361). This led to a period of increasingly stringent economic sanctions that culminated in the freezing of all Japanese assets in the United States following Japan's 1941 invasion of Indochina (2:361-365).

The United States and Japan continued to "negotiate" a resolution to their differences throughout the summer and fall of 1941. On 26 November, Secretary of State Cordell Hull presented Japanese Ambassador Nomura Kichisaboro with a comprehensive proposal for a peaceful settlement. Japan gave her final answer to that proposal in the pre-dawn hours of 7 December 1941 (2:363).

The attack on the United States Pacific Fleet in Pearl Harbor claimed

> 3,963 casualties--896 wounded and 3,067 either killed, dead of wounds, or missing and declared dead. The battleships Arizona, California, Oklahoma, and West Virginia were sunk; and the Nevada was beached to avoid its sinking. The auxiliary vessels Utah and Oglala were also sunk. The other battleships in the harbor,

> Pennsylvania, Maryland, and Tennessee, the cruisers Helena, Honolulu and Raleigh, the destroyers Shaw, Cassin and Downes, and the auxiliaries Curtis and Vestal were seriously damaged. A total of 249 airplanes (patrol, fighter, scout bombers, torpedo bombers, battleship and cruiser planes, and utility and transport planes) were destroyed. (8:74)

On 8 December 1941 America was at war with Japan. After Germany and Italy declared war on the United States, President Roosevelt declared war on both countries on 11 December 1941 (14:448). The nation departed from the sanctuary of isolationism. America was on the course to becoming a world power.

Building the Force

The United States had anticipated the possibility it may have to join the war effort. The services had begun a slow expansion program two years prior to the declaration of war against Japan, Germany, and Italy. No one could have guessed how much manpower and material would be put into service by war's end.

Aircraft Status. During the early interwar years pilots flew surplus World War I aircraft since there was no money to buy new ones. Between 1 July 1920 and 30 June 1921, 69 airmen were killed and 27 seriously injured in a total of 330 crashes. These old aircraft took a heavy toll on the force of less than 900 pilots and observers (11:55).

Of the 16,300 aircraft purchased during World War I, some 2000 aircraft were all that remained at the close of the War (11:55;4:19). By 1 July 1924 only 754 of these aircraft were serviceable. "These included 457 observation, 59 bomber, 78 pursuit, and 8 attack airplanes." This pathetic state of the Air Service led to the five-year expansion program included in the Air Corps Act of 1926. "This program

called for a five-year buildup of the Air Corps to 1,800 aircraft, 1,650 officers, and 15,000 enlisted men" and had a target completion date of 30 June 1932 (11:55). Later, World War II pushed these numbers far beyond those planned for in the five-year expansion program but those days were yet to come.

Between 1939 and 1944 the Army Air Forces aircraft inventory went from 2,422 aircraft to 78,757 with United States involvement in World War II (13:8). Although this tremendous growth in aircraft did not happen overnight it did take place very rapidly. This much growth in equipment and the need to operate in 12 major war theaters outside of the continental United States required a massive pattern of expansion in Army Air Forces manpower .

Manpower. The recruiting of a force large enough to meet wartime demands became an immediate concern following Hitler's 1939 invasion of Poland. The peacetime economy was in a state of growth as industry began supplying the Allies. While the conditions surrounding the Depression created a workforce eager to join the military in the 1930s, by 1940 the situation had reversed. In response to the reduction in enlistment rates Congress passed America's first peacetime conscription act, the Burke-Wadsworth Bill, on 16 September 1940 and President Franklin D. Roosevelt signed it into law (5:39).

The law officially became titled "The Selective Training and Service Act of 1940." It authorized the draft of male citizens, between the ages of 21 to 35, for 12 months of military service. Less than a year after the United States entered the war the age range was lowered to 18 and the length of service was extended to "for the duration." Throughout the war more than 45 million men registered for the draft.

Some 31 million were found eligible to serve, and about 15 million of those served with the armed forces between late 1940 and the end of the war in 1945 (5:39-40).

Pursuit and Attack Aviation

During the interwar years pursuit aviation suffered from the same neglect as the rest of the force. Even after America's air leaders observed actions in Europe they were unable to come to an agreement on the role of pursuit aviation. The mission of pursuit aviation was largely seen as one of air defense through interception of enemy bombers, yet it also included the role of escort to bomber aircraft. These two roles required different types of aircraft, the interceptor and the long-range escort. Compromise was considered the answer and the decision was made to produce one fighter to fulfill both roles. The resulting single-seat aircraft, like the Curtiss P-40, did not satisfy either requirement and development of two separate fighters continued. One success story was the Lockheed P-38 Lightning (11:72). The P-38 was designed for high altitude interception but it was later used for long-range escort duties (7). "The unusually configured Lightning was built in smaller numbers than any of the other major US Air Force fighters of the Second World War--a total of 9,923 were produced between 1939 and 1945--but it had the distinction of serving on most battlefronts and in most roles" (3:89). The solution to the interceptor problem was simple compared to that of the long-range escort requirement (11:72).

Interceptors were designed to be quick and maneuverable, with a relatively short range. Aircraft such as the Bell P-39 Airacobra and

Lockheed P-38 Lightning seemed the most promising as interceptors. The problem was with the long-range escort and the Army's decision to pursue a multi-seat escort aircraft. No such aircraft had been developed and serious doubts were raised by experienced pilots as to the fitness of such an aircraft. In a December 1939 conference these pilots expressed their belief that such a fighter would be too slow and would be just as vulnerable as the bombers they were to escort. As a result, when America entered the war it had no long-range fighter to perform the important escort function (11:72).

Attack aviation experienced similar problems. The air leaders had always been opposed to developing aircraft specifically for ground support. Yet, success on the Russian front in the Fall of 1941 spurred efforts to develop a dive bomber to provide some ground support. This aircraft was to be smaller, more maneuverable, and equipped with cannon, machine guns, and small bombs for use against enemy armor. Eventually, several standard pursuit models were used to support this mission (11:72).

Developments in both pursuit and attack aviation continued throughout the war. New aircraft, tactics, and organizations were tried with much of the development based on the particular theater of operations in which the airmen were operating. Aircraft maintenance in World War II developed in much the same way: most alterations from the pre-war and early war standard system came in the several theaters of operation as needs seemed to dictate.

Maintenance Manpower

Over two million of those 15 million who served the nation found themselves serving in the Air Corps. In 1939 Air Corps manning stood at 23,455, but by the close of the war some 2,282,259 saw service as members of the air arm (12:40). Many of those who served were trained as aircraft mechanics.

Training. In September 1940, the Air Corps approved a plan to train 25,348 mechanics by 1 January 1942. However, as the threat of war grew, this plan was changed to allow for the training of 65,500 mechanics per year. When America entered the war the training of mechanics stepped up to a pace where, by January 1943, 185,000 mechanics per year would be trained (1:20).

The requirements for skilled maintenance personnel far outweighed their availability. Before long the six month course taught at Chanute Field, Illinois was changed to get mechanics to the field sooner. "The course length was shortened and the 'crew chief' method of training was replaced by more and more specialized training" (10:21).

In 1943, the Army Air Forces realized attrition among the mechanics was very low. This meant fewer replacements were needed in the field. As a result the emphasis in training shifted away from quantity training to quality training. In addition, enlisted aircrew members were again given a basic mechanics course to aid them in solving simple mechanical problems (1:23).

The Specialist System of Maintenance. The crew chief system which developed during the interwar years was soon replaced by a specialist

system. This system was born of necessity--a need for more narrowly skilled workers, trained in minimum time, to meet the huge wartime demand for competent manpower. By 1942, technical schools were training mechanics on a specific type of aircraft in classes which lasted as little as 36 days (10:21). The mechanics graduated from these schools were identified with a particular type of aircraft although they really possessed little in-depth knowledge of it or their general specialty (1:21). Nevertheless, they did become effective producers of mission capable aircraft and systems (7).

The high demand for skilled mechanics in the overseas theaters forced a return to the World War I concept of maintenance. New maintainers were taught narrow work requirements and sent to the field to perform repetitive tasks. "Crews were established to perform such specialized work as cylinder changes, engine changes, or propeller changes" (1:21). Other ways of getting these skilled mechanics to the field included "the immediate assignment of draftees and enlistees, who were qualified welders, painters, sheetmetal workers, etc, in civilian life directly to the appropriate maintenance shop, with no formal schooling" (10:22). With such a high degree of specialization, the master mechanic eventually disappeared.

The loss of the master mechanic led to a modified crew chief concept of maintenance.

> The service and repair personnel of a squadron were organized into ground crews, each of which was responsible for the service and maintenance of a particular plane. The ground crews consisted of aircraft mechanics and specialists. Each crew was supervised by a crew chief and the crew chiefs were supervised by a line chief who was a master sergeant. (1:22)

Although the job description for an aircraft mechanic remained very broad it was a team and not an individual which maintained the aircraft in working order. These changes in maintenance manpower were reflected by similar changes in the aircraft maintenance organization.

Aircraft Maintenance Organization

On 20 June 1941, the United States Army Air Corps became officially known as the United States Army Air Forces (AAF). The AAF used the same four echelons of maintenance as those used in World War I. The system was formalized in the United States Army Air Forces Regulation 65-1 published on 14 August 1942. The echelons were defined as follows:(6:119)

> First Echelon - That maintenance performed by the air echelon of the combat unit. This would normally consist of servicing airplanes and airplane equipment; preflight and daily inspections; minor repairs, adjustments, and replacements. All essential tools and equipment must be air transportable.
>
> Second Echelon - That maintenance performed by the ground echelon of the combat unit, air base squadrons, and airways detachments. This would normally include servicing airplanes and airplane equipment; performance of periodic preventative inspections and such adjustments, repairs, and replacements as may be accomplished by the use of hand tools and mobile equipment authorized by the Tables of Basic Allowance for issue to the combat unit. This includes engine change when the organization concerned is at the location where the change is required. Most of the tools and equipment for 2nd echelon maintenance can be transported by air, but at certain times such as transportation, radio, etc., necessitate ground transportation.
>
> Third Echelon - That maintenance performed by service groups and subdepots. This maintenance embraces repairs and replacements requiring mobile machinery and other equipment of such weight and bulk that ground means of transportation is necessary. Units charged with this echelon require specialized mechanics. This echelon includes field repairs and salvage, removal and replacement of major unit assemblies, fabrication of minor parts, minor repairs to aircraft structures and equipment. Normally, this

echelon embraces repairs which can be completed within a limited time period with the period determined by the situation.

Fourth Echelon - That maintenance performed by the air groups and air depots. This includes all operations necessary to completely restore worn or damaged aircraft to a condition of tactical serviceability and the periodic major overhaul of engines, unit assemblies, accessories, and auxiliary equipment; the fabrication of such parts as may be required in an emergency or as directed in technical instructions; the accomplishment of technical compliance changes as directed; replacement, repair, and service checking of auxiliary equipment; and the recovery, reclamation, or repair and return to service of aircraft incapable of flight.

The main difference between these descriptions of the maintenance echelons and those used prior to World War II is the inclusion of the requirement that equipment be air transportable. This was essential for mobile repair teams or for squadron movements.

The location of these maintenance facilities varied little between the theaters. In the Pacific, most were located in tents while in Europe they found shelter in tents, Quonset huts, or other buildings. Certain shops were mounted in fully enclosed semi-trailers. Each had its own power and compressed air source which made these shops self-supporting. Some shops, like the instrument and bomb sight shops, required air conditioning making them a popular place to visit on hot days (6:120).

Squadron Level Maintenance In The Continental United States (CONUS). The distinction between aircraft maintenance, as organized in the CONUS, and that of other theaters is deliberate. Generally, in World War II, the Headquarters Army Air Forces (and Air Service Command) instructions were mandatory only in the CONUS. Overseas, theater commanders could use, modify, or ignore these instructions--other than Technical Orders. As a result, each theater maintenance operation was somewhat unique: no two were exactly alike, and none were like those in

the CONUS. For example, in 13th Air Force (AF), there was no prescribed maintenance organizational structure other than what was given in the Tables of Organization and Equipment (TO&E). Production Line Maintenance, as described below, was not used in 13th AF, and the squadron engineering officer oversaw the maintenance effort rather than being controlled by the group engineering officer. The squadron accomplished the maintenance pretty much as it saw fit considering resource availability, scheduling requirements for the aircraft, and the technical skills of the personnel guided by the technical orders (7).

Within the CONUS, the maintenance structure was quite different. The first and second echelon ground crews were normally grouped into specialties to make maximum use of their training and to allow many mechanics to work on the airplane simultaneously. For instance, one "group could check spark plugs while another checked radios, while still another group checked landing gears, etc." (1:22)

These echelons operated within the maintenance section of a CONUS combat group. Each maintenance section was under the supervision of the group engineering officer who was responsible to the group commander for all maintenance actions. They were further divided into two branches--Flying Line Maintenance and Production Line Maintenance--under the supervision of an assistant engineering officer (10:24).

The Flying Line Maintenance Branch was made up of four units including: maintenance, servicing, armament, and communications. The branch was responsible for servicing; pre-flight, daily and 25-hour inspections; proper accomplishment of aircraft forms; loading of munitions; all contact with the air crew; replacement of aircraft engines if downtime could be minimized; and accomplishment of technical

order changes (10:24-25). In 1944, "the Air Service Command calculated the following numbers of personnel to be sufficient to properly perform the duties of the Flying Line Maintenance Branch" (1:23-24).

TYPE OF AIRCRAFT	NO. PER AIRCRAFT
Heavy bombardment - B-17/B24	6
Medium Bombardment - B25/B26	4
Large Cargo - C54/C87/C47/C33	4
Twin Engine Fighter - P38	3
Single Engine Fighter - P39/P40/P47/P51	2

The Production Line Maintenance Branch

> was responsible for washing and cleaning the aircraft, accomplishment of the 50-hour, 100-hour and other periodic inspections not accomplished by the Flying Line Maintenance Branch, engine changes, technical order changes beyond the capability of the Flying Line Maintenance Branch, changing major assemblies, metal repair, maintenance and servicing of flight line and hangar equipment, and preparation of engine and aircraft for return to supply. (10:25)

The following 14 units, or functions, were organized to carry out these duties: cleaning, cockpit and cabin, flight controls and surface, hydraulic and landing gear, engine, fuel and oil, electrical, instrument, propeller, armament, communications, metal repair, ground equipment repair, and parachute (10:25).

In 1945, the Army published a regulation which formalized maintenance specialization. United States Army Strategic Air Force Regulation 65-1 created specific organizational elements. These included "flight line maintenance, scheduled maintenance, servicing, engine buildup, tire buildup, and combat maintenance officer positions. A wing maintenance control function was included to provide strong centralized control." It was believed that this new organization was responsible for reducing overall aircraft out-of-commission rates for maintenance from 21.5

percent in 1944 to 17.9 percent in 1945 (15:17.27). It is interesting to see how statistics were already being used to capture the effects of management changes on maintenance production. This method of justification remains with the Air Force today.

Depot Level Maintenance. During World War II the depot system expanded to 12 air depots and over 2000 sub-depots. Since wartime expansion could not keep pace with demand some contract overhaul was used during the war (15:17.27). Heavy maintenance was normally performed by the sub-depots located on the air base and under the control of the Air Service Command (later the Air Technical Service Command). Mobile repair activities were created to allow for major repairs and assistance on site where no sub-depot was located (10:22).

In late 1944 the Army Air Forces delivered the first floating depot to the Philippines. This depot was built on a Liberty-type vessel, supported by several smaller maintenance ships. By the time this first depot arrived it was too late. The Philippine Islands had become a stable base of operations. The manpower and equipment was removed from the ship and put to work in a land-based depot facility. Although the floating depot was not successful in World War II, the idea was used later in the Vietnam War as a helicopter maintenance platform (6:121).

Aircraft Maintenance Issues In Summary

American maintenance personnel faced some pretty tough challenges in World War II. They kept aircraft flying in regions of the world most of them had never even heard of. They braved the elements, supply

shortages, and a lack of training and experience, and came through with flying colors. The success of the aircraft maintenance operation in World War II, given the sheer number of aircraft and personnel placed in diverse operating conditions, is a testament to the leadership and dedication of the aircraft maintenance troops.

The following offer a brief recap of the maintenance situation in World War II:

1. "The Selective Training and Service Act of 1940" authorized the draft of male citizens, between the ages of 21 to 35, for 12 months of military service. In less than a year after the United States entered the war the draft age was lowered to 18 and the length of service was extended to "the duration." The draft brought many unskilled aircraft mechanics into the maintenance units, forcing changes in organizational structure and training.

2. Although the four echelon maintenance system of World War I remained, it was altered. The main difference was the inclusion of the requirement that certain equipment be air transportable. Maintenance units below depot level were expected to be highly mobile and capable of working in unimproved conditions.

3. First and second echelon ground crews were grouped into their specialties in some theaters of operation to maximize their use. This meant many mechanics might work on the airplane simultaneously under the general control of the crew chief. This was a direct departure from the crew chief concept of maintenance practiced in World War I where the crew chief performed the majority of maintenance on his aircraft.

4. Two branches were formed to perform squadron level maintenance in some theaters and the CONUS Air Training Command. The Flying Line

Maintenance Branch, the forerunner of today's Aircraft Maintenance Unit, performed servicing, pre-flight, light inspections, and other daily tasks. The Production Line Maintenance Branch, the forerunner of today's off-equipment maintenance squadrons, performed the more time consuming and technically complicated tasks not directly involved with the day's flying. The process of formalizing this concept of maintenance laid the foundation of the maintenance organization that still exists today.

5. The requirements for skilled maintenance personnel far outweighed their availability. Training courses were shortened and the crew chief method of training was replaced by one of more specialized training--narrower tasks and quicker training.

6. The crew chief was assisted by specialists. The mechanics were identified to a particular type of aircraft although they really possessed little in-depth knowledge of it.

The years following the war brought radical changes to aircraft maintenance. These changes were founded mainly in the experiences of World War II. Those who served had left behind a legacy that would shape maintenance policy in the interwar years.

War Comes To An End

By the spring of 1945 United States, British, Free French, and allied troops were on Germany's doorstep. Germany surrendered on 7 May 1945 bringing to a close the European War. The defeat of the Japanese was quite a different matter. The dropping of two atomic bombs, the first on Hiroshima and the second on Nagasaki, finally forced Japan to

surrender on 14 August 1945 (14:512). World War II had made its way into every aspect of American life. It changed the way the United States would see the world and how the country would be seen by every other nation in the world.

Demobilization following the war is described in most literature as "rapid." During the war some 750,000 United States Army Air Forces' personnel were performing aircraft maintenance. Two years after the close of the war the number of maintenance personnel had dropped to 56,000 (4:8-6). Most of the maintainers who left the service were in the lower ranks. This led to a condition where there were "too many chiefs and not enough indians" to maintain the aircraft fleet. Many other problems, such as confusion over centralized maintenance concepts, also developed as a result of demobilization. These problems will be investigated in the next chapter.

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V. A Short Respite: From World War II to Korea 1946-1950

The United States In Perspective

The few years between World War II and the Korean War were uneasy years in America. United States participation in World War II had thrust the nation into the spotlight as a world leader. It was a new experience for a country once dedicated to letting the world solve its own problems. In these years, changes took place in both the national and international scenes which would affect America for decades. Chief among these changes were the events leading up to, and culminating in, the Cold War.

In contrast with the rapid demobilization of the United States military forces, the drawdown of Soviet armed forces progressed much more slowly. In fact, for practical purposes, the Soviet military did not demobilize. Author, and military historian, James A. Huston outlined Soviet forces in the aftermath of World War II.

> Soviet Army strength dropped to about 2.5 million early in 1947, and stabilized there, at least for the next six years. In addition to Regular Army troops, Russia maintained some 400,000 security police. Also to be counted on the side of Soviet strength were some sixty-eight divisions in the satellite coun tries of Eastern Europe, and twenty-four regiments of East German "police" forces. Not to be discounted were the Communist fifth columns to be found in the countries of Western Europe, where they interfered with logistical operations of ports and lines of communication, and hampered industrial production. (2:601)

The United States government recognized the Soviet Union as a threat to the nation and the world. In 1947, President Truman presented the Truman Doctrine to Congress requesting aid to Greece and Turkey to combat communist expansionism. Congress approved his proposal, on 15 May 1947, thereby opening the door for other future aid programs. A

couple of weeks later, Congress approved the Marshall Plan as well. This plan called for financial aid to Western European countries in an effort to restore economic stability and capability. On 4 June 1947, Congress authorized some $12 billion in aid to be spread over a four year period. The money went toward revitalizing and improving industry, agriculture, and business concerns throughout Western Europe. (9:446;5).

The alliance of the United States, Canada, and 10 Western European nations was accelerated by the Soviet blockade of Berlin of 1948-1949. If there was any doubt about Soviet intention, it was removed by this action. On 24 August 1949, the North Atlantic Treaty Organization (NATO) was formed. Initial NATO members included Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, United Kingdom, and the United States (9:781). "The United States, together with those European States and Canada, committed itself not only to come to the assistance of any member attacked in the North Atlantic area, but to contribute to a program of mutual materiel assistance" (2:602). NATO provided for the

> consultation among the parties, but it did not envisage an active military organization. Two events changed its character--the announcement in September 1949 of an atomic explosion in the Soviet Union and the Communist attack in Korea on 25 June 1950. The immediate fear of Europeans was that they might be next. France inquired in August 1950 if the United States was prepared to contribute ground forces for the defense of Western Europe and whether forces of the Allies should be integrated under a supreme commander. The reply of the United States was an unprecedented affirmative on both counts. (2:602)

The fight against communism had begun.

Evidence of this battle was found in the heart of America. In late 1949 eleven leaders of the United States Communist Party were convicted after a nine-month trial in New York City. They had been

charged with advocating the violent overthrow of the United States government. Ten defendants were each sentenced to five years in prison and the eleventh defendant to three years. The appeal traveled to the Supreme Court and the convictions were upheld by the Court in 1951 (9:446). Although the fear of communism dominated the social fabric of the United States in those years, a few other social developments merit attention.

One example of social change in America came when baseball player Jackie Robinson broke the color barrier in major league baseball when he joined the Brooklyn Dodgers 11 April 1947. Labor unrest also permeated these years. The miners organized a strike of some 400,000 mine workers in April 1946, and other industries soon followed suit. In an attempt to curb more strikes, the Taft-Hartley Labor Act was introduced. President Truman vetoed the bill on 20 June 1947, but Congress overrode the veto. In 1950 President Truman found himself on the other side, fighting to prevent a railroad workers strike. On 27 August 1950, President Truman ordered the Army to seize all railroads to prevent the general strike and the railroads were not returned to the owners until 1952 (9:446). Despite the labor unrest in some quarters, economic conditions in the United States remained stable.

Status of the Force

At the end of World War II, 1945, Army Air Force manning stood at 2,282,259. In only one year that number had dropped to 455,515 and by 1947 it had dropped even further to 305,827. Between 1948 and 1950 Air Force manning numbers fluctuated. The Air Force had 387,730 men in

1948, then the number rose slightly to 419,347 in 1949, but by 1950 it had fallen to 411,277. During the interwar period, 1945-1950, average manning was 395,939 (8:40). Aircraft maintenance manning reflected the overall reductions in Air Force manpower numbers.

In the peak years of the war the Army Air Forces had some 750,000 airmen performing maintenance. When the United States Air Force was created by the National Security Act of 1947, those numbers had been reduced to only 56,000 airmen (3:8-6). These small numbers placed the maintenance organization in dire straits. At some bases officers were pressed into duty as aircraft and engine mechanics where they performed periodic inspections. "Very often it was necessary to route an aircraft completed by these officers through a work station manned by NCOs (non-commissioned officers) to assure the work had been properly and safely accomplished" (4:151). This, and other slowdowns in maintenance, including a return to a "peace-time" military, resulted in unrealistic flight schedules and an overall loss of combat capability (4:151). It did not take the Air Force long to recognize the seriousness of the situation and take some steps to remedy it.

Development Of Maintenance Policy

> With demobilization came a decline in the interest of maintaining strong, centrally controlled maintenance organizational concepts and procedures. Each major command had its own concept of how a maintenance organization should be organized and controlled. Each command had its own regulations, manuals, and directives. Most of them had a tendency to return to a modified type of the crew chief system which included considerable specialization in certain aircraft subsystems. (1:25)

This diversity in maintenance concepts caused many problems. In an attempt to standardize the maintenance organizations the Air Force

issued an order in July 1947 for all commands to implement the "Hobson Plan."

> This plan made the wing headquarters the highest echelon on a base. Subordinate to the wing headquarters were four groups: the combat group, the maintenance and supply group, the airdrome group, and the medical group. Combat squadrons within the combat group had the responsibility for the first and second echelon maintenance on assigned aircraft. This included engine changes. The maintenance squadron within the maintenance and supply group was responsible for third echelon maintenance and all maintenance on base flight and transient aircraft. (1:26)

The adoption of the Hobson Plan was only one step the Air Force took toward stabilizing the maintenance complex.

In 1948, Headquarters United States Air Force (USAF) sent out a survey to each Air Force command in the United States and overseas. The goal of the survey was to gather representative opinions about USAF maintenance practices. Headquarters planned to discuss, in conference, the problems identified in the survey results, and develop "an orderly plan of research, study, and corrective action" to deal with the problems. Out of the mass of information gathered by the survey, the Maintenance Division of Headquarters, USAF produced a small volume which examined maintenance practices and suggested some changes. The Maintenance Division hoped these changes "would increase the effectiveness of the peacetime maintenance organization; would reduce maintenance costs; and finally, would provide a sound basic organization for mobilization expansion" (10:141). This was, and is, a very important concept for maintenance. These goals for the maintenance organization have been the mainstay of maintenance improvement efforts throughout the years. The following paragraphs outline the survey results and some of the strategy used to tackle the identified problems.

Maintenance Problems

Manpower Shortages. The post-war economy offered a lot more to the average worker than in previous years. Industry, it seemed, had learned some lessons. Job security, retirement benefits, and higher pay--especially for skilled workers--were available in the factories as well as in Civil Service. The workers found big industries competing for their skills and so they were unwilling to work in lower-paid government jobs. "Likewise, the young fellows just released from military service did not show any great longing to re-enlist." The Air Force expanded its training facilities to offer technical training in exchange for time served, but the response by Civil Service and military personnel was not overwhelming (10:142).

Consequently, in the years following World War II, there were not enough people available to do the maintenance work. This lack of personnel was complicated by the increasing complexity of Air Force equipment. "Air Force maintenance men were confronted with an interesting array of tricky, delicate gadgets which had no counterparts in industry. And in case of an emergency, there would be no industrial sources of manpower to draw from" (10:142).

Mechanical Problems. The Cold War further complicated this issue by stimulating the Air Force to produce even more sophisticated equipment. This was done rapidly and the service testing and engineering phases were often bypassed. Thus, this accelerated production often resulted in aircraft which were not easily maintainable.

> Designers and buyers of military airplanes never have shown much consideration for the maintenance man. During the late 1940s and early 1950s, while the West was looking anxiously eastward and wondering what was cooking behind the iron curtain, airplane

> people seemed even less concerned with maintenance than before. Designers were urged to make their dream birds fly higher, faster, and longer. Performance was what was wanted; what happened between flights was of less concern. Consequently, the Air Force gave maintenance features such a low priority in determining the military characteristics of new aircraft that airplanes were accepted which almost defied the maintenance mechanic. (10:142-143).

The concept of reliability and maintainability (R&M) had not yet taken root.

An example of this disregard for R&M was the F-84 Thunderjet. It was nicknamed "the mechanic's nightmare" because it spent 66 hours in maintenance for every hour flown during its first year in the Air Force inventory. Modifications improved the F-84, but not without considerable costs in time, money, effort, and bitterness (10:143).

The Specialist Solution. The days when a talented crew chief and his team were assigned to an aircraft evaporated in World War II. "The Air Force and the aircraft industry had learned that even the most complex systems, when broken down into their basic components, could be overhauled satisfactorily on a production-line basis by unskilled workers within a short period of time" (10:144). Strategic Air Command (SAC) took the lead in establishing a new maintenance organization under the specialized concept.

In 1949, SAC Regulation 66-12 was published. The stated purpose of the regulation was to " establish a functional aircraft maintenance organization within the wing-base organization which would insure full utilization of personnel and facilities to produce maximum availability of aircraft" (6:28). Base level maintenance was divided into four agencies. These were wing maintenance control, organizational maintenance, field maintenance, and base flight and transient maintenance (6:28). "Shortly, the electronics functions of field maintenance were

used to create the armament-electronics maintenance unit, which much later came to be known as the avionics maintenance squadron" (5).

The center pole of this structure was wing maintenance control. It was responsible for the centralized direction and control of wing maintenance. Organizational maintenance handled flightline maintenance, periodic inspections, and technical order compliance. Field maintenance dealt with aero repair, communications and electronics, armament, fabrication, and power plant problems. It was also responsible for supplying specialists to organizational maintenance as required. Base flight and transient maintenance controlled all maintenance on base assigned and transient aircraft (6:29) "and received specialist support from field maintenance" (5). SAC created this organization to provide for the most efficient use of available manpower.

> The aim was to provide a sufficient amount of work to keep the work force continuously occupied. To do this under conditions where the workload was sporadic a backlog of work was maintained for slack periods. Since specialists' work in the tactical squadron fluctuated considerably, specialists were moved to the intermediate squadrons of field maintenance and avionics maintenance where the backlog of low priority work on reparables could be processed when work was not being performed directly on the aircraft. (1:27)

Specialized maintenance did not always work as well as planned in the early years. This was due "to a lack of teamwork stemming from misunderstandings, interpretations, poorly defined responsibilities, and inadequate facilities for this type of operation" (1:27). Perhaps part of the confusion stemmed from the change in the terms that described the levels of maintenance.

When the Air Force was formed, in 1947, the echelons of maintenance were redefined. "What had previously been first and second echelon maintenance became organizational; third echelon became field;

and fourth echelon was named depot" (6:29). The old and new designations were often mixed and this may have created some confusion among the "older" maintenance troops. Other problems, of a different type, were also plaguing the fledgling Air Force.

Organizational Problems

In-Commission Rate. "It is a fact that aircraft in-commission rate is a measure of Air Force effectiveness" (10:144). As defined by Air Force Regulation 65-110, 7 November 1950, an aircraft was in-commission "when it is safe and capable of normal flight operation without additional repair or maintenance." Common sense says that "the number of aircraft ready to perform their jobs at a given time is the number to count, regardless of how many airplanes might be around in the docks and hangars." Yet experiences in both World Wars showed that few Air Force people considered in-commission rate important. It was frequently the lack of a single spare part kept many of the aircraft grounded (10:145). This lack of spare parts was measured by the "Aircraft Out of Commission for Parts" (AOCP) rate.

During World War I, then Lieutenant Henry H. Arnold asked Mr. Howard Coffin, Director of Aircraft Production, about spare parts. Mr. Coffin replied "What do you want spare parts for?" This same disregard for spares was practiced by the Army Air Forces (AAF) in World War II. The Material Division, USAAF decided spares production should have the same priority as production for immediate installation, but that decision was rejected by Headquarters, AAF. Headquarters felt production for installation took priority at the cost of spares production. "As a

result of this policy, B-29s were grounded all over the Pacific for lack of parts" (10:144-145).

To remedy this situation, the Air Technical Service Command set up a special radio room, operating 24 hours per day, just to receive parts requests from the field. The information was relayed to the proper units in the Supply Division, where corrective action could be taken. "Sometimes this involved personal trips around the country to ferret out critical items of supply." Parts were taken from the production line and flown to the grounded aircraft. This created chaos on production lines already experiencing problems. The procedure cost a lot of money, time, and aggravation, and was justified on the basis of wartime emergency. As soon as the war ended this service was halted resulting in an immediate rise in the AOCP rate (10:145).

Dealing With The AOCP Rate. In November 1947, 15 percent of the Air Force aircraft were sitting on the ground waiting for parts. The Air Material Command (AMC) Supply Division set up an Aircraft Status Unit to track status of every Air Force airplane. It did this through a series of reports from Air Force units. The daily AOCP report gave the figures needed for computing consumption rates of spare parts. The "14-Day Report" gave the bases a chance to say whether the parts requested were delivered by the supply activity within a two week-period. The last was a "30-Day Report" which the depots used to report parts which kept more than five aircraft grounded during the calendar month. Management actions based on these reports caused the AOCP rate to decline. By September 1948 the AOCP rate sat at a low 4.8 percent, which the Air Force considered good (10:145-146). Once the AOCP rate started to come under control another problem surfaced in status reporting.

In-Commission Rate Reporting. When an aircraft was out of commission, the reason was reported under one of four categories. The number of hours an aircraft was out of commission was due to waiting for parts, technical order compliance, maintenance, or other reasons. The Air Force soon discovered the reporting for technical order compliance and for maintenance was faulty (10:146).

Maintenance, as defined for reporting purposes, included time spent on regular periodic maintenance, and unscheduled maintenance, and time lost waiting for technical order compliance and periodic maintenance. Thus, because the term "maintenance" was not well defined, the same time could be counted in several categories. Headquarters, USAF "proposed the reporting system be revised so that the hours spent on periodic maintenance, malfunctions, and technical order compliance would be separated." The AMC agreed and in the fall of 1950 this reporting system went into effect (10:147).

The Air Force's goal was to "develop a maintenance system that would accomplish peacetime objectives effectively; it also wanted that system to be adaptable for quick change to war conditions without upsetting operating procedures." In developing this program Headquarters, USAF felt it must develop realistic in-commission and utilization rates for all program aircraft (10:147). This raised the question: "What is a good in-commission rate?

Defining The In-Commission Rate. The Maintenance Division, USAF, had established 70 percent as a rule-of-thumb in-commission rate for aircraft regardless of assignment, type, location, or mission. It was a directed measure to start with, but Operational Readiness tests resulted in varied performance rates ranging from 35 to 70 percent. SAC stepped

in and established standards that varied by type of aircraft. "Sixty percent was the goal for heavy bombers, 70 percent for medium bombers, and 80 percent for fighters. The Continental Air Command (CONAC) had a similar objective for fighters." Yet each command had its own idea of what was meant by in-commission (10:148).

CONAC considered a fighter to be in-commission if it could be made flyable within six hours. The Military Air Transport Service (MATS) agreed with CONAC and established the same six-hour tolerance for four-engine transports. SAC settled on one hour per each installed engine with a ceiling of four hours per aircraft (10:148).

The Maintenance Division felt there were actually two different in-commission standards. One standard could be attained under normal operating conditions, when economy was the key, and the other standard was based on an all-out effort. The Division's thinking was based on the fact that normal duty hours accounted for only 23.5 percent of reported aircraft hours, and the limitation on the number of mechanics who could physically work on an aircraft without getting in each other's way. In case of emergency, where economy was thrown out as a consideration, shifts could be extended to meet higher in-commission rates. In an emergency, having aircraft combat ready would be more important than cost conscious maintenance (10:148-149). [Note: At this point, the author makes a subtle shift from "in-commission" to "combat ready." SAC argued that these two were not the same. In-commission meant safe for "normal" flight. The question was asked: "What did 'normal' mean?" SAC said it meant "flyable," where "combat ready" meant that--depending on the mission--certain systems were needed. SAC also emphasized the system requirements may differ within the same type of aircraft depend-

ing on the war-time mission of the wing they were assigned to (5). This issue has still not been resolved in today's Air Force.]

The Maintenance Division and Operations Analysis Division joined forces to conduct a study of both the economic and maximum obtainable in-commission rates for each type of aircraft. With the entry of the United States into the Korean War, efforts at establishing in-commission rate standards were postponed (10:149).

Non-Aeronautical Maintenance Workload. The primary job of the combat wing Field Maintenance Squadron and Armament-Electronics Maintenance Squadron was to take care of the aircraft; however, other kinds of repair work often interfered seriously with this primary goal.

> In the spring of 1950, for example, from 20 to 45 percent of the effort of a Maintenance Squadron of one Maintenance and Supply Group was spent on such non-aeronautical equipment as office equipment, musical instruments, railroad rolling stock, chaplain equipment, kitchen utensils, laundry and dry cleaning equipment, and agricultural equipment. (10:149-150)

While all of these tasks may have had certain importance, they were consuming an increasingly large proportion of maintenance squadron's time. Maintenance Division, USAF felt the bulk of maintenance time should be used keeping aircraft combat ready and it took steps to remedy the situation. They suggested the name "Maintenance Squadron" should be changed to "Aircraft Maintenance Squadron" to focus on the fact that this squadron was responsible for aircraft vice other equipment. The performance of field echelon maintenance of other non-aircraft equipment, the Division suggested, should be spread between the Air Installation Squadron, Communications Squadron, and Vehicle Squadron. "Finally, the Maintenance Division suggested that it be designated as the staff agency for placing maintenance responsibilities at all operating levels,

other than the maintenance of buildings, structures, and installed equipment." This suggestion entered into debate and was still not resolved when the Air Force entered the Korean War (10:151).

Other Maintenance Issues of the Interwar Years

The aforementioned issues constitute only a few of those tackled by the Maintenance Division, USAF during the interwar years of 1946 through 1950. Several other important issues merit mention because they went on to shape today's maintenance environment.

Manpower Discrepancies. As previously mentioned, there was a shortage of maintenance personnel in all areas during the post-World War II years. "During the nine-month period preceding 15 June 1950, there were shortages of 10 percent or more in 69 of the 112 principal occupational specialties in the maintenance field" (10:159). These shortages were felt most severely by the tactical commands, while the Air Training Command (ATC) was over-strength in all maintenance fields. To correct this situation, the Maintenance Division, USAF sought to move some ATC airmen to the tactical commands. It also advocated the use of more civilian employees at base level and in ATC. In addition, the Division sought the assignment of civilian technical advisors from equipment manufacturers (forerunners of today's technical representatives) at supervisory levels in Maintenance and Supply Groups in the Continental United States (10:160).

Career Development. In the course of the Headquarters, USAF survey, Maintenance Division, USAF made some interesting discoveries about USAF maintenance officers. In June 1950, fewer than 5 percent of

the maintenance officers were college graduates; fewer than 2 percent were engineering graduates; and only 39 percent were high school graduates (10:160).

> These officers and Warrant Officers were principally World War II veterans. They had performed effectively during the war and chose to remain in military service after the war. They were in their mid-20s to mid-30s, for the most part, and had their education disturbed by the Great Depression and their military service during the war. The statistics depicting education were shocking but understandable given recent history. (5)

These figures nevertheless upset the Division because it strongly believed in the importance of the maintenance job. The Maintenance Division felt "a larger number of less-skilled, more poorly educated military population could be found in the maintenance organization than in any other organization of comparable importance." It was believed "the more-skilled, better educated minority were highly competent; otherwise the maintenance job would not have been done as well as it was." The Maintenance Division felt this "placed a disproportionate responsibility for the efficient performance and administration of material maintenance function" on their shoulders (10:160-161).

The Maintenance Division, USAF advanced two theories to explain why it was so hard to attract more well-qualified officers into the maintenance field. The first was based on the fact there was no career progression plan established for these officers which would allow them to move into higher positions. The second theory was based in technological advancement. Many of the maintenance officers were eager to get out of maintenance because the new design and advancement in aircraft technology and equipment had gone beyond the scope of their technical knowledge. No provisions had been made to train these officers for the growing difficulties of their jobs (10:161). These difficulties

included more than just technology. In wartime, the maintenance officer's main job was to make technological decisions and get the work out fast. In peacetime, the focus shifted to the maintenance officer's ability to manage people, materiel, and facilities to provide adequate maintenance coverage within budgetary limitations (14;161).

To remedy these problems the Maintenance Division made several suggestions. First, it suggested the Deputy Chief of Staff, Materiel monitor the assignment of maintenance officers through the group level. It also suggested a board screen the qualifications of officers assigned to key maintenance positions to make sure they were qualified to hold those jobs. If they were not, they would be assigned to positions in which they could perform effectively. Another screening board was suggested to review the records of non-maintenance officers to locate those whose backgrounds made them eligible for maintenance. "Finally, the Maintenance Division, USAF recommended a Maintenance Training and Requirement Liaison Unit be set up within the Air Material Command to prescribe the requirements for training airmen within the maintenance field." (10:162-163). The AMC concurred with all these suggestions. However, the final one, "needed to have appropriate USAF authorization included in Air Force Regulation 20-43, Organization Air Material Command. As for the other suggestion, 'implementing action (was) indicated for Hq USAF'" (10:162-163).

Maintenance Manual. Air Force Manual 66-1, the Maintenance Manual, was a creation of the interwar years. The Maintenance Division, USAF suggested the manual should consolidate "all regulations, technical orders, and letters of general or policy nature applicable to or bearing on the field of maintenance." A Task Committee, comprised of field

representatives and member of the Air Material Command embarked on this ambitious project in late 1950 (10:186-188). The Table of Contents for such a manual would include the following: (10:187)

1. Maintenance Policies
2. Definitions of the Categories of Maintenance
3. Supply's Responsibilities Toward Maintenance, and Maintenance's Responsibilities Toward Civilian Components
4. Aircraft, Vehicle, and Equipment Reclamation and Salvage
5. Aircraft Distribution, Assignment, and Transfer
6. Unsatisfactory Reports, Exhibits and Samples
7. Aircraft Accident Reporting and Investigation
8. Air Force Technical Publication Distribution
9. Explanation of the Technical Order System
10. Technical Inspection Procedure
11. Cost Accounting Responsibilities of Maintenance
12. Air Force Forms Utilized by Maintenance
13. Weight and Balance--Procedures and Responsibilities
14. Production Control Systems
15. Maintenance Priority Systems
16. Tables of Organization and Equipment, Tables of Allowances, and Tables of Equipment (summarized as to issue of special and authorized maintenance equipment)
17. Technical Representatives
18. Aircraft Modification and Technical Order Compliance

Maintenance Facilities. During the interwar years Maintenance Division, USAF also took an interest in everything from hangar structure, to tools and equipment, to ramps and runways, and even to the assignment of aircraft. The many changes in aircraft design and technology demanded attention be given to these areas. With the increase in the size of some aircraft, bombers for example, outdoor lighting needed to be developed and installed so work could be performed on the aircraft after sunset (10:189).

The increase in the thickness of materials used to make the aircraft caused concern about the need for heavy equipment to repair the airplane and manufacture spare structural parts. A review of the equipment on-hand or under development assured the Maintenance Division and AMC the problem was well under control (10:189-190).

Aircraft cleanliness became an issue following World War II. The Air Force had discouraged the cleaning and waxing of aircraft during wartime and that attitude caused a generally lax post-war approach to any cleaning efforts (10:190-191). Further, as aircraft construction materials changed, corrosion became a potentially major problem. This required the assured cleanliness of abutting and external surfaces (5). The development of proper tools, materials, and facilities to reduce the labor and the clock time required to clean an aircraft now became a priority (10:190-191).

Clean aircraft were not enough. Ramps, runways, taxiways, and runup areas also needed to be kept clean to prevent foreign object damage (FOD) to aircraft and engines. From January to April 1950, the Maintenance Division pointed out 60 engine failures were caused by FOD. When soaked with JP-1 fuel the macadam runway surfaces became very soft. As the aircraft taxied it stuck to the tires. On takeoff, the softened macadam was thrown into the wheel wells where it fouled up the landing gear and added to potential corrosion problems. Several changes were made to remedy these situations. First, and foremost, the requirement for daily inspection of the runways, taxiways, and parking areas was added to the AFR 85-21, Installations--General Preventive Maintenance. To improve the fueling situation the decision was made that all aircraft procured after 1950 would have a single-point refueling system. This would allow the aircraft to be fueled either from a fixed hydrant or a mobile truck through a single point instead of having a hose moved to various fueling points on the aircraft (10:192-195).

Assignment of Aircraft. One final issue to report here is the assignment of aircraft. Following World War II aircraft were returned

to the United States in a somewhat haphazard manner. For example, "March Air Force Base had 12 aircraft types assigned to it; Biggs Air Force Base, 16; and Hamilton, 18." The assignment of so many varied aircraft types caused maintenance jobs to be so diverse standard procedures could not be worked out. Maintenance Division, USAF proposed the Chief of Staff establish a policy to reduce the number of types of aircraft assigned to an Air Force base. It was believed this would provide: "(1) the necessary standardization for production methods in performing periodic inspection; (2) a means of reducing inactive inventories of spares held at many bases just to take care of a few aircraft; (3) a means of reduction in quantity and variety of equipment for maintenance support; and (4) a means of reduction of the number of skilled specialists so necessary when there was a large accumulation of dissimilar aircraft stationed at one base" (10:196).

Many other issues were worked by Maintenance Division, USAF in concert with Air Material Command and Headquarters, USAF. The question which comes to mind is why had maintenance become such a top item for Air Force consideration?

Maintenance As a Priority

> The answer could be found by observing the sharp changes that had taken place in the techniques of warfare. The day of the "big battalions" had passed. Mechanization of military power had reached a point where "the concept is no longer that of equipping men, but rather of manning and maintaining equipment." Nearly one-fourth of all Air Force people, both military and civilian, were working on one phase or another of maintenance. Ineffective maintenance was reflected in the rising rate of aircraft out of commission, and this in turn affected the availability and mobility of tactical units. (10:200)

Thus, the ineffectiveness of maintenance was reflected in a loss of ability for the Air Force to meet its responsibilities.

By 1951, the organization chart for Headquarters, USAF reflected this new awareness of maintenance. The former Directorate, Maintenance, Supply and Services had been divided, and a new Directorate of Maintenance Engineering had been created. The activities of this new organization would be many, but at least there was a "recognition of the growing importance of maintenance" (10:201).

Aircraft Maintenance Issues In Summary

The years between World War II and the Korean War were filled with pace-setting events in aircraft maintenance. Many of the decisions made during this period are reflected in the maintenance organization as it stands today. The following statements provide a brief summary of the issues covered in this chapter.

1. The adoption of the Hobson Plan, in 1947, was an important first step toward standardization and stabilization of the maintenance organization. This plan made the wing headquarters the highest echelon on a base and created four subordinate groups including the combat and maintenance and supply groups. These groups were responsible for first, second, and third echelon maintenance within the wing.

2. Manpower shortages, brought on by an improved civilian economy, created concern over the Air Force's ability to expand its combat capability in times of war. The concern then was that there was no counterpart in industry to the military aircraft maintainer.

3. The reliability and maintainability (R&M) of an aircraft were not design considerations up until this time. Although some consideration was given to this area, the Air Force gave little more than lip service to the R&M concepts.

4. Specialist maintenance was reborn in a slightly different format. The new maintenance concept, developed by SAC, placed specialists in an off-equipment setting. This provided a situation where the specialist could be kept busy with backlog maintenance. Although it took some years for this concept to catch on, it served, until very recently, as the core of the maintenance organizational concept.

The Maintenance Division, USAF concentrated on many other issues which have had a lasting impact on maintenance. In a period of only five years, the Division made large strides in developing maintenance policy and procedure. Much of the work started during this time was not finished by the time the Air Force was once again called to war. Yet, the efforts made by these maintenance pioneers set the pace for the future.

Setting the Stage For War

On 25 June 1950, the North Koreans invaded South Korea. That same day, the United Nations asked for troops to restore the peace. Two days later, President Truman ordered the Air Force and Navy to Korea. On 30 June 1950, he approved ground and air strikes against the North Koreans (9:446). Only five short years after World War II, the United States found itself back at war.

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VI. The Korean War 1950-1953

The United States In Perspective

America spent the short period of interwar years concentrating on rebuilding the civilian economy and hastening a return to peacetime production. This desire to build the nation's internal peacetime strength was the number one priority of the government. When hostilities broke out in Korea the United States was faced with two immediate needs. First, with the urging of the United Nations, it had to stop the North Korean army's invasion of South Korea. Second, the United States needed to conduct a general military buildup under the threat of increased worldwide tension spurred by the Communist invasion. The "top political and military authorities decided United States policy would be to meet these major military needs while simultaneously helping the gross national product, and the civilian standard of living, to continue to grow" (7:174). It was hoped, if their lives were not disrupted by the War, the American people would be more willing to support large-scale military spending. In the end, President Truman made the decision to enter into an offensive campaign but not to declare war. Behind this decision went the belief the United States was facing "a long period of tension in the world and not just the immediate crisis in Korea" (7:169-174).

This approach toward the war helped to shape the American social, political, and economic fabric during the three years of the war and several years following. The balance between wartime commitment and national stability was reflected in the events of this period. Certain-

ly the deployment of United States troops to Korea, 27 June 1950, was an important national event, but so was the assassination attempt on President Truman that same year.

On 1 November, two members of a Puerto Rican nationalist movement tried to shoot their way into Blair House, the presidential guest quarters. One of the assailants, Griselio Torresola was killed along with a guard, Private Leslie Coffelt. Oscar Collazo was eventually convicted of Coffelt's murder (12:547).

In 1950, America also started on a track which would ultimately involve the nation in yet another war in Vietnam. On 27 June, the United States sent 35 military advisors to South Vietnam and agreed to provide military and economic aid to the anti-Communist government there (12:447).

In 1951, America experienced a mixture of national, war related, and international events of some significance. The trial of three United States citizens--Julius Rosenberg, Ethel Rosenberg, and Morton Sobell--ended with their conviction, 29 March, on charges of conspiracy to commit wartime espionage. The Rosenbergs were sentenced to death and were executed in 1953. Sobell was sentenced to 30 years in prison, but was paroled in 1969. The Korean War continued despite cease-fire talks, which began in July, and the fighting continued until 27 July 1953. The rest of the international scene was quite active. The United States suspended all tariff concessions to the Soviet Union, Communist China, and all communist-dominated lands on 1 August 1951. The next month, the United States, Australia, and New Zealand signed a mutual security pact. That pact was followed by the signing of the Japanese Peace Treaty, 8 September, by the United States and 47 other nations (12:447).

The next year, 1952, also saw a mix of events. It began with President Truman's seizure of the nation's steel mills, 8 April, to avert a strike. The mill owners took the issue to the Supreme Court where it was ruled illegal. This year also brought another peace contract to the world. On 26 May, West Germany, the United States, Great Britain, and France signed an alliance. Socially, the United States took a large stride in the passage of the Immigration and Naturalization Act of 1952. By its passage, the last racial and ethnic barriers to naturalization were removed. Finally, as if in reflection of the volatility of the world situation, the United States exploded the first hydrogen device at Eniwetok Atoll in the Pacific (12:447).

In 1953, Dwight David Eisenhower was sworn in as America's 34th president. He considered himself a political moderate and a strong believer in the "free market system" (12:435). He also considered foreign aid as an important tool in the fight against Communism. He proved that with an 8 May announcement to the nation. In that speech, he explained that he had given France $60 million in aid for the Indochina War. A later announcement, in September, indicated even more aid was given. Estimates, made in 1954, indicated three-fourths of France's war costs were met by United States' financial contributions (12:447). This was one more step toward American entanglement in South-east Asia.

On 27 July 1953, a compromise agreement ended active fighting in Korea. Neutral zones were established on either side of the 38th parallel and prisoners were exchanged by both sides. A subsequent agreement provided for international supervision of the area, "and for a

high-level political conference to discuss the peaceful settlement of the Korean question on the basis of reunification" (1:479-480).

The outbreak of war in Korea removed any doubt about America's commitment to contain the spread of communism and promote democracy. These ideals were the fundamental obligations of the world's democratic leader. The Korean War was the first combat test of America's new ideal. It was a challenge to the nation's leadership, both civilian and military. The role of United States Air Force in the Korean War was quite different than in World War II. Tactical forces emerged as the mainstay of the Air Force in Korea. The forces met with many challenges in the years of the war. The pages which follow outline a number of the challenges faced by aircraft maintenance personnel during the conduct of the Korean War.

Status of the Force

The Emergence of the Tactical Air Force (TAF). The five interwar years were quiet days in American military policy. The United States had the atomic bomb and the long-range bombers to deliver it. No other country could compete with such military might. "This atomic umbrella, held aloft by the Strategic Air Command, was our guarantee of peace" (9:17). The other parts of the Air Force withered on the vine as the massive demobilization after World War II took place. The nation felt safe with SAC and the A-bomb and that left little need for fighter planes (9:17).

The threat of the A-bomb worked well for a while That is until Russia exploded its own nuclear bomb, 29 August 1949--three years

earlier than the United States had anticipated. Soon after, North Korea launched its attack across the 38th parallel into South Korea. For whatever reason, America made no threat to use the A-bomb and North Korea continued its attack (9:18).

President Truman had once said that "It must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressure" (9:18). He so firmly believed this he convinced the United Nations to intervene in Korea. The United Nations called on the United States to provide forces to restore the peace. It was a golden opportunity for the Tactical Air Command (TAC) and the Korean War became the gestation period for this budding organization (9:18-19).

TAC was officially conceived, 21 March 1946, as just one part of the Continental Air Command (CONAC). It "did not receive the same amount of unity under CONAC as did the Air Defense Command. TAC forces could be used for both tactical air operations, and air defense, and these forces had to be shifted from the United States to the theater of operations to meet commitments overseas" (10:80).

> Under the economy of the pre-Korean years the USAF Continental Air Command had found itself responsible for managing the Eastern and Western Defense Forces and the Tactical Air Command as well as other duties. These multifarious responsibilities of the Continental Air Command were resolved into major component parts on 1 December 1950 when the Tactical Air Command reemerged as a major command and on 1 January 1951 when the Air Defense Command again became a major command. (4:710)

During its peak year of the Korean War, 1951, TAC had 25 combat wings. Transfers to Europe and the Far East reduced that number to 21 wings by 1953 (4:710). The fighter aircraft of these three air arms; TAC, Far East Air Forces (FEAF)--later to be called Pacific Air Forces (PACAF),

and United States Air Forces in Europe (USAFE), formed the basis for what is now called the Tactical Air Forces (TAF).

Aircraft Status. At the start of the war, FEAF Commander Lieutenant General George E. Stratemeyer made a decision to shift his existing air units from a defensive to offensive position. His purpose was to bring as much of his force to bear against North Korea as he could while still maintaining the air defenses of the Far East Command. From the end of June to early July 1950, aircraft were shifted throughout the Far East in compliance with the FEAF's deployment plan (4:67-68).

During this period, General Stratemeyer sent several requests to Washington for aircraft and personnel. One specified the manpower he would need to bring his units up to combat strength (one and one-half times peace strength). Another requested "164 F-80s, 21 F-82s, 22 B-26s, 23 B-29s, 21 C-54s, 64 F-51s, and 15 C-47s" (4:68). On 1 July, General Stratemeyer submitted one more request asking for air units to serve both in Korea and as defense forces in the Far East. He wanted "one medium bombardment wing, two Mustang wings (F-51), two F-82 (Twin Mustang) all-weather squadrons, one troop carrier wing, three F-80C (Shooting Star) squadrons to augment the Japan-based fighter wings, a B-26 (Invader) wing, two B-26 squadrons to fill out the 3rd Bombardment Wing, an RF-51 reconnaissance squadron, an RB-26 night photographic squadron, and a tactical air-control squadron" (4:69). He was supported in his request by General Douglas MacArthur, Commander, Far East Command (4:69). [Note: The reader may wonder about the Mustang designation being changed from the more familiar "P-51" to the "F-51." In June

1948, the USAF changed the "P", or "pursuit," designator to the now familiar "F" for "fighter".]

The United States Air Force (USAF) Chief of Staff, General Hoyt S. Vandenberg, agreed with General Stratemeyer. Unfortunately, the desires could not be met with existing Air Force inventory. "In July 1950 the USAF had a total inventory of less than 2500 jet aircraft of all types" (4:69). To assess the situation, General Vandenberg formed a team headed by Lieutenant General K.B. Wolfe, the USAF Deputy Chief of Staff for Materiel, and dispatched it to the Far East (4:69).

One member of the team, Major General Frank F. Everest, was charged with explaining why the number of F-80C jets requested could not be provided. His answer was simple; they did not exist. Although 325 F-80A and B model aircraft could be modified, the process would be very slow--yielding only 27 aircraft per month. His answer was similar for the F-32. Only 168 F-82s existed and most of those were assigned to units in Alaska and the Pacific Northwest. General Everest added that if the FEAF continued to use the F-82s it already had, supply support would be exhausted in sixty days. Once the limitations were explored, a plan was drawn up to capitalize on the USAF strengths (4:69).

General Everest pointed out that the Air Force had a large supply of F-51s--764 assigned to the Air National Guard and 794 in storage. One hundred forty-five of the F-51s were recalled from the Guard, along with pilots and mechanics, and were shipped to Korea aboard the carrier "Boxer." At a conference in Tokyo, 7 July 1950, the FEAF agreed to convert six of its F-80 squadrons to F-51s, and to withdraw its F-82s from combat. Enough RF-80s were to be provided to keep the 8th Tactical Reconnaissance Wing up to wartime strength so the FEAF withdrew its

request for an RF-51 squadron. Further, it was agreed that two SAC groups would deploy to meet the B-29 requirement. Finally, the 374th Troop Carrier Group was reformed with two squadrons of C-54 aircraft and one squadron of C-47s. The FEAF was promised additional troop carrier support if Army airborne units were sent to the Far East (4:70).

TAF aircraft used in Korea during the war ranged from World War II conventional aircraft, such as the F-51 Mustang, to new jet fighters, like the Lockheed F-94 Starfire. The Lockheed F-80 Shooting Star was the first TAF jet fighter to be used operationally in Korea and the F-94 Starfire the last (2:123,141). Although the FEAF's jet fighter wings were up to 90 percent of peacetime equipment strength, their conversion from the F-51 Mustang to the F-80C Shooting Star (1948-1950) brought with it many problems which had not been resolved by the time the United States entered the war (4:59). These problems spanned every area of logistics from lack of adequate runways to a lack of trained maintenance personnel.

Manpower Numbers. When the United States Air Force was called to Korea in 1950, manning stood at 411,277, a mere 18 percent of its World War II peak strength. By 1951 those numbers had nearly doubled to 788,381, and at the end of active fighting, in 1953, the force had grown to 977,593 (11:40).

"During July and August 1950, the USAF drew on its regular and reservist manpower resources to meet FEAF's requirements for Air Force personnel." By 1 September 1950 FEAF had 45,991 airmen assigned of the 46,233 it was authorized. This was a substantial increase of manpower since 30 June when authorizations totaled 39,975 and assigned personnel only 33,625. Much of the increase came from new tactical units arriving

in the FEAF, but some was attributed to the augmentation of combat crews and staff positions to combat strength levels (4:71-72).

In spite of these dramatic efforts, the Air Force was not able to provide all the specialized personnel FEAF requested. "Most FEAF units continued to be alarmingly short of specialists in aircraft accessories, ordnance, and communications" (4:72). As mentioned in the previous chapter, the interwar years witnessed an exodus of trained technicians who were lured away by private industry. This lack of qualified maintenance personnel and other maintenance problems are discussed further in the next section.

Aircraft Maintenance In The Jet Age

During the Korean War aircraft maintenance was performed at any one, or a combination of, four major locations. These were K-sites in Korea, REMCOs in Japan, depots in Japan, or depots in the United States (3:69). Before moving on, two terms need to be defined here, "K-site" and "REMCO."

The term "K-site" was adopted to stem the confusion over various locations in Korea. Often either a single name was so close in structure to another it seemed to refer to more than one place, or more than one name was given for an airfield. For example, an "airfield on the southeastern coast of Korea was variously called Geijitsu Bay, Yongli-wan, Pohang-dong, Pohang-wan, or Pohang" (4:65) depending on who was speaking. To simplify the matter, in July 1950 all sites were given a "K-site" number for purposes of exact designation. This identification system lasted throughout the war. The second term, "REMCO," is the

acronym for "Rear Echelon Maintenance Combined Operation" (4:640). The concept of REMCO maintenance is discussed later.

Unit Organization. "The mission of the aircraft, the local situation (facilities and transportation routes), and the desires of the wing commander determined the organization of the combat wing and how these aircraft were to be repaired and maintained" (3:69). The four main categories of wing organization included situations where the whole wing moved as a group, the tactical group with minimum support went forward, the operational portion moved forward leaving maintenance as a tenant unit in the rear, or the entire wing moved forward but had a "sub-depot" located in the rear to handle heavier maintenance. Of course, dependent on conditions, any number of variations of these systems were used (3:69-70).

In any case, the Korean War presented some new and some old challenges to aircraft maintenance. Some of the difficulties maintenance faced and the solutions used to conquer the problems are explored in the following paragraphs.

Personnel. There were many problems with aircraft maintenance personnel in the Korean War. Manning, as reported in the previous section, was one problem. "During December 1950, for example, the 3rd Maintenance Squadron (5th Air Force) had a considerable shortage of airmen, 109 assigned of 158 authorized. The squadron had to work 24-hour days with three shifts working seven days a week. In many sections, personnel did not get a day off for 10 to 15 days at a time" (3:34-35). While overall shortages were one aspect of the picture, shortages in specific career fields was another. "Sometimes one career field was fully manned while another was critically short" (3:35).

Inadequate training was also a problem. With the conversion from conventional aircraft to jets, a mechanic could find himself trained on the P-51 but assigned to an F-84 squadron (3:35).

This lack of maintenance personnel created some serious problems in the Korean War. Many of the first term airmen were assigned either to bases in Korea or Japan. There they found themselves "working on equipment for which they were not trained and with which they were unfamiliar" (3:35). When assigned to Korea, these untrained and unqualified people created a serious problem. On-the-job training had to be carried out in a combat theater to the detriment of a unit's combat capabilities (8). This situation was further complicated by the 12 month tour-of-duty in Korea. This meant that personnel were rotated back to the United States every 11 months. About the time the maintainer got accustomed to the aircraft, or equipment, he was rotated out of the theater. "The rotation policy prevented the development of experienced maintenance organizations such as those in the Second World War" (6:12). In addition, overall manpower shortages often forced highly skilled personnel to perform the more low skill tasks. The immediate result was a loss of a valuable resource, and in the long run, it further served to upset the balance of the maintenance complex (3:35).

There was no easy solution to the personnel problem. Commanders were faced with shortages in skilled maintenance personnel throughout the war. The maintenance system the Air Force had been operating during and after World War II simply was not responsive to the conditions found in Korea. "But it must be stated unsatisfactory personnel assignments to combat and support units in Korea were at least equally at fault" (8).

The Modified Crew Chief System. An example of maintenance system unsuitability can be found in the breakdown of this system. When the Air Force first went to Korea, tactical units were using the Modified Crew Chief System. "In this system, the basic crew consisted of both aircraft general specialists and engine specialists under a crew chief. The crew was responsible for flight line and periodic maintenance and had a pool of specialists within the squadron to call on for assistance as needed. Heavy maintenance was performed by a Field Maintenance activity" (6:2).

This was fine during the first year when the tactical units were assigned to reasonably equipped bases in Japan. However, a combination of personnel rotation and frequent moves soon brought the Modified Crew Chief System to its knees. The rotation stripped the units of skilled crew chiefs needed to meet the demands for all the aircraft. Added to the loss of crew chiefs was the demand for an overall smaller front-line maintenance force. The constant movement of the units--through the give-and-take of battle--demanded a more mobile maintenance force. This rendered the old manpower intensive Modified Crew Chief System useless (6:12). In addition to these personnel and crew chief problems, aircraft maintainers in Korea faced other, sometimes severe, limitations.

Other Maintenance Problems. The living and working conditions for maintenance personnel in Korea left a lot to be desired. "Most of the air fields had been built by the Japanese (during World War II) and the majority had been abandoned for some time" (3:36). Most of these bases had only a couple of permanent buildings which were mainly used as supply warehouses. Construction of runways and other base facilities

took priority over providing permanent maintenance facilities and personnel quarters. Pre-fabricated buildings or tents were used as alternates to permanent construction. The lack of permanent buildings contributed to cold weather maintenance problems (3:36-37).

"In the wintertime, some maintenance personnel worked in hangars or tents with interior temperatures below freezing." The cold weather forced maintainers "to only perform minimal pre-flight and post-flight inspections, and replacement of failed parts. This inadequate maintenance helped promote the deterioration of aircraft sooner than expected" (3:36-37).

Runway and taxiway conditions also contributed to poor aircraft condition. Jet aircraft, with their small wheels, higher tire pressure (200 psi versus the 80 psi of conventional aircraft), and jet blasts, tore up existing runways. Although construction efforts were constantly underway to repair and rebuild the runways they were only marginally successful. The use of pierced steel planking over asphalt worked the best, but it was still inadequate for jet aircraft use. The rough surfaces frequently caused damage to the landing gear and tires of the jets, which were not as sturdy as their conventional counterparts (3:37-38).

This kind of abuse meant continuous replacement of the struts and tires and forced maintenance to rely very heavily on supply support. The problem was further aggravated because supply was facing its own difficulties. First, the "provisioning of spare parts was done on the basis of peace-time usage. In combat, the supply of spares was either inadequate or non-existent." The poor storage facilities, or lack thereof, contributed to weather deterioration and pilferage of supplies.

The arrival of a new series of aircraft in Korea only made the situation worse since adequate parts supplies and parts lists were seldom shipped with the aircraft. As a result of these problems, aircraft were often grounded for longer than expected (3:39).

To overcome the shortage of parts, maintenance resorted to cannibalization of aircraft already out-of-commission for parts. "This procedure doubled maintenance man-hours and increased the AOCP (aircraft out-of-commission for parts) rate because of the additional need for more spare parts and the long supply wait which often exceeded 90 days" (3:40). Damage done to parts during cannibalization also contributed to a reduction in component reliability. Fifth Air Force, the largest of the FEAF subordinate commands (4:2), directed its units to exhaust all local means of supply before resorting to cannibalization (3:40).

Shortages of tools and equipment provided another challenge for maintenance. Much of the equipment used in Korea was World War II vintage. "The items were often almost beyond repair and were a constant maintenance problem owing to the frequent minor adjustments, quick fixes, and repeated replacement of old, worn-out components. One problem area was that the older, and some of the new equipment, was not build to stand up to the ruggedness of the environment." There were several reasons for the lack of sturdy construction. First, much of the equipment "was made lightweight for air transportation without consideration of its potential usage." Second, "low contract costs were emphasized and the quality of the equipment was below that of the equipment it was replacing or repairing." Third, "many items were not designed to take the punishment of the rough field usage found in Korea." Finally, "most items were designed for a relatively short life

span." Equipment replacement was difficult "due to the low priority it was given and the difficulty involved in having new equipment built" (3:80).

All of these maintenance problems were complicated by the frequency of unit movements. One reason for these moves was the give-and-take nature of the battles in the Korean theater. Units would move forward as the enemy retreated, and then back as the enemy advanced. The occupation of bases was contingent on ground security and in the many turns of battle, this security often was not assured.

> With the breakout from Pusan, air units followed ground forces north, occupying or reoccupying bases liberated from the North Koreans. Some of these were well above the 38th parallel. After the entrance of the Chinese into the war, and in the face of their advance south, bases newly occupied by 5th Air Force units were again surrendered to the enemy. Air units were forced to move south or back to Japan. Finally, as the Chinese were pressed back to the 38th parallel, units again moved to reoccupy liberated bases, this time with more certain security. (5:20-21)

Other reasons existed for unit movements aside from advances and retreats. Sometimes a unit was forced to move either because the facilities did not match the aircraft, or the facilities were in much worse shape than first believed.

> In one instance, it was decided that the short runway at Kimpo AB was inadequate for the F-80s operating there although it could easily handle lightly loaded F-86s. Suwon AB had a runway capable of handling F-80s but was occupied by F-86s. The units consequently "traded bases," a deceptively simple description of an operation that necessarily entails much more than merely flying aircraft from one location to another. (5:21)

These unit movements added to the shoddy conditions already faced by the maintenance troops. Bases were not just evacuated. Equipment, buildings, and any other facilities of potential use to the enemy were destroyed. Air Force attacks against the then "enemy" airfields further added to their poor condition. These frequent moves also took a toll on

the equipment and supplies evacuated from the bases. For example, "In the UN withdrawal from Pyongyang, roads were so jammed that stalled vehicles were pushed off the side of the road and burned, load and all, to prevent halting the overall movement" (5:22).

In addition to the problems already mentioned, aircraft maintenance personnel faced other barriers such as; inadequate transportation, the threat of enemy attack, fuel contamination, and other difficulties. In the face of all of these problems, the tactical units soon found themselves performing only servicing, minor inspections, component removal and replacement, and other minor maintenance at forward operating locations. "Major inspections and major maintenance, including modifications were accomplished in Japan and the rear areas of Korea by units using specialized maintenance concepts" (13:17.28).

Rear Echelon Maintenance Combined Operation--REMCO. Rear echelon maintenance was not a new concept. It had been used in World War II "to take advantage of the equipment and facilities behind the combat zones which had not been destroyed by bombardment" (3:95). REMCOs were used in Korea for much the same reason.

> Located a hundred or more miles to the rear of the operating bases, the REMCOs arose out a combination of poor operating conditions in Korea and of excellent operating conditions and plant facilities in Japan. Japan was a friendly country not under attack and this permitted greatly reduced stress for the maintenance personnel. In addition, Japan offered an abundance of skilled indigenous labor and a good rail transportation system. (3:95)

At first the REMCOs were created simply by "withdrawing men, equipment, and supplies from the wings" and establishing a facility in Japan. It was not long before wings, which flew similar aircraft,

combined their REMCOs to take advantage of greater output capacity. Thus the name "Rear Echelon Combined Maintenance Operation" (3:95-96).

By 1952, PEAF was taking formal actions to create a permanent REMCO structure.

> Policies, procedures, and organizational structures were developed to accommodate the REMCO system. Some of the actions taken were: (1) consolidate aircraft parts supply giving the REMCOs base accounts and wing service stocks; (2) place all military personnel assigned to the REMCOs on the same tour-of-duty; (3) raise civilian personnel ceilings to authorize the employment of large numbers of indigenous personnel at the REMCOs; and (4) expand plant facilities and special engine test stands to increase maintenance plant capabilities. (3:96)

During this process two basic REMCO patterns emerged, the "parent wing" and the "reinforced wing."

The parent wing concept called for the combination of two or more standard wings in one REMCO. One of the wing commanders assumed the responsibility for supervising the REMCO as well as his own wing. The participating wings all gave certain maintenance personnel and equipment to the REMCO in exchange for specified maintenance and supply services. In this case the REMCO became the sole source of support for the contributing wings. Maintenance personnel and equipment above that required to perform flightline maintenance tasks was kept by the REMCO "These personnel, plus the personnel of the maintenance squadron of the base-assigned maintenance and supply group, constituted the periodic maintenance section of the REMCO." Even spare parts needed in the field were supplied by the REMCOs "thereby reducing the quantities of supplies at the forward bases" (3:96-97).

In contrast to the parent wing REMCO system, there was the reinforced wing concept.

> The reinforced wing consisted of a combination of two or more combat groups and one REMCO under the command of a wing commander. This combination required extensive reorganization but was implemented because it provided easy channels of communication and authority up and down the chain of command, made the wing self-sufficient, and erased the overlap and duplication of command. (3:98)

Rear echelon maintenance during the Korean War had its share of detractors. "The tactical commanders cited a number of disadvantages to the REMCO scheme, but they did not succeed in changing it because its effectiveness overcame its shortcomings" (7:196). The principle complaints were: (7:196-197)

- too much time of aircraft, and crews, was lost ferrying aircraft to and from the REMCO;
- weather changes caused the scheduled return of aircraft to be missed and missions either had to be scrubbed or other already overworked aircraft and crews had to do double duty;
- the needs for increased communications capability, and increased coordination, were too great for a mobile unit; and
- they found their maintenance and supply personnel assigned to the REMCO were unhappy and felt no esprit in a remote unit with no visible contribution to combat success.

During the course of the War REMCO maintenance officers often found units were dumping their more undesirable or incompetent troops on the REMCO. To counter this problem the FEAF stepped in and took control of REMCO personnel assignments. The FEAF felt the REMCOs could only be effective if they had capable personnel assigned so they took responsibility for approving personnel assignments to the REMCOs (7:197).

In the end, REMCO proved to be a very successful maintenance venture.

> The maintenance accomplished, and the supply support provided, was on the whole exceptionally good. The mobility of the tactical wings was markedly improved and the tactical commanders had fewer

personnel problems to deal with. Further, REMCO permitted the use of specialized maintenance concepts which were generally more economical. The maintenance could be accomplished in permanent and efficient facilities with overall greater logistics support for the combat units. (7:197)

Aircraft Maintenance Issues In Summary

The overall scale of the conflict aside, the Korean War presented some unique challenges to aircraft maintenance. First, the Korean War was the first "jet" war ever fought. This alone contributed heavily to the problems faced by maintenance. The Korean War was also one of give-and-take. The lack of permanent, adequate bases of operation coupled with the need for constant mobility took a grievous toll on manpower, equipment, and supplies. A summary of the problems found in the Korean War is provided in the following statements.

1. Despite dramatic efforts to increase personnel numbers, the Air Force was not able to provide all the specialized personnel FEAF requested. This forced the use of OJT in the combat theater and hurt the combat capability of the units.

2. This situation was further complicated by the 12 month tour-of-duty in Korea. About the time the maintainer got accustomed to the aircraft, or equipment, he was rotated out of the theater. This policy prevented the development of experienced maintenance organizations.

3. In addition, manpower shortages often forced highly skilled personnel to perform the low-skill tasks. The immediate result was a loss of a valuable resource, and a further deterioration of the maintenance complex.

4. The Modified Crew Chief System did not work in Korea. The frequent rotation of personnel stripped the units of skilled crew chiefs.

5. The living and working conditions for maintenance personnel were not good. Pre-fabricated buildings or tents were used as alternates to permanent onstruction. This lack of permanent buildings limited maintenance personnel to performing rudimentary maintenance during cold weather periods. Inadequate maintenance promoted the deterioration of aircraft sooner than expected.

6. Runway and taxiway surfaces were destroyed by the smaller, high pressure tires and exhaust blast from the jet aircraft. Since the landing gear and tires on the jets were not as sturdy as their conventional counterparts the rough surfaces caused them to fail faster than expected.

7. Equipment problems, caused by the runway conditions, forced maintenance to rely very heavily on supply support to keep the aircraft flying. Unfortunately, supply faced its own share of problems and was not able to meet maintenance demands.

8. To overcome the shortage of parts maintenance resorted to cannibalization. Cannibalization doubled the maintenance workload and contributed to a reduction in component reliability.

9. Shortages of tools and equipment provided another challenge for maintenance. Much of the equipment was World War II vintage and required constant attention. Even new equipment could not stand up to the rigors of the Korean environment, so maintenance often went without.

10. All of these maintenance problems were complicated by the frequency of unit movements. Equipment, buildings, and any other

facilities of possible use to the enemy were destroyed. The moves also took a toll on the equipment and supplies that were evacuated from the bases.

11. Aircraft maintenance personnel faced other barriers such as inadequate transportation, the threat of enemy attack, fuel contamination, and other difficulties.

12. In response to some of these problems the REMCO system was formed. Commanders sometimes complained that their maintenance and supply personnel at the REMCOs were unhappy and felt they were not contributing to combat success. At times, maintenance personnel of less than sterling quality were assigned to the REMCOs. This caused the PEAF to intervene and approve all personnel assignments to the REMCOs. On the whole the REMCOs were very successful.

Aftermath Of The War

> Communist military aggression in Korea in 1950 marked the beginning of a new military policy for the United States. In the years since 1945 the United States had come to recognize a state of cold war with Communism, but the Korean aggression was positive proof that Russia and her satellites were willing to risk a general war by "brush-fire" aggressions all over the world. The limited military strength of the United States had not been a cause for peace but had tempted the Communists to exploit war as an instrument of national policy. "The final recognition of this fact by the American people," stated Secretary of Defense George C. Marshall, "made it possible to start the rebuilding of the armed forces to the minimum strength required for the security of the United States...." (4:708)

This radical departure from previous United States security policy had far reaching effects on the Air Force. The build-up of the force and its effects on aircraft maintenance in the TAF will be explored in the next chapter.

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VII. Post-Korea Through the Vietnam War 1954-1973

The United States In Perspective

The nearly two decades presented in this chapter were turbulent times in America. These were years marked by many firsts, by the struggle for civil rights, by the continued fight against communism, by the assassination of some of the nation's leaders, and by a host of other dramatic events. To give the reader a frame of reference for understanding the Air Force changes, during these 20 years, several are recounted in the paragraphs that follow.

American Firsts. Most of the "firsts" which occurred in these years were scientific firsts. In 1956, the first transatlantic telephone cable went into operation. Two years later, 1 January 1958, the first United States earth satellite was lifted into earth orbit. About a year later, 10 December 1958, the first domestic jet airliner passenger service, traveling between New York and Miami, was opened by National Airlines. Between 1960 and 1969, several "firsts" were linked to the newest frontier--space. On 1 April 1960, the first weather satellite was launched into space. Just a little more than a year later, 5 May 1961, Commander Alan B. Shepard, Jr., took the first United States manned sub-orbital space flight. The next year, 1962, Lieutenant Colonel John Glenn, Jr., became the first American to orbit the earth. He did so three times in his spacecraft, Friendship 7. That same year, the United States launched its first communication satellite into earth orbit (12:447). One of the most memorable space events took place on 20

July 1969. On that day astronaut Neil A. Armstrong became the first human to set foot on the moon (12:448).

There were also some firsts which must rightfully be attributed to then President Richard M. Nixon. On 15 May 1970, he named the first two female generals in United States military history (12:448). They were Chief of the Army Nurse Corps, Colonel Anna Mae Hayes and Chief of the Women's Army Corps, Colonel Elizabeth P. Hoisington (7:202). Two years later he made two diplomatic firsts. On 21 February 1972, President Nixon arrived in Peking "for an 8-day visit to China, which he called a 'journey for peace.' The unprecedented visit ended with a joint communique pledging both powers would work for 'a normalization of relations'" (13:449). Several months later, President Nixon became the first United States president visit Moscow. The week of summit talks with Kremlin leaders culminated in a landmark strategic arms pact (12:449).

The Struggle for Civil Rights. It is impossible to address the entire spectrum of the fight for civil rights in these few lines. However, a brief account of the major events which marked this battle will help the reader understand the scope of the civil rights movement. On 17 May 1954, the Supreme Court unanimously ruled school segregation as unconstitutional. This ruling was challenged in 1957 by Arkansas Governor Orval Faubus when, on 4 September, he called out the National Guard to block blacks from entering the all-white Central High School in Little Rock. On 21 September, Governor Faubus complied with a federal court order to remove the National Guard. The black students left the school under threat of violence. This became a national issue when President Eisenhower called in federal troops to enforce the court

order. Several years later, 1 October 1962, James Meredith became the first black student at the University of Mississippi (12:447).

Protests for civil rights took place on both an individual and large scale basis. In 1955, Rosa Parks refused to give up her seat to a white man on a Montgomery, Alabama bus. Following a year long period of boycotts and protests by the National Association for the Advancement of Colored People (NAACP), a federal court ruled the local bus segregation ordinance unconstitutional. A large scale protest followed the refusal of service to four black students at a Woolworth lunch counter in Greensboro, North Carolina. Between February 1960 and September 1961 an estimated 70,000 students, both black and white, participated in sit-ins dramatizing the national situation (12:448).

The remaining years of the 1960s were punctuated by several major civil rights events. On 28 August 1963, 200,000 persons staged a demonstration in Washington, D.C. in support of black demands for equal rights. The highlight of this event was Dr. Martin Luther King's speech in which he said: "I have a dream that this nation will rise up and live out the true meaning of its creed, 'We hold these truths to be self-evident: that all men are created equal'" (12:448). Less than a year later, 29 June 1964, Congress passed a civil rights bill banning discrimination in voting, employment, and the use of public facilities. In three years, blacks witnessed several firsts which signaled some civil rights progress. On 8 November 1966, Edward Brooke became the first black senator elected by Massachusetts voters in 85 years. Less than one year later, Thurgood Marshall was appointed the first black Supreme Court justice. Two major United States cities--Gary, Indiana and Cleveland, Ohio--elected their first black mayors. Finally, in 1968,

Shirley Chisholm was elected as the first black congresswoman in United States history (12:448).

Conflict, Communism, and the Vietnam War. The mid to late 1950s was a time of tentative and often challenged stability in relations between the United States and the Soviet Union. It was also a time of escalation in America's role in Vietnam. "In September, 1954, a few months after the Geneva Conference had provided for the establishment of a Communist-led provisional government in North Vietnam and at a time when Chinese Communists seemed to threaten an invasion of Taiwan, the United States met at Manila with Great Britain, France, Australia, New Zealand, the Philippines, Thailand, and Pakistan to form the Southeast Asia Treaty Organization (SEATO)" (3:515). Members pledged to help one another, within the limits of their constitutional processes, in the event of Communist aggression or subversion. Laos, Cambodia, and "'the free territory under the jurisdiction of the State of Vietnam'" were also included in the terms of SEATO (3:515). By February 1955, the United States had agreed to train the South Vietnamese army (12:447). This continued America's involvement in South Vietnam which had begun in the early 1950s.

The downing of a United States U-2 spy plane over the Soviet Union, 1 May 1960, was the harbinger of changing relations between these two nations. Over the next ten plus years events further aggravated the situation. One of the most dramatic of these events was the Cuban Missile Crisis. On 22 October 1962, President John F. Kennedy revealed a Soviet offensive missile buildup in Cuba when he ordered a naval and air quarantine on the shipment of Soviet offensive military equipment to the island. "This led to a massive preparation of United States

military forces--an action greater than any since World War II--for action in the event the Soviet Union did not remove its missiles from Cuba" (9). The standoff ended on 28 October when President Kennedy and Soviet Premier Khrushchev reached an agreement on a formula to end the crisis. On 2 November, President Kennedy announced the Soviet missile bases in Cuba were being dismantled (12:447-448).

For the next ten years the War in Vietnam dominated the fight against Communist aggression "although the cold war in Europe continued and United States support to the North Atlantic Treaty Organization (NATO) grew in dollar cost and the application of defense resources" (9). By 1963, some 15,000 United States troops were in South Vietnam and more than $500 million in aid had been given. In May 1964 the first United States military aircraft went to Laos. Following the August 1964 attack on two United States destroyers in the Tonkin Gulf, Congress passed the Tonkin Gulf resolution authorizing presidential military action in Vietnam. In February 1965, President Johnson ordered continuous bombing of North Vietnam below the 20th parallel. By the end of that year, 184,300 United States troops were in South Vietnam. On 1 May 1966 the bombing of Cambodia had begun, followed by seven months of bombing in and around Hanoi. In 1966, 385,300 American troops were stationed in South Vietnam, 60,000 more were off-shore, and 33,000 others were in Thailand. By 1967 there were 475,000 troops in South Vietnam and large scale anti-war protests had started in the United States. Peace talks began in 1969, but by the time United States troop withdrawal began on 8 July 1969, troop strength in South Vietnam had reached 543,400 men and women. On 30 April 1970 United States and South Vietnamese troops crossed into Cambodia. Protests against the United

States involvement in Vietnam continued. The accidental shooting of four Kent State students by the Ohio National Guard, 7 May 1970, further focused national attention on the war (12:448). On 27 January 1973, "the four major combatants--the United States and South Vietnam on the one side and North Vietnam and the Viet Cong (the Provisional Revolutionary Government of the Republic of South Vietnam) on the other--signed the cease-fire agreement" (1:321). Two months later 590 American prisoners of war were released by the North Vietnamese. The last troops were withdrawn from South Vietnam on 29 March 1973 (12:449).

Assassinations. In the 1960s the nation witnessed the sudden loss of several of America's leaders. The first to die was President John F. Kennedy. He was shot 22 November 1963 as he travelled by motorcade through downtown Dallas, Texas. Lee Harvey Oswald was arrested and charged with the murder, but was killed by nightclub owner Jack Ruby before he could be brought to trial. Ruby later died of natural causes in 1967 while awaiting retrial on his murder conviction (12:448). The Reverend Dr. Martin Luther King, a leading civil rights figure, was killed on 4 April 1968 in Memphis, Tennessee. An escaped convict, James Earl Ray, pleaded guilty to the murder charge and was sentenced to 99 years in prison (12:448). Finally, the nation watched in horror as Democratic Presidential candidate Senator Robert F. Kennedy was shot following a celebratory speech in Los Angeles 5 June 1968. Sirhan Bishara Sirhan, a Jordanian, was convicted of Kennedy's murder (12:448).

Other Notable Events. Several other happenings of the period are of interest since they describe more of the social character of the United States at that time. In 1955, the two largest unions--the

American Federation of Labor and the Congress of Industrial Organizations--merged to become the AFL-CIO. The union became the largest in the United States with an estimated membership of 15 million (12:447). In 1959 the United States became larger, adding Alaska as the 49th state in January, and Hawaii as the 50th state in August (12:447).

The 1960s saw the dawning of a new counterculture which "rejected bourgeois life goals and personal habits." The use of marijuana and hallucinogens, the wear of miniskirts and long hair, the birth of rock musicals, and other cultural changes typified the turbulence of the years (12:448).

During the same time American troops were returning from Vietnam, the political scene was blown apart. On 17 June 1972 five men were arrested for breaking into the offices of the Democratic National Committee in the Watergate office complex in Washington, D.C. Seven defendants were tried in the Watergate break-in trial, and all were sentenced in January 1973 (12:449). Scandal after scandal plagued the Nixon administration throughout the early 1970s, culminating in President Nixon's resignation on 9 August 1974. President Gerald Ford pardoned him on 8 September 1974 (12:449).

Status of the Force

Post-Korean War. At the start of the Korean War the United States Air Force (USAF) was struggling to maintain 48 air wings "with annual appropriations which were sufficient for only 42 combat wings" (6:709). In early 1951 the Joint Chiefs of Staff approved USAF expansion to a total of 95 wings. By November that same year the USAF expansion plan

had gone up to 143 wings. By the close of the Korean War "the United States Air Force (USAF) possessed 106 active wings, of which 93 were considered operational" (6:709).

> The Department of Defense decision to expand to 143 wings marked its departure from older policies of distributing funds equally among the three services and its acceptance of the principle of allocating military funds in accordance with the priorities assigned to the missions of the services. (6:709)

The goal for USAF expansion fluctuated for a several years. The target of 143 wings was downsized to 120 wings to be attained by the end of June 1956. Then, following President Eisenhower's announcement of his "New Look" defense plan, that goal was revised to 137 wings to be reached by June 1957 (6:709). In his 7 January 1954 State of the Union address the President "explained that the new military policies were taking account of a growing stock of nuclear weapons and the more effective means of using them against any aggressor. The new weapons systems emphasized airpower and permitted economies in manpower" (6:709).

In concert with President Eisenhower's policy, the Department of Defense budget stressed the development of both Navy and Air Force aviation and the continued modernization of land and sea forces (6:709). In any case, the message to the Air Force was quite clear; airpower had been accepted as the predominant power among America's armed-forces. During the expansion programs of the 1950s the USAF moved toward establishing a more modern organization and procuring more jet aircraft.

Tactical Air Command (TAC) Aircraft After Korea. Even before the end of the Korean War TAC had begun to retire the conventional F-51 Mustangs and F-80 Shooting Star jet fighters from the active inventory.

> In 1954 supersonic F-100A fighters began to replace F-86 Sabres and swept wing F-84Fs began to retire straight-wing F-84Gs. During 1955 Tactical Air Command received the F-100C for use as a day-fighter and fighter-bomber, and in 1956 it got the more-advanced F-100D fighter-bomber. In the tactical bomber force the B-57 replaced the old obsolete B-26 beginning in June 1954, and new B-66 and RB-66 all-weather bombers joined the tactical fleet in 1956. Needed to operate into unprepared airstrips where C-119s and C-124s could not land, C-123 Avitrucs and turbo-powered C-130 Hercules transports entered into the Tactical Air Command inventory in July 1955 and December 1956. (6:711)

In addition to the aircraft buildup, new nuclear bombs had been developed which allowed TAC fighter-bombers to deliver weapons of mass destruction. In response to this new found capability, TAC began developing a more mobile force with the capability to deploy on short notice to anywhere in the world (6:711).

The United States had learned that a lack of military strength rather than deterring aggression seemed to invite it. The Korean War left the American people with a clear impression that "world peace would come through strength not weakness. To other Americans the Korean war emphasized the age-old lesson that the price of peace is eternal vigilance--vigilance to detect and halt aggression wherever it appears" (6:711). The Air Force emerged from the Korean War as "a power better able to maintain peace through preparedness" (6:711).

TAC Aircraft Through the Vietnam War. Modernization of TAC continued throughout the late 1950s and into the 1960s. In May 1957, the first McDonnell F-101A Voodoo entered active service with the 27th Tactical Fighter Wing at Bergstrom AFB, TX. It was followed by the F-101C and several reconnaissance variants, the RF-101C, RF-101G, and RF-101H. Although it was short-lived as a tactical fighter, the RF versions saw service in Southeast Asia (5:162). That same year another century series fighter appeared, the Republic F-105 Thunderchief. "The Thunder-

chief was the first supersonic tactical fighter to be developed from scratch" for the USAF. The first production aircraft was delivered to the 355th Tactical Fighter Squadron at Eglin AFB, FL in May 1957. Several models of the Thunderchief were also produced, most numerous of these being the F-105D. The F-105G became the last version of the Thunderchief to be produced in the mid-1960s (5:166).

Although the F-104 Starfighter was produced before the F-105, TAC did not take delivery of the F-104C and F-104D until October 1958. A total of 77 F-104Cs and 22 F-104Ds were assigned to the 831st Air Division at George AFB, CA. They were later transferred to the Air National Guard (5:165). The Convair F-106 Delta Dart was the last of the century series aircraft. Some 340 F-106A and B model aircraft were delivered to the USAF, but all were assigned to Air Defense Command (5:169).

The Northrup F-5 Freedom Fighter, McDonnell Douglas F-4 Phantom II, and General Dynamics F-111 and FB-111 series aircraft were the next generation of TAC fighter aircraft. The F-5 developed from Northrup's 1954 search for a lightweight fighter aircraft. Although it was selected for supply to foreign forces under the Military Assistance Program, TAC never accepted it as a front line fighter (5:172). It was the F-4 Phantom II which became "one of the most successful Western combat aircraft ever built" (5:174). The F-4 was originally conceived as a shipborne fighter for the Navy. However, the Air Force was so impressed by its performance that in 1962 it made the F-4 the standard interceptor and reconnaissance aircraft for TAC, USAF in Europe, and Pacific Air Force. There were several versions of the F-4 ranging from the F-4A to the F-4G. The Air Force took delivery of 583 F-4Cs, 503 RF-

4Cs, 793 F-4Ds, 949 F-4Es, and 116 F-Gs (modified F-4Es). The F-4 saw extensive action in Southeast Asia (5:174). The last of the 1960s era fighters, the F-111, "grew out of the US Defence Department's TFX (Tri-service fighter, Experimental) programme, aimed at finding a common multi-role fighter for all three services" (5:189). It was not considered a success tory by anyone's account. The development and deployment of the F-111 met with problems throughout its rocky ten-plus year career. Several versions of the F-111 were developed from the F-111A to the F-111E. In March 1968 the Air Force deployed an F-111 squadron to Vietnam. Following the loss of several aircraft, and a succession of groundings production was stopped at 562 of the more than 1700 aircraft originally scheduled (5:189).

Manning. Unlike in times past the Air Force was not forced to drastically reduce manpower after the Korean War. Active duty strength at the end of the war was 977,593, it dropped to 947,918 in 1954, but actually rose in 1955 to 959,946. Over the next 14 years manning strength rose and fell slightly, with a low of 814,213 in 1960 and a high of 904,759 in 1968. During the waning years of the Vietnam War, 1970-1973, manning numbers slowly crept down until they bottomed out at 690,999 when the Paris peace pact was signed ending United States military action in Vietnam (11:40).

Aircraft Maintenance: 1954-1973

Maintenance Management. Until TAC published its own maintenance manual in 1957, its aircraft maintenance remained under the Hobson Plan of 1947. The Hobson Plan made "the wing headquarters the highest

organizational echelon on the base" (2:25-26). Of the four subordinate groups created by this plan, two had aircraft maintenance responsibilities. Combat squadrons, within the combat group, were responsible for first and second echelon maintenance on assigned aircraft. The maintenance squadron, within the maintenance and supply group, handled third echelon maintenance on assigned aircraft and all maintenance on base flight and transient aircraft. This organization led to a concept of specialized maintenance in which specialists were removed from the flightline assignments and placed in the maintenance squadrons. The goal was to smooth out fluctuations in demand by having the specialists work on lower priority reparables when they were not needed on the flightline (2:26-27).

AF Manual 66-1: 1956. The Strategic Air Command (SAC) formalized its specialized concept of maintenance in 1949, when it published SAC Regulation 66-12 which later became SAC Manual 66-12. Seven years later the Air Force published its own version of the SAC specialized maintenance manual identified as AFM 66-1. "This manual emphasized centralized control and decentralized maintenance activities" (112:17.28). The following maintenance concepts were formalized in AFM 66-1: (112:17.28-29;10:39)

1. An organization responsible for all actions on assigned equipment with a top manager (Chief of Maintenance) responsible to the (wing) commander.
2. Maintenance staff functions assigned to the top maintenance manager (Chief of maintenance).
3. All tactical equipment of the organizations assigned to, and controlled by, the maintenance organization.
4. Decentralized maintenance functions.

5. Centralized control of all maintenance by a staff function known as maintenance control.

6. Mechanized maintenance data collection; i.e. manhour accounting based on the principle of exception time accounting, technical maintenance actions, and aircraft status reporting.

The Air Force did not at first make adoption of AFM 66-1 mandatory. In fact, United States Air Forces Europe (USAFE) was the only command to make AFM 66-1 mandatory in 1958 (10:38).

TAC Manual 66-1: 1957. Even after AFM 66-1 was published, SAC continued using its SAC Manual 66-12 and TAC published TAC Manual 66-1 in 1957 (2:27). The TAC Manual 66-1, Maintenance Management, was similar to SAC Manual 66-12.

> It emphasized that all aircraft maintenance activities were under the direct control of the chief of maintenance, even though some maintenance personnel were assigned to the tactical squadrons. It also emphasized that the crew chief would not request specialist support or defer maintenance on his aircraft for work that was within the capability of his crew unless time was a factor. The crew chief was responsible for supervising all maintenance performed on his assigned aircraft and was the individual most familiar with its condition. The entire maintenance organization was designed to assist him in fulfilling his responsibility. (2:28-29)

TAC's main departure from SAC Manual 66-12 was that the maintenance people not assigned to the tactical squadrons were assigned to consolidated aircraft maintenance squadrons vice the SAC Piled and Armament-Electronics Maintenance squadrons (2:29).

AF Manual 66-1: 1959. In 1959 the Air Force revised AFM 66-1 and made it mandatory for maintenance management throughout the Air Force. This new AFM 66-1 directed that specialized maintenance concepts be adopted Air Force wide. It also moved the scheduling of all aircraft to the Chief of Maintenance staff. There were several benefits realized under this version of AFM 66-1. "First, it provided a standardized maintenance organizational structure for all commands" (10:39).

Although the major commands published supplements to AFM 66-1, which somewhat altered the organizational structure, the basic Chief of Maintenance Organization stayed intact. Second, the AFM 66-1 published in 1959 brought together some 50 years of aircraft maintenance experience into one document. It did not call for a complete restructuring of the maintenance organization, rather it formalized already existing structures and procedures. This, in itself, had a stabilizing effect on the maintenance organization (10:39).

"Next, the manual set USAF standards, goals, and objectives for the maintenance structure to meet. These standards, goals, and objectives included aircraft in-commission rates; component repair standards; aircraft scheduling objectives; and many others." This gave the maintenance person an idea of what was expected, and the capability to measure performance against known standards (10:40).

Finally, the 1959 version of AFM 66-1 enhanced the maintenance data collection (MDC) system first introduced in the 1956 issue. Although the information was still collected manually it was transferred to punch cards and entered into a computer. Prior to the introduction of automated MDC, "there was no real maintenance data flow from base level through intermediate headquarters to the depots of HQ USAF;" (10:40) what little information provided was in the form of manual reports. The data was fragmented, the reports were bulky and hard to comprehend, and they were forwarded only on a monthly basis. The new MDC system "provided for daily, weekly, semi-monthly and monthly reports to base managers, intermediate headquarters, HQ USAF, and to the depots." The data provided by the MDC system "told managers and planners what was done, why it was done, when the requirement was

discovered, what system was involved, how long it took to do it, and weapon system identification." Data from the MDC were primarily used for procuring spares and equipment, tracking weapon system reliability and maintainability, determining manpower needs, budgeting, and for many other purposes (10:40-41).

TAC Enhancement and TAC Manual 66-31: 1966. In 1966, TAC took steps to reorganize its maintenance structure under a program called "TAC Enhancement" and published TAC Manual 66-31 as guidance for the new structure. The goal of this program was "to provide the tactical squadron commander self-contained maintenance capability during periods of squadron deployments, which became commonplace in the 1960s" (10:43). "To meet mobility requirements prior to the reorganization, the tactical squadrons had to be augmented with support and maintenance personnel." This meant the tactical squadron commander had a "new" organization for every deployment. The results of the reorganization under TACM 66-31 were two-fold. First, the tactical squadron commander controlled his own day-to-day maintenance, and second, that same unit was deployed as a single entity (10:43).

> What TAC did, basically, was to decentralize maintenance into the tactical squadrons, which became the basic operational unit. Flight line personnel were reassigned from the organizational maintenance squadron into the tactical squadrons. Munitions load crews were likewise moved; and phase inspection was moved into the tactical squadron from field maintenance. Also, specialist support was placed in the tactical squadron for limited on-aircraft maintenance to consist mainly of removal and replacement of components. There was even a supply section and maintenance control unit in the tactical squadron provided in this mini-maintenance organization. (10:42)

The base field maintenance and avionics maintenance squadrons still existed, but their responsibilities shifted to providing only off-

equipment (in-shop) repair, or maintenance beyond the capability of the tactical maintenance squadron (10:42).

TAC Aircraft Maintenance and Management In Southeast Asia. In the initial stages of the Vietnam War "there were no provisions or planning made for extensive maintenance support in-country" (8:259). The first USAF maintenance personnel arrived in South Vietnam to find "little in the way of adequate maintenance facilities" (1:245).

> At several bases, lean-to or other temporary structures constituted the only roofed work area. At other bases, buildings which had been built through the Military Assistance Program or those used by the French Air Force were available. One of the first challenges facing the Farm Gate crews (training detachments sent to South Vietnam as early as 1961) was to set up a flightline supply and maintenance capability. To support them in this area, AFLC successfully developed, equipped, and shipped to Vietnam 24 mobile maintenance vans. (1:245)

The vans were quite similar to those used by the service squadrons in World War II and were equipped to perform "machine shop, sheet metal shop, instrument shop, and other shop" work. These vans were mounted on flat bed or semi-trailer trucks which could be moved to a site and quickly set up. The vans came with a generator and an initial supply of essential materials (8:260). As the war went on, some units became so permanently established at their bases they created shops and other maintenance facilities just like in the United States resulting in a gradual phase-out of the vans (8:259-261).

Heavy, non-organizational maintenance for the Air Force was done either in the Philippines or in Japan. However, the Air Force policy of base self-sufficiency "required each unit to accomplish all the maintenance it could and move to the next higher echelon only that which exceeded its capability" (8:260). This policy demanded adequate facilities and a ready supply of spare parts be made available in-country

(8:259). In the early 1960s units deployed with 30-day mission support kits which were replenished from the United States. Additional parts support came from Clark AB in the Philippines. "This (practice) was not completely satisfactory because of the time required to fly in spare parts from Clark to bases in South Vietnam and Thailand" (1:245). To counter this problem, in 1962 the Air Force established Tan Son Nhut Air Base, South Vietnam, as a main logistic base. Several months later the Air Force ordered a return to normal supply procedures for South Vietnam "in lieu of the special aerial resupply system being used." Supply shortages which resulted in aircraft being grounded for parts forced a later return to a modified aerial resupply system (1:245).

Technical Training: A Serious Challenge To TAC. The serious shortage of maintenance personnel during the early years of the war was a manpower problem second only to the aircrew shortage. As in the Korean War, the tour of duty in Vietnam was limited to one year. Thus "the Air Force found it necessary to provide for a continuous flow of airmen (maintenance) technicians to Southeast Asia. Consequently, the training of aircraft, engine, radar, and other specialists became a priority matter, and, on 28 October 1965, Headquarters USAF directed TAC and ATC (Air Training Command) to undertake an expanded program for this purpose" (1:302).

In December 1965, TAC and ATC concluded that TAC should supply the majority of replacements through an expanded on-the-job training (OJT) program on its own bases. Both commands rejected a proposal which would have transferred TAC aircraft to ATC technical training centers. ATC supported TAC in its efforts by expanding field training detachments at 16 TAC bases (1:303).

> TAC was expected to provide half of the maintenance replacements for Southeast Asia with other commands supplying the remainder. But since many airmen in the latter group would lack current qualification or would have no experience on TAC aircraft, TAC and ATC jointly undertook another improvision. Such personnel would be sent to TAC bases in a temporary "enroute to SEA" duty status and receive job-oriented flight line proficiency training as well as specialized instruction. The airmen would get 4 hours of proficiency training from TAC personnel daily during the TDY period, expected to average 30 days. (1:303)

Approximately 1800 maintenance personnel scheduled to augment TAC units already deployed to Southeast Asia were given the highest training priority. Those deployed units had already discovered they needed 25 to 35 percent more maintenance personnel per squadron to meet the high combat sortie rate. The accelerated training program began in January 1966. By May more than 1800 personnel had completed the course and were ready to perform maintenance on aircraft such as the F-100, F-105, F-4C, RF-4C, RB-66, or C-130 aircraft (1:303).

In April 1966 Pacific Air Forces (PACAF) requested 4,813 replacement maintenance personnel for the period July 1966 through May 1967. This request, coupled with an awareness that additional units would deploy to Southeast Asia between May 1966 and April 1967, triggered a second phase of emergency training. The Air Force estimated "ATC and TAC would have to train 3,237 technicians to support the additional units." This estimate was eventually downsized because many units received additional personnel prior to their departure (1:303).

"As the demand for replacements increased during 1966, TAC suffered a steady decline of skilled personnel and had to depend more and more on semi-skilled maintenance men" (1:303). To ease the burden on TAC, USAF decreased TAC's commitment to supply replacements to 45 percent. This caused the TAC OJT rate to jump from 16,711 airmen in

July 1966 to 32,355 by December that same year as other command trainees came through the "enroute" program. These trainees "overloaded housing and messing facilities and, at one point, some enroute personnel undergoing TDY training lived off base and were transported to and from the maintenance shops and flight lines" (1:303). This situation eased a bit after PACAF agreed to take semi-skilled personnel to meet one-third of its requirements (1:303).

The New AFM 66-1. TAC units deployed to Southeast Asia operated under TACM 66-31 and continued to do so until 1972 when TAC reverted to AFM 66-1. This change was motivated both by post-Vietnam War budget cutbacks, and by a training problem created by the clash of the two maintenance management systems--AFM 66-1 and TACM 66-31. The times called for the standardization of management systems into a cost effective organization (10:43).

The Air Force responded to this need by updating AFM 66-1. Since it had been published in 1956, major command "supplements grew to such an extent that once again it appeared each command had its own maintenance management system" (2:29). In a move to counter this situation the Air Force launched project RIVET RALLY, 1 January 1972. "RIVET RALLY was initiated by HQ USAF/Director of Maintenance with an overall goal of improving the management of maintenance." The project "was designed to centralize base level maintenance organizations, standardize functions within those organizations, and develop a common maintenance management directive for use by all commands" (12-17.29). The four phases of RIVET RALLY were: (13:17.29-30)

1. Rewrite AFM 66-1.

2. Review records, reports, and data systems. Rewrite of selected technical orders relating to maintenance management.

3. Field training.

4. Implementation of the new AFM 66-1, 1 October 1972.

The Air Force also incorporated several provisions in the new AFM 66-1 which severely limited supplementation by the major commands (2:29).

Aircraft Maintenance Issues In Summary

Most of the issues facing the aircraft maintenance community, from 1954-1973, were founded in changes in maintenance policy. America's participation in the Vietnam War resulted in few unexpected maintenance problems. The "normal" logistics challenges such as limited facilities, inadequate supplies, and problems organizing maintenance were more or less expected. These kind of challenges are as old as war itself. This is not to say these problems were not important but rather to point out that they carried less weight in an Air Force which had not reduced its numbers, nor ceased to prepare for war. This simply was not the case. The United States had made a commitment to a strong national defense and the public had supported that pledge with tax dollars. Thus, the challenges faced in these nearly 20 years were those inflicted on maintenance by changes in policy and organization. The following paragraphs sum up the maintenance challenges.

1. The Air Force emerged from the Korean war as the predominant power among America's armed-forces. During the expansion programs which followed the war, the USAF took steps to modernize the force and procure more jet aircraft. To the maintenance man this meant there was less of a drawdown in the force and an actual improvement in the overall outlook

for maintenance. Unlike times past the Air Force was not forced to drastically reduce manpower after the Korean War. Although active duty strength declined from 977,593 in 1953 to 690,999 in 1973 it was a gradual decline. The procurement of more jet aircraft meant the phasing out of older aircraft. Although some of these aircraft were not the maintenance person's dream, they certainly were a step up from the Korean War era jet and reciprocating engine aircraft.

2. Until TAC published its own maintenance manual in 1957, its aircraft maintenance remained under the Hobson Plan of 1947. This plan created two aircraft maintenance areas of responsibility. Combat squadrons were responsible for first and second echelon maintenance on assigned aircraft, and the maintenance squadron handled third echelon maintenance on assigned aircraft and all maintenance on base flight and transient aircraft. This approach placed the specialists in the intermediate squadrons allowing them to work on lower priority reparables when they were not needed on the flightline.

3. The Air Force published its specialized maintenance manual, AFM 66-1, in September 1956. AFM 66-1 installed the Chief of Maintenance as the top maintenance manager, gave him a staff, assigned the aircraft to maintenance, centralized control but decentralized maintenance, and provided for mechanized maintenance data collection.

4. TAC published its own TAC Manual 66-1 in 1957. TACM 66-1 also provided for the chief of maintenance but went beyond the AFM 66-1 by providing a strong crew chief system. The crew chief was responsible for supervising all maintenance performed on his assigned aircraft and the entire maintenance organization was designed to assist him in fulfilling his responsibility.

5. In 1959 the Air Force revised AFM 66-1 and made it mandatory for maintenance management throughout the Air Force. This new AFM 66-1 directed that specialized maintenance concepts be adopted Air Force wide. It also moved the scheduling of all aircraft to the Chief of Maintenance staff. The benefits realized under this new version of AFM 66-1 included:

- the creation of a standardized maintenance organizational structure for all commands;

- the bringing together of some 50 years of aircraft maintenance experience into one document, thereby stabilizing the maintenance complex;

- the setting of USAF standards, goals, and objectives for the maintenance structure to meet;

- and finally, the enhancing of the maintenance data collection (MDC) system first introduced in the 1956. These MDC data were then used primarily to procure spares and equipment, track weapon system reliability and maintainability, determine manpower needs, set a budget, and for many other purposes.

6. In 1966, TAC reorganized its maintenance structure under a program called "TAC Enhancement" and published TAC Manual 66-31 as guidance for the new structure. This program provided the tactical squadron commander with a self-contained maintenance capability for squadron deployments.

7. TAC faced some maintenance problems in the Vietnam War. These included:

- an initial lack of maintenance facilities was overcome by fairly large mobile maintenance vans;

- the performance of heavy, non-organizational level maintenance in the Philippines or in Japan in direct conflict with the Air Force policy of base self-sufficiency;

- the lack of a sufficient supply system which resulted in the use of an expensive aerial resupply system;

- a serious shortage of trained maintenance personnel which forced TAC to undertake a massive maintenance training program;

- and, the use of more semi-skilled personnel by TAC caused by the rise in demand for replacements during 1966;

8. Post-Vietnam War budget cutbacks, and training problems created by the clash of the two maintenance management systems--AFM 66-1 and TACM 66-31--called for the standardization of management systems into a cost effective organization. In response to this problem USAF launched project RIVET RALLY in January 1972. RIVET RALLY was aimed at centralizing base level maintenance organizations, standardizing functions within those organizations, and developing a common maintenance management directive for use by all commands. RIVET RALLY culminated in a new AFM 66-1 with provisions to limit supplementation by the major commands.

Afterword

After the dust had settled on the Vietnam War the Air Force was again forced to change its maintenance structure. The scarcity of money resulted in Air Force wide maintenance consolidations, both inter-command and intra-command. These were aimed at eliminating "needless duplication of manpower, equipment, and facilities" (10:44). "The Chief

of Staff, USAF, directed the establishment of a Maintenance Posture Improvement Program (MPIP), to develop new ways to more effectively and efficiently perform the aircraft maintenance mission" (10:44). A further explanation of MPIP and the TAC reaction to the program will be covered in the next chapter.

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VIII. Changing Times 1973-1933

The United States In Perspective

The remainder of the 1970s and the early 1980s were tough times in the United States. Mistrust of the government, a relatively sluggish economy, energy and resource shortages, and environmental problems fed America's feelings of disillusionment.

American Firsts. Apart from these generalization, the mid-1970s through the mid-1980s were also years marked by several "firsts." In 1977, Gary Gilmore was executed in Utah. He was the first person to be executed anywhere in the United States in 10 years. On 12 April 1981, the world's first reusable spacecraft, space shuttle Columbia, was launched. Several months later, Sandra Day O'Conner became the first woman appointed to the Supreme Court. In 1982, Dr. Robert Jarvick implanted the first permanent artificial heart in Dr. Barney Clark, 61, a retired dentist. Finally, on 18 June 1983, Sally Ride, aboard the space shuttle Challenger, became the first American woman in space (6:450).

The Resource "Crunch" and Financial Change. As noted earlier, financial changes and resource shortages were also present in these years. The United States faced first a natural gas crunch in 1975, and then a gasoline shortage in 1979 (6:514). That same year, Congress bailed the nation's third largest automobile maker--the Chrysler Corporation--out of financial ruin with a $1.5 billion loan-guarantee. The largest tax cut in United States history was passed by Congress on 29 July 1981. The first cut, in 1982, totalled $37.6 billion with

another $750 billion to be cut over the next five years. Unfortunately, 1982 witnessed the highest unemployment rate since 1940 at 10.8 percent with an estimated 11 million persons out of work.

Conflict in the Far and Middle East. America also experienced a number of hostile actions over these years. Some were actions initiated by the United States and others were perpetrated against the United States through another nation's citizens. Two years after the close of the Vietnam War, the North Vietnamese communists completed a take over of South Vietnam. United States civilians were evacuated from Saigon on 29 April 1975 as North Vietnamese forces swept across the South. Two weeks later, Cambodian forces seized the United States merchant ship Mayaguez and her crew in the Gulf of Siam. In rescue-operations, United States Marines attacked Tang Island, and planes bombed the nearby air base, until Cambodia released the ship and crew (6:449-450).

In the following years trouble shifted from the Far East to the Middle East. On 4 November 1979, 63 Americans were taken hostage at the American embassy in Teheran, Iran by militant student followers of the Ayatollah Khomeini. The Ayatollah demanded the return of former Shah Mohammad Reza Pahlavi, who was in the United States undergoing medical treatment. Although several of the hostages were released over the next two years the remaining 52 were held until freed on 20 January 1981 in exchange for the release of over $8 billion in frozen assets. In 1980, a year after the hostages were taken in Iran, President Carter announced sanctions against the Soviet Union in response to its invasion of Afghanistan. These sanctions were mostly fulfilled by embargoes of grain and high technology. The United States Olympic Committee also voted not to participate in the Moscow Summer Olympics (6:450).

Tragedy struck the nation when a 23 October 1983 terrorist bomb attack in Beirut, Lebanon claimed the lives of 241 United States Marines and sailors. These Americans were part of a United Nations' multinational peacekeeping force housed at the Beirut International Airport. Two days later, in an unrelated move, United States Marines and Army Rangers, along with a force from six small Caribbean nations, invaded the island of Grenada. The Organization of Eastern Caribbean States requested this support under threats of a Cuban takeover of the island nation. After several days of fighting, the Grenadian militia and "Cuban construction workers" were overcome and the Marxist regime deposed. Hundreds of United States citizens, many of them students, were evacuated from the island to safety. Under the 1973 War Powers Act, United States troops were required to leave Grenada no-later-than 24 December 1983 and they did (6:451).

Other Events. Finally, the years following the Vietnam War were filled with a number of unrelated events which helped shape the nearly two decades. In a hot week in July 1976, 29 American Legion conventioneers in Philadelphia were killed by the mysterious "legionnaires disease." It took nearly a year to discover the cause of the disease was a bacterium found in the air conditioning system of the hotel. In 1977, President Carter gave a blanket pardon to an estimated 10,000 Vietnam era draft dodgers. Disaster struck the nation when, on 28 March 1979, the nuclear reactor at Three Mile Island near Middletown, Pennsylvania experienced a partial meltdown. A combination of equipment failure and human error was blamed for the accident. The next year President Ronald Reagan was elected to the first of two terms, becoming the nation's 40th president (6:450). President Reagan became the fifth president in

United States history to survive an assassination attempt on 30 March 1981. The President along with his press secretary James Brady, Secret Service agent Timothy J. McCarthy, and a Washington, D.C. policeman, Thomas Delahanty, were shot and seriously wounded by John W. Hinckley, Jr. (6:547). In 1982, the Equal Rights Amendment drew its last breath following a long, but failed, ten year struggle for ratification (6:450).

Status of the Force

There are two distinct periods of development in the Air Force in the post-Vietnam War period. The first covers the period of drawdown following the war and the second, the years following President Ronald Reagan's election in 1981. In that first period,

> the relationship between the military and American society reached new lows as many Americans blamed the military for our involvement, for the 'immoral' conduct of the war, and for the inability to achieve a clear victory. For several years, the aversion to all things military resulted in a gulf between society and military unknown since before World War II. The replacement of the draft by the all-volunteer army (1973), several years of reduced military budgets, and the decline of ROTC programs across the country reflected an antimilitary attitude that went beyond mere neglect. (4:61)

The end of fighting in Vietnam led to a large scale drawdown of United States military forces. Over a six year period, from 1974 through 1980, active duty manning fell steadily. In 1974 Air Force strength stood at 643,795, but reached a low of 557,969 by 1980 (5:40). However, this reduction was not met with an equal reduction in the threat of the Soviet Union. America's attention had been "refocused on the defense of Western Europe, promoting peace in the Middle East, and insuring governments in the Third World (were) not overthrown by external forces"

(1:75). The Air Force was striving to meet these commitments through a high state of readiness. To keep an aircrew well trained meant many hours of flying. "Aircraft maintenance, in turn, had to bear the brunt of the incompatible factors of low manning and high sortie production" (1:75). "The old, worn out cliche of 'doing more with less' was the obvious order of the day. What was not so obvious was the means to accomplish it" (1:75).

Changes in the structure of aircraft maintenance were motivated by the concern over Air Force readiness. "A major question was raised regarding the ability of the USAF to increase sortie generation and provide better surge capability" (1:75-76).

> In the past, there had been a shortfall in aircraft sortie production to meet the needs of operational and aircrew training requirements. An identified cause for the inability to meet those requirements was maintenance capability and training. (1:76)

This need to increase sortie production capability was complicated by a small aircraft maintenance force. In 1977 there were approximately 137,000 base level aircraft maintenance personnel. Of those, "approximately 16 percent were in overhead or management positions above the flight chief of work center supervisor level" (1:76). This situation pointed to the need to better utilize all available maintenance personnel. TAC's approach to the development of the aircraft maintenance system is covered in detail in the following sections.

A second period of Air Force development followed President Ronald Reagan's 1981 election. A strong supporter of national defense, President Reagan steadily built up United States military forces. As a result of the build up Air Force manning rose from 570,302 in 1981 to 592,044 by 1983 (5:40).

TAC Aircraft Maintenance in the Post-Vietnam Era

The post-Vietnam era was "marked by maintenance consolidation at every level." As dollars became more scarce, emphasis on economy of effort became more pronounced. "Maintenance consolidation throughout the Air Force, both inter-command and intra-command (was) directed to eliminate needless duplication of manpower, equipment, and facilities" (3:44). During this time, the Chief of Staff, USAF, created the Maintenance Posture Improvement Program (MPIP), "to develop new ways to perform required maintenance with diminishing numbers of personnel without compromising safety standards" (1:76). MPIP's executive board, the Major Command's directors of maintenance and their staffs, were tasked to consider the following areas: (1:77)

1. Manpower and how it is utilized.
2. Training of maintenance personnel.
3. Modernization of ground equipment.
4. Aircraft shelters.
5. Hardening of maintenance facilities.
6. Dispersal of shops.
7. Organizational structure of the maintenance operation.
8. Numerous other areas which impact on how maintenance does business.

MPIP's executive board believed during the first several days of a Western European war, "aircraft will have to fly as many as 10 to 15 sorties per day, compared to the present training level of 1.5 sorties per day" (1:77). The question first asked was "Can maintenance generace a sufficient number of sorties and sustain it over a period of time?" (1:77). With the current manning, organizational structure, and equip-

ment availability the Air Force did not feel very confident in answering the question in the affirmative. What the Israelis did in the Yom Kippur War in October 1973 caused the Air Force to change its mind (1:77).

In that war the Israelis were able to produce a high sortie generation rate. In an effort to discover how they had done this the Chief of Staff dispatched a joint Air Staff/TAC team to Israel. What they discovered had a significant impact on the restructuring of TAC aircraft maintenance. The Israelis assigned the people who did maintenance on the aircraft directly to the flightline instead of having them dispatched from the shops. All maintenance personnel worked together to launch and recover aircraft, resulting in less specialization on the flightline. (This practice was in direct contrast to the system currently in use in the United States Air Force.) This system of maintenance "appeared to have great possibilities in the fighter environment" where "rapid aircraft turnaround sortie generation and surge capability were essential" (1:78). Yet, this concept did not lend itself well to strategic bombing and airlift operations. "Therefore, the major commands agreed to take a new, innovative approach to aircraft maintenance, in support of MPIP," but the commands would not force standardization. If standardization could be achieved by weapon system and mission, so be it, but "standardization for the sake of standardization was no longer a valid mode of operation" (1:78).

The Production Oriented Maintenance Organization (POMO). Several factors led to the development of POMO. Not the least of these was the tasking leveled by HQ USAF, in 1974, for TAC to develop and test a program based on the basic concepts of Israeli aircraft maintenance.

TAC would transition from a centralized maintenance concept under AFM 66-1 to one of its own creation under AFR 66-5. Before explaining the POMO concept it may be helpful to briefly review an outline of the features of the centralized maintenance concept. They include the following: (2:22-23)

1. Maintenance was centralized at wing level. Included in this were: avionics specialists, weapons load personnel, periodic maintenance, AGE, maintenance support section (bench stock, tool boxes, etc..), flight debriefing, data analysis, controlling (job control), monitoring, supply interface, and planning and scheduling.

2. Any wing pilot flew any wing aircraft.

3. Any crew chief and any specialist worked on any aircraft.

4. Crew chiefs were on the flightline, all others were behind, or off the flightline.

5. Lots of coordination, transporting, and paperwork were required--which meant lots of clerks were needed.

6. Statistics were aggregated by wing; strong carried the weak (and the weak got away with it).

7. A squadron had to be "assembled" from the various parts of the wing to go to war--essentially it was an organization where everyone was strangers.

Control was placed at the top. The workers were considered to be generally self-motivating and self-supervising. When they had to troubleshoot a weapon system or component

> the specialist was transported to the aircraft to isolate the failed component, remove it, travel back to the shop to troubleshoot it, order parts, and repair it. Much time was lost during this transportation process. Also, during slack periods, much time was wasted by specialists waiting for a dispatch from job control. It (was) theorized that a good deal of this travel time and waiting time could be otherwise spent repairing aircraft or assisting in launch, recovery, or servicing if personnel were located closer to the aircraft and trained to perform those tasks. (1:79)

The theory was if all the inputs were just right then the output would take care of itself. Since all the performance statistics were aggregated "it was virtually impossible to accurately judge the relative success or failure of the various sub-elements. There was no competition--in fact, it was discouraged both by theory and by the organizational arrangement. Unit pride was not a player" (2:23). So TAC set out to reorganize, and the first step in this reorganization effort was POMO.

POMO took advantage of the "natural 'on' and 'off' equipment split in maintenance" (1:80). It divided the specialists into two distinct categories, those who were dispatched to the flightline and those who remained in the back shop. (This action created further specialization of some specialties, as the terms "flightline" and "back shop" were adopted to designate what type of work the specialist did.). Those specialists who were normally dispatched to the flightline were taken out of the shops and assigned to the flightline organization--the Aircraft Generation Squadron, or AGS. Within the AGS, assuming a full wing, three separate Aircraft Maintenance Units (AMUs) were established. "Each AMU consisted of all the (maintenance) skills required for warfighting" (2:24). The remaining specialists were divided into two off-equipment units--the Equipment Maintenance Squadron (EMS), and Component Repair Squadron (CRS). The key to the POMO concept was "the cross training of the flightline specialist to perform many general type tasks which (were) relatively simple and routine in daily maintenance. However, the individual (would) still retain his primary specialty" (1:80). It was hoped that by placing these people where the work was

they would become more personally involved in sortie production and the sortie rates would go up (1:80).

POMO, however, did not achieve the desired results. It was true that the AMU concept provided a basis for comparison and competition, but that was not enough.

> There was still a split in authority and responsibility between AGS and job control. The Aircraft Generation Squadron owned the people; but control remained vested in the "job control" that had been the centerpiece of the centralized concept. Job control could still move specialists around the flightline--they had the authority, but AGS had the responsibility for producing the sorties. (2:24)

This, and other problems, led TAC to take a second step in the reorganization of maintenance.

The Combat Oriented Maintenance Organization (COMO). When General W.L. Creech took command of TAC in May 1978 he commissioned a study to see just how well POMO was working in TAC. He took this action because "he had noted from afar that whatever else the merit of the centralized maintenance organization, it certainly wasn't doing very well across the Air Force in producing sorties." General Creech wanted to "quantify where TAC had been, where it was, and where it was going in terms of sortie productivity." He felt sortie productivity was the "critical measurement" of the product because "the flying sorties train the aircrews who are the ones to go to war" (2:17). The 1978 study revealed that TAC did indeed have a serious problem.

The study, which covered the period from 1969 through the second quarter of 1978, showed TAC was experiencing a steady decline in sortie production. TAC's goal was an aircraft utilization rate (UTE rate) of 18 sorties and 25 hours per aircraft per month. The study showed not only that TAC was not close to meeting that goal, but, in fact, was

losing an average of 7.8 percent of its sortie production per year. Although the study pointed out several reasons for this decline, one of them was not a shortage of authorized flying hours. Congress had provided ample budget authority, but TAC simply "could not produce the hours and sorties it had programmed." The effect of TAC under-flying these sorties was showing up in the growth of aircrew dissatisfaction levels and a lowered combat readiness posture (2:19-20). General Creech knew where TAC had been, and where it was now; what he had left to do was point the direction for TAC to go.

He believed the major problem underlying TAC's inability to meet sortie production goals was the organization of aircraft maintenance. POMO, although better than the centralized maintenance concept under AFM 66-1, still needed attention. The new maintenance initiative, born from the study, is COMO--Combat Oriented Maintenance Organization. COMO's features include: (2:25)

1. Each squadron/AMU does its own scheduling vice the wing; and is responsible for its own UTE rate.

2. Each squadron/AMU has its own dedicated analyst to provide statistical analysis.

3. Wing score-keeping functions such as MSL (Maintenance Supply Liaison) were eliminated and supply responsibility is decentralized to each squadron/AMU.

4. Under the new Combat Oriented Supply Organization (COSO), the squadron/AMU has its own supply support section instead of it being centralized.

5. COSO also provides for the squadron/AMU supply computer to interface with the AGS Parts Store (a flightline located supply warehouse.)

6. The squadron/AMU does its own maintenance debrief instead of having it centralized at the wing.

7. The squadron/AMU has its own dedicated AGE sub-pool.

8. The squadron/AMU has dedicated phase docks for aircraft inspection.

9. Maintenance has gone from three shifts to two, with increased supervision on the swing, or "fix" shift.

10. Dedicated crew chiefs and assistants are assigned to each aircraft.

11. Job control was replaced by the MOCC (Maintenance Operations Coordination Center); power rests in the AMU not in MOCC.

12. There is squadron integrity; red hat maintenance on red tail aircraft flown by red scarf pilots.

The appeal is to unit pride. This is the central theme of COMO. General Creech felt the people had to be able to identify with their unit. The units had to not only be responsible for their actions, but to have the authority to go along with that responsibility (2:26).

The results of the transition to COMO have been dramatic. Sortie production, from the third quarter of 1978 through the third quarter of 1983, rose at an annual rate of 11.2 percent. In the first full year under COMO, 1979, TAC flew all of its programmed sorties for the first time in a decade. General Creech's study points out that this was done despite a worsening supply picture and declining workforce experience level (2:29). In 1978, TAC had 14.9 percent of its aircraft grounded for parts, but by 1979 that number rose to 15.8 percent (2:30). Although the percentage of "first termers" to "career" maintenance specialists dropped from 62 percent in 1978 to 61.5 in 1979 it was not a significant change since TAC was experiencing serious shortages in seven- and nine-level senior NCO supervisors. From 1978 to 1979 the shortages in assigned versus authorized manning levels jumped 2.6 percent for 7-levels, and 3.6 percent for 9-levels (2:32). The General concluded it was not "more people, or more experience, or more parts"

which made the difference; it was the leadership and organization under COMO.

COMO promotes unit competition and uses other techniques--such as the dedicated crew chief and expanded awards programs--to "foster motivation, pride, and responsibility" (2:34). As part of COMO, TAC implemented a system of annual and monthly goals. Since "like" aircraft fly "like" UTE goals, these goals can be translated across wings and allow for a method of comparison. The control over how to schedule to meet year-end sortie goals is placed in the unit. The unit decides how many sorties it is going to fly each month to meet that goal (2:34). TAC also made some major improvements in the maintenance facilities through programs like "New Look, Smart Look, and Bright Look." The goal here was to create "a feeling of pride and a sense of quality in the maintenance technicians." As General Creech put it, "You can't treat them shabbily, and house them shabbily, and expect quality work in return" (2:34).

From January 1978 through January 1983, the maintenance trends reflected the changes brought about by COMO. The mission capable (MC) rate rose from 57.8% to 72.6% for all TAC aircraft, and actually hit 73% for TAC operational fighter aircraft (2:41). Total non-mission capable for maintenance (TNMCM) rates fell from 35.6% to 18% for all TAC aircraft, and from 38% to 15.3% for TAC operational fighter aircraft (2:42). Other maintenance figures, based on all operational TAC fighter aircraft from the second quarter of 1978 through 1984, reflect a continuing trend toward improvement. The break rate, the percent of aircraft landing and requiring repair before the next flight (2:A-7), dropped from 19.0% to 17.3%. The 8-hour fix rate, the percent of

aircraft returned to MC status in 8 hours (2:A-7), rose from 20.1% to 74.6%, an increase of 271%. The out for maintenance rate, the percent of those aircraft requiring repair before the next flight (2:A-7), dropped from 41.5% to 12.0%. Finally, The MC rate continued to rise from 51.7% to 83.0%, for an increase of 61% (2:A-6). (The TAC briefing slides are presented at Appendix D.)

Aircraft Maintenance Issues In Summary

This chapter represents 10 years in the development of Air Force aircraft maintenance. New concepts were tried, modified, accepted, used, and discarded. The following paragraphs summarize the many maintenance issues covered in this chapter.

1. Of the nearly 137,000 base level aircraft maintenance personnel in the Air Force in 1977, approximately 16% were in overhead or management positions above the flight chief of work center supervisor level. The need to increase sortie production forced the Air Force to reconsider the supervisory structure of the maintenance organization.

2. The scarcity of defense dollars in the post-Vietnam era forced both inter-command and intra-command maintenance consolidations. To develop new ways to perform maintenance with diminishing numbers of personnel the Chief of Staff, USAF, created the Maintenance Posture Improvement Program (MPIP). MPIP's executive board considered many key areas such as manpower, training, modernization of equipment, maintenance organization, etc. . . . The end result of TAC's participation in MPIP was the Production Oriented Maintenance Organization (POMO).

3. POMO took advantage of the "natural 'on' and 'off' equipment split in maintenance" (1:80). Specialists were taken out of the shops and assigned to the flightline organization, the AGS. Within the AGS three separate Aircraft Maintenance Units (AMUs) were established. Specialists not needed for direct flightline production were divided into two off-equipment units--EMS, and CRS. The key to the POMO concept was to cross-train the flightline specialist to perform many aircraft general tasks while still retaining a primary specialty. POMO did not achieve the desired increase in sortie production rates. TAC felt this was due to the disparity between having the responsibility to produce and having the authority to enforce production. This led TAC to enhance POMO through the creation of the Combat Oriented Maintenance Organization (COMO).

4. COMO promoted unit competition and used other techniques--such as the dedicated crew chief and expanded awards programs--to "foster motivation, pride, and responsibility" (2:34). As part of COMO, TAC implemented a system of annual and monthly goals to act as achievement bench- marks. Control over how to schedule to meet year-end sortie goals was placed in the unit. TAC also improved the maintenance facilities through programs like "New Look, Smart Look, and Bright Look." The goal here was to create "a feeling of pride and a sense of quality in the maintenance technicians" (2:34).

Afterword

The ten years covered by this chapter reflect several changes in the structure of the TAF aircraft maintenance organization. The scarcity of

defense dollars in the post-Vietnam War era drove the Air Force to consider new ways to accomplish the required maintenance with fewer people and assets. TAC met the challenge through the creation of POMO and its successor, COMO--which continues as the standard concept of TAF aircraft maintenance. However, additional cuts in the defense budget coupled with rapid changes in world politics are presenting new challenges to the TAF aircraft maintenance structure. The next chapter explores the TAF response to these challenges.

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IX. New Challenges 1984-1991

The United States In Perspective

The Reagan Years. President Reagan's eight year presidency (1981-1988) "brought the longest economic boom in U.S. history via budget and tax cuts, deregulation, 'junk bond' financing, leveraged buyouts, mergers, and takeovers" (17:516). The Reagan administration also took "a strong anti-Communist stance via increased defense spending, aid to anti-communists in Central America, invasion of Cuba-threatened Grenada, championing of (the) MX missile system and 'Star Wars' (a space based defense system)" (17:516). Four summits between President Reagan and Soviet President Mikhail Gorbachev, 1985-1988, climaxed in the Intermediate Nuclear Forces (INF) treaty of 1987 (17:516). The "Reagan Years" were not without their share of problems. Financial scandals, the stock market "crash" of 1987, a growth in trade imbalance (especially with Japan), a soaring budget deficit ($3.2 trillion in 1988), a rise in the number of homeless persons, increasing drug abuse, and the Iran-Contra scandal marred the American social landscape (17:516).

Other Events. The 1980s were filled with many significant national events. On 7 February 1984, Navy Captain Bruce McCandless and Army Lieutenant Colonel Robert Stewart became the first humans to fly free of a spacecraft (17:451). That same year, Walter Mondale, the 1984 Democratic presidential nominee, made history when he selected a woman--Representative Geraldine Ferraro, as his vice-presidential running mate (17:451). As the federal deficit continued to climb, Congress made a last-ditch effort to curb it by passing the Gramm-Rudman-Hollings (GRH)

bill on 11 December 1985 and President Reagan signed the bill into law the next day. GRH was aimed at forcing the government to produce a balanced budget by 1991; it did not work (17:451). To add to the nation's financial woes, the stock market experienced a series of "mini-crashes" culminating in a record 508 point drop in the Dow-Jones Industrial average on 19 October 1987 (17:452). The space program suffered a major setback following the 28 January 1986 explosion of the space shuttle Challenger shortly after takeoff. All seven astronauts were killed in the accident. Investigation revealed that "NASA had abandoned 'good judgement and common sense' regarding safety problems (which) caused the explosion" (17:451). On 4 February 1988 federal grand juries in Miami and Tampa, Florida returned indictments against General Manuel Noriega. The ruler of Panama was charged with protecting and assisting the Medellin (South American) drug cartel with drug smuggling operations into the United States. The cartel's operations were thought to be responsible for up to 80 percent of the cocaine smuggled into the United States. United States troops eventually went into Panama, captured General Noriega, and transferred him to a Miami jail where in August 1991 he is still awaiting trial. That same year a United States Immigration and Naturalization policy allowed nearly 1.4 million illegal aliens to apply for amnesty and seek American citizenship. Trouble again flared up in the Middle East only this time it was an American missile which caused the damage. On 3 July 1988, a missile fired from the Navy warship Vincennes struck and destroyed an Iranian airliner killing all 290 persons aboard. The Pentagon claimed the crew had mistaken the airliner as an attacking Iranian F-14 fighter, but that theory was later disproved and the crew was disciplined. In November

1988, Vice-President George Bush became America's 41st president (17:452). Five years later, 10 August 1989, President Bush nominated Army General Colin Powell as the first black Chief of Staff (17:453). Acquired Immune Deficiency Syndrome, or AIDS, became a national concern in the 1980s. By June 1986 an estimated 11,713 deaths were attributed to AIDS and some 21,517 cases had been documented in the United States (17:450). United States officials predicted the number of AIDS cases would increase tenfold over the next ten years. AIDS researchers announced in 1990 a drop in the rate of increase of the number of AIDS cases in the United States (17:53). By the close of 1989, AIDS cases were estimated at 29,731 with 21,360 deaths attributed to the disease (17:846).

Shifts in World Politics. The American experiences in the three years since President Bush's election have largely been overshadowed by dramatic events in Europe. The decade of the 1990s will probably best be remembered for the decline of communism. As Soviet President Mikhail Gorbachev promoted his policies of glasnost and perestroika the walls literally came tumbling down. In October 1989, Erich Honecker stepped down as leader of the Socialist Unity (Communist) Party in East Germany. His successor, Egon Krenz, was unable to stem the flow of domestic reform. After the border with Czechoslovakia was opened, thousands of East Germans asked to leave. On 9 November 1989, Krenz's government agreed to issue exit visas to anyone who wished to go. This was the day the Berlin Wall, a symbol of Communist oppression, came down. A whirlwind of events swept through the two Germanys culminating in their official reunification on 3 October 1990 (17:37). Other Communist countries have felt the winds of change as well. Buzzwords like "reform

and breakaway republic" are commonplace in world news. To many, the Cold War has ended; only time will tell if that statement is true.

Status of the Force

From 1984 through 1986 military manning continued the steady climb initiated by President Reagan. By 1986 Air Force manning had risen to 608,199 airmen (14:40). Then, in 1987, Air Force manning numbers began to decline. The fact is times are, again, changing. Today's Air Force faces a break up of the Soviet east bloc coupled with an economic downturn in the United States. "Concurrent with these changes are the economically and politically induced DOD 'streamlining' efforts which mandate getting the job done with a lot less" (8:2). Force restructuring efforts include force reductions, fewer promotions, selective early retirement, early outs, and large strength cuts (8:2). In 1991 Air Force strength reached its lowest level in 40 years--508,558--and this level is projected to fall even further to 486,819 by 1992 (14:40). How the TAF is coping with these rapid changes is outlined in the following pages.

Changes in the TAF Concept of Aircraft Maintenance

COMO has been a success story not only for TAC but for the entire Tactical Air Force (TAC, USAFE, and PACAF) operating--pretty much in its original form--for nearly 14 years. Today, however, logistics planners are facing two new challenges

> which will dictate the future of our combat forces and their ability to assert the national will. The most immediate, yet not the most significant, is financial--obtaining defense dollars

> during a period of economic retrenchment. Conversely, the most important, yet easiest to delay considering, is the dramatic change inside the Soviet Union. (7:16)

These two challenges, no matter how diverse, are nearly impossible to separate in that each is driving changes in the structure of the Air Force. Within the TAF aircraft maintenance community the most significant challenges have been the adoption of Rivet Workforce, a proposed move to the concept of two-level maintenance, and the creation of two types of new wings; the TAF Composite Wing, and the TAF Objective Wing. The TAF Composite Wing is organized around the concept of being "a self-contained, self-sufficient fighter wing" which includes "all facets of (a) strike force package" (16:11). The TAF Objective Wing, on the other hand, is not designed as a self-sustaining unit. However, in both cases, the organizational structure of the wing is very similar. Both the TAF Composite and Objective Wings are discussed in greater detail in the following pages.

Rivet Workforce. Leaders in the aircraft maintenance community were already looking at ways of reducing their manpower numbers years before these current reductions. In 1984, the Air Force began an internally generated study of aircraft maintenance. The result was a new maintenance manpower initiative--Rivet Workforce. Rivet Workforce was conceived after the study revealed basic organizational and structural problems in the aircraft maintenance Air Force Specialty Codes (AFSCs) (6:2). An AFSC is a grouping of duties and tasks related in skill, knowledge, or difficulty for the purpose of effectively matching skills to tasks. The following paragraph details the findings of the study.

First, the study found over 100 AFSCs were not being sufficiently used and still others were being over-tasked. Second, it found the

number of people required for some AFSCs was being driven by shift coverage instead of workload need. Third, the study recognized certain critical AFSCs were needed for deployment. However, it found those AFSCs were often not used effectively during deployments. Examples were the engine or hydraulic specialists. They were needed for deployment, yet if they had no work they simply sat idle waiting for the next job to come. Finally, the study found the more technologically advanced, or "newer," aircraft do not break as often; however, when they do, the breaks are often more complex than breaks in older aircraft (6:2).

This last finding was of immediate concern to the Air Force because "under the old AFSC system, maintenance personnel moved from one weapons system to another" (6:2). The Air Force felt this practice degraded the technician's skills, rendering them less capable to fix the newer aircraft.

> As an example, over 40% of our /-level integrated avionics technicians were working on different aircraft than the one they were last assigned. Besides the loss of expertise, we had to "retrain" these technicians on the new aircraft and some tasks couldn't be taught in the classroom. This moving from weapon system to weapon system prevented our technicians from developing to their full technical potential. (6:2-3)

In response to the deficiencies noted by the study, Rivet Workforce was designed "to create a more flexible, mobile, and survivable workforce of aircraft maintainers" (6:3). To help with the construction of Rivet Workforce, the Air Force enlisted the Human Resource Laboratories (HRL), Wright-Patterson AFB Ohio, and the major commands (MAJCOMs). HRL interviewed technicians to evaluate old AFSCs and to create new ones. The new AFSCs were aimed at linking similar technologies and evening workloads. The proposed AFSC combinations were

thoroughly reviewed by MAJCOM and field level technicians before their adoption (6:3-4).

Under Rivet Workforce, technicians are aligned to a specific aircraft type or system throughout their career. Within this framework, the Air Force outlined several benefits of Rivet Workforce. For one, it allows individuals to become experts on their particular aircraft or system. It allows basic technical training to be provided up front and continuation training to be offered throughout an individual's career. The time and money spent on training technicians on new systems can now be funneled into advanced workcenter training, using advanced training systems such as the Interactive Video Disk (IVD). Rivet Workforce will also help technicians better plan their careers. They can be more aware of competition within their AFSC and can also better predict future assignments (6:3-4).

The Air Force recognized the training challenges Rivet Workforce created right from the start. Literally hundreds of individuals needed to complete new career development courses (CDCs) and attend classes taught by maintenance training branches/squadrons, and field training detachments. In conjunction with the formal schooling, significant time would be required to conduct on-the-job training (OJT) (6:3-4). Yet, many units overcame these barriers and TAC predicts it will have 85% of the Rivet Workforce training completed by mid-1992 (4).

Two-Level Maintenance. The next major challenge to the TAF maintenance community involves the relative location of intermediate repair facilities. AFR 66-14, USAF Equipment Maintenance Program, defines the three levels of maintenance as follows: (1:1)

- Organizational: On-equipment (on-aircraft) maintenance; removal, repair, and replacement.

- Intermediate: Off-equipment (off-aircraft) component repair, normally done at the same operating location.

- Depot: Overhaul or extensive repair, on- or off-equipment, usually at a centralized facility having special skills and major tooling.

The two-level maintenance concept removes intermediate maintenance from the operating base and either centralizes it at regional locations (based on aircraft/system type) or turns it over to the depot. General Merrill A. McPeak, Air Force Chief of Staff, favors

> a move toward two-level maintenance for all our wings, composite or other. This would off-load elaborate intermediate level equipment requirements, improving deployability. We could also downsize the maintenance establishment at wing level, including removal of considerable overhead. Retaining only organizational maintenance in the wing permits us to contemplate returning flightline maintenance to the flying squadrons, increasing unit cohesion. (9:9)

The success of the two-level maintenance program hinges on reliability and maintainability (R&M) engineering of new systems plus R&M improvements in existing systems. This, in itself, is a complicated issue. Take the F-15 aircraft for example. "The F-15 requires about 85% of the maintenance of the F-4 because of R&M improvements during design" (3:3), and it has the best aircraft safety record in Air Force history.

> While these facts speak well of the reliability and maintainability of the F-15 system, we have only just begun to make improvements that can bring dramatic changes to the flexibility of this weapons system. Consider the possibilities with the aircraft's electronics. When we lump together electronic portions of the engine controls, flight controls, and secondary power with the avionics portions of an aircraft, we find electronic functions account for some 45% to 50% of unscheduled aircraft maintenance. With improved reliability and maintainability, we could eliminate the avionics intermediate shop (AIS) and a whole host of support problems. (3:3)

This is a significant achievement for two reasons. First, "the variety of spares needed to support the AIS is greater than the number needed to support the F-15 itself" (3:3). Second, to move an AIS from one theater to another requires five C-141 transport aircraft. By eliminating the AIS that airlift could be used to move the entire F-15 squadron (3:3).

The main goal of the R&M effort is "to create weapon systems that perform the employment missions with minimal combat support once the acquisition process is complete" (3:5). The reality is many of the current weapon systems are not R&M engineered. Today, most of the older line replaceable units (LRUs)

> run about 100 hours MTBR (mean time between removal). This means any LRU has about a 98% chance of finishing a two-hour mission without the necessity for removal. This sounds pretty good from a performance standpoint until one realizes that, if an aircraft has 25 LRUs, there is only a 40% chance the aircraft will return from a mission without some indication of failure. (3:4)

On 1 July 1991, TAC--supported by the Logistics Management Center, Gunter AFB, AL, and the Rand Corporation--began a limited test of the two-level maintenance, or as TAC calls it, the "Alternatives to Maintenance," concept with the 388th Tactical Fighter Wing, Hill AFB, UT. The test plan covers thirty-two selected line replaceable units (LRUs) from block 42 F-16C and D model aircraft. (This particular block was chosen because it was deemed the most reliable and maintainable of the F-16 aircraft fleet.) All of the selected LRUs are "automatic," which means the LRU must be evaluated by the Avionics Intermediate System (AIS) during troubleshooting, versus the "manual" type of LRU which is simply given a "go-no-go" test. As a part of the test, all of the F-16 manual LRUs have been put into the "flightline environment." All manual testing of these LRUs will be done, facilities permitting, in the AMUs.

At the start of the test, TAC established a baseline for supply statistics on the 32 selected LRUs, along with other maintenance statistics such as: mission capable rate, not-mission-capable for supply (NMCS), not-mission-capable for maintenance (NMCM), and other pertinent indicators of the maintenance health of the 388th. The status of the 32 LRUs within the entire supply system is also being monitored. On 10 October 1991, the 363rd Tactical Fighter Wing, Shaw AFB, S.C., will be added to the test. TAC feels the addition of another unit will expand the strain on the supply system and create a more realistic environment. Although the test is scheduled to run through February 1992, TAC has been tasked to provide its five-year Alternatives to Maintenance Plan to the Air Staff by 1 October 1991 (2).

The TAF Composite Wing. Although it has operated under several different names, the TAF Composite Wing concept is not new to the Air Force. Since aircraft became a standard tool of war, America has combined varying air resources at a single location under a single commander. In most cases; however, the squadrons and groups retained a great deal of their individual unit identity within the wing structure. A good example of this is found in the Composite Air Strike Force (CASF), created in 1955 (15:3-4).

Following World War II the United States was the sole possessor of nuclear weapons and the means to deliver those weapons. The threat of Strategic Air Command's deterrent force limited the Soviet Union in its push for global expansion. The situation changed drastically once the Soviet Union gained nuclear strike capability. "It was more important than ever that SAC be kept poised to react to a Soviet nuclear attack on the United States" (15:4). The Soviets

> realizing that the United States would now be more reluctant to use any portion of SAC for other purposes, was then in a better position to permit her satellites and Communist groups in other countries to initiate armed conflict at times and in areas of her choosing and with her support. (15:4)

In reaction to this threat to world peace, "USAF directed Tactical Air Command to develop a force capable of deploying rapidly to any area of the world where outbreak of limited war was imminent" (15:4).

In response to the USAF tasking, TAC activated Headquarters Nineteenth Air Force and made it solely responsible for planning "for deployment and employment of the Composite Air Strike Force" (15:4). The CASF did not include permanently assigned units, and Nineteenth Air Force assumed "operational control of the CASF only during maneuvers, exercises, and limited-war deployments" (15:4). When the CASF was activated, selected combat-ready units would respond dependent on what "package" was called for. This allowed Nineteenth Air Force a lot of flexibility to shape the CASF dependent on the situation. When the units were not under CASF control they were assigned to and trained by Ninth and Twelfth Air Forces.

The self-sustaining CASF was composed of

> tactical fighters, day, night, electronic-countermeasures, and weather-reconnaissance aircraft, KB-50J tankers, and C-130 and C-123 transports. In addition to the tactical squadrons and their support personnel and equipment, (there were) communications and aircraft control and warning (AC&W) packages designed to provide the CASF with internal communications and ground-controlled interception and aircraft recovery capability. (15:5)

Whenever possible, the deployments were planned to be air refueled non-stop from staging bases. The transports provided airlift with support from the Military Air Transport Service when needed. Quick turn-around at the destination was planned to provide for immediate nuclear or non-nuclear air strikes. The CASF was tested in two actual deployments; the

first to Incirlik Air Base Turkey, July-October 1958, and the second to Taiwan, August-December 1958 (15:6,11). By all standards, both deployments were considered very successful. Some adjustments were required, but on the whole the CASF concept proved its worth.

The "New" TAF Composite Wing. The two CASF deployments alerted the services to the need for better joint and Allied services coordination leading to the creation of multi-service task forces. Within this multi-service structure the Air Force continued to work on the composite strike concept; however, each iteration still focused on the idea of a CASF made up from various non-assigned units.

For several reasons, this concept of drawing non-assigned units together to create a single deployment force has come under scrutiny in 1990-1991. First comes the argument that large scale conventional war, particularly in Europe, has been rendered unlikely. The fear of escalation to nuclear war, added to the disintegration of the Communist east bloc, lend credence to this idea. This leads to the second argument, that future wars will be on a smaller scale. This will require either the use of in-theater forces or the rapid deployment of CONUS based forces to the site of the trouble (16:11).

The operations community has voiced two main concerns about these options. First, it fears pulling together various units to perform under a single commander is like tasking "a large group of strangers to join up and get acquainted on the way to the target" (9:11). Second, the operations community fears the complications the command, control, and communications (C^3) structure may face. Based on the rapid deployment premise, the lead time needed to work out the complicated command and control (C^2) structure will simply not be there (9:7-8). Added to

this is the concern that communications capability, particularly in the European theater, may be so seriously downgraded it will paralyze the effective direction of strike force packages. Therefore, "what is needed is relatively self-contained, self-sufficient fighter wings that can launch from one base all facets of the strike force package and its support against preplanned, prefragged target 'areas of responsibility' to keep the war going" (16:11).

Supporters feel the best way to meet this is through the TAF Composite Wing concept. TAC summarizes the goals of the TAF Composite Wing as follows: (5)

- Collects all assets at one base, under one commander.
- Is capable of responding to immediate request for unilateral air action against any opponent worldwide.
- Moves from a garrison air force with a large overseas presence to a rapid deployment force with a quick expeditionary capability.
- Matches air force missions to much reduced available resources.

General McPeak, in an August 1991 interview with Sergeants magazine, defined the several forms a composite wing might take. Basically, General McPeak broadly defines a composite wing as one where more than one type aircraft operates in a wing. He points out that in the 2nd Bombardment Wing at Barksdale AFB LA, B-52s and tankers are already operating under the same wing. So, the first type of composite wing is one in which the units have a composite operation on the flightline which is simply brought together under one wing. The second type of composite wing is "built from the ground up to support the expeditionary role of the Air Force. For example, at Mountain Home AFB, Idaho, the 366th Wing, which now has only F-111s, will become a composite wing with

F-15Cs, F-15Es, AWACS, tankers, and F-16s" (10:11). Still another type of composite wing is scheduled for Pope AFB, North Carolina. "The mission at Pope will be to support rapid deployment and employment of the Army's 82nd Airborne Division" (10:11).

The TAF Objective Wing. Not all of the TAF wings will become composite wings. In fact, TAC predicts there will be only four TAF Composite Wings; one in PACAF, one in USAFE, and two in the CONUS (2). The remaining TAF wings will be structured as TAF Objective Wings. The TAF Objective Wing is more representative of today's fighter wing. It is organized under a scaled-down version of the streamlined TAF Composite Wing management structure, since fewer operational squadrons will be needed (2). (Since the majority of TAF wings will be Objective Wings, this term will represent both types of wings for the remainder of this study.)

Maintenance Structure in the TAF Objective Wing. At the head of the TAF Objective Wing is a wing commander (CC). Below the CC is the deputy commander for operations (DO)--head of the Operations (OPS) Group, and the deputy commander for logistics (LG)--head of the Logistics (LOG) Group. The LG title results from the combining of the deputy commander for maintenance (DCM) and resource manager (RM) under one title. The old DCM staff is divided up, with some functions going to the Operations (OPS) Support Squadron and others going to the Logistics (LOG) Support Squadron. The reorganization places all production oriented maintenance activities under the operations squadrons, and combines the off-equipment maintenance activities from the Equipment Maintenance Squadron (EMS) and Component Repair Squadron (CRS) under EMS

(12:6). An overall view of the basic objective wing structure is presented in Figure 1.

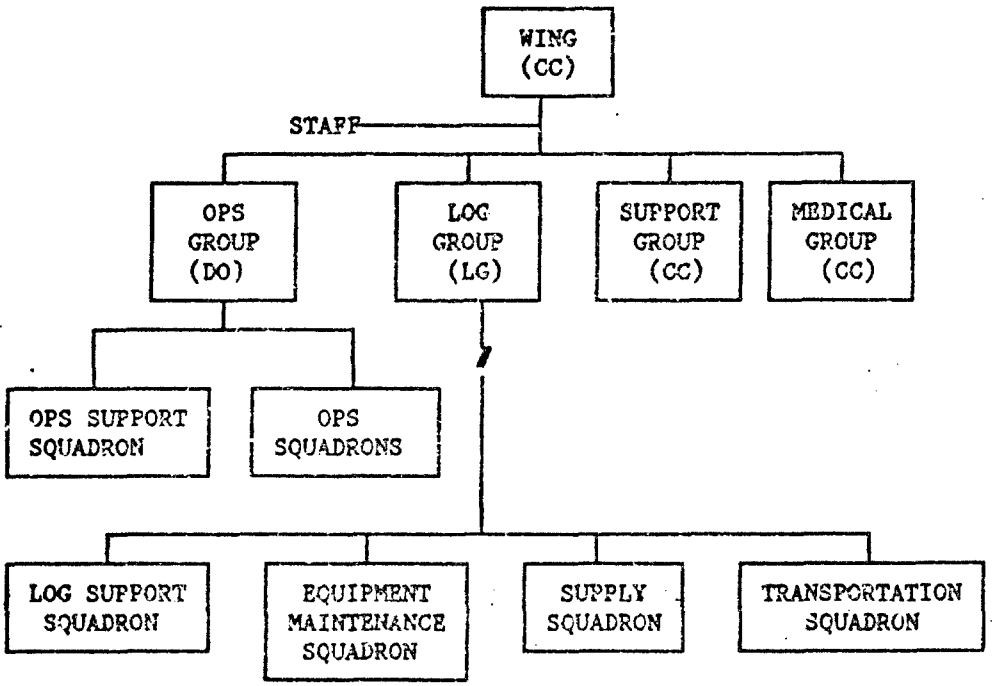

Figure 1. TAF Objective Wing Structure (5)

As previously noted, maintenance personnel are located in several places within the wing structure, with the majority placed under the operations and logistics groups. Figure 2 shows a typical operations squadron. The operations (OPS) squadron includes the mass of maintenance troops under the operations group. Within the operations squadron the operations officer and maintenance officer share equal ranking under the squadron commander. The operations officer is responsible for the various flights (FLT) and for the support flight (SUPP FLT). The number of aircraft flights depends on the number, and type of aircraft assigned

to the squadron. For example, if the squadron is assigned 24 F-15 aircraft, the squadron is broken down into four flights of six aircraft plus the pilots for those aircraft. The support flight includes the administrative and life-support functions. The maintenance officer is responsible for the various maintenance flights including the aircraft flight (ACFT FLT), the weapons flight (WPN FLT), the specialist flight (SPEC FLT), the support flight (SUPP FLT), and the aerospace ground equipment flight (AGE FLT). In this case, the support flight includes tool room and supply support.

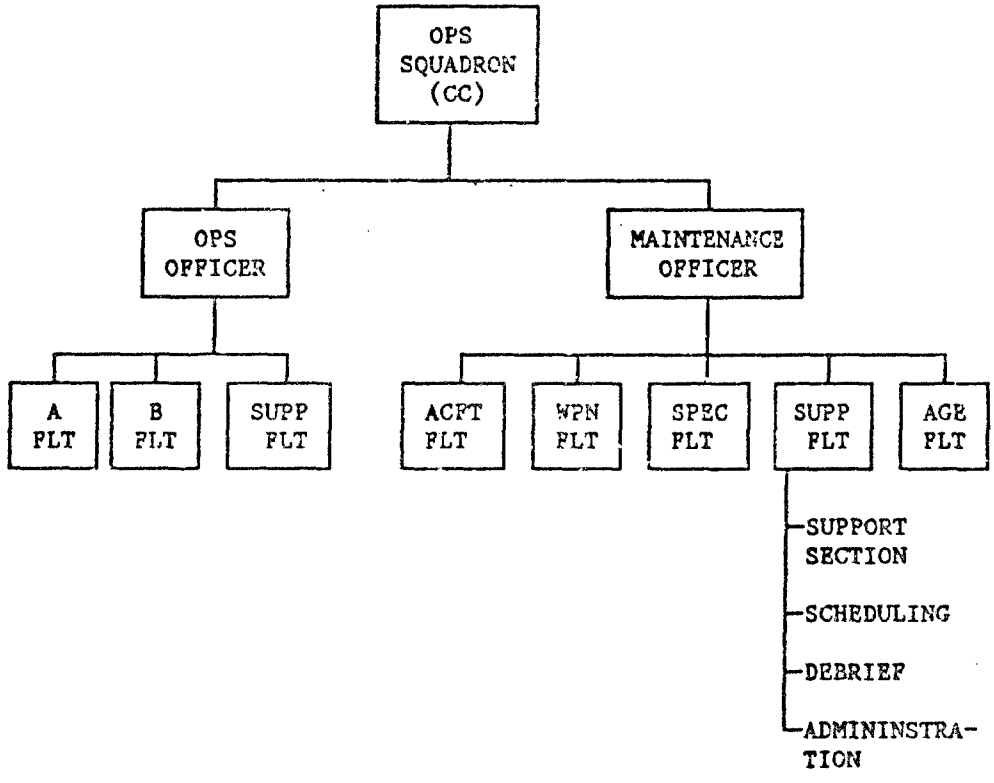

Figure 2. TAP Flying Squadron (5)

Within the logistics group, maintenance functions are found predominantly in the equipment maintenance squadron (EMS) and logistics support squadron. EMS is charged with off-equipment maintenance and includes several flights, such as: fabrication; propulsion; munitions; avionics; accessories; and test, measurement, and diagnostic equipment. The logistics support squadron performs many of the old "DCM staff" functions. A typical logistics support squadron, shown in Figure 3, includes the logistics plans and mobility, maintenance management, and maintenance training flights. The logistics plans and mobility flight includes combat plans; maintenance supply liaison; plans, scheduling, and documentation; and a resource advisor. The maintenance management flight includes the analysis, programs, and technical administration divisions. Finally, the maintenance training flight includes a training and administration, and development and applications division (5).

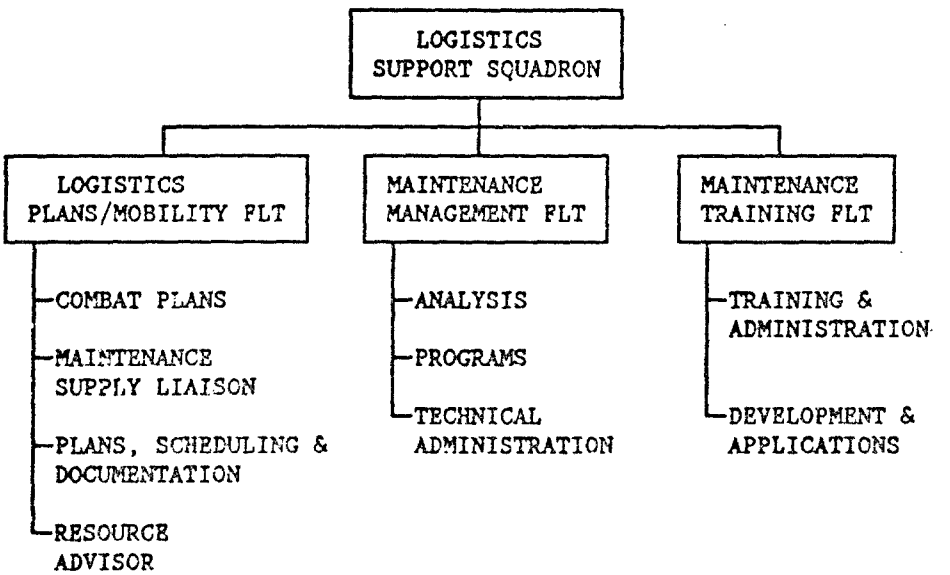

Figure 3. TAF Logistics Support Squadron (5)

Maintenance Problems Related to the TAF Objective Wing. At first glance, the new TAF Composite/Objective Wing appears to be at odds with the current and projected manning and fiscal posture of the Air Force. The Department of Defense has mandated reductions in Air Force manpower and material, not expansions. Yet, according to the Air Force Chief of Staff, "composite wings may be somewhat more expensive to operate and that the added costs may not be entirely offset by savings that will accrue through scaling back the C^2 apparatus" (9:9). Every argument for the new wing structure carries with it a counter-argument. The following paragraphs present some of the major points of contention.

Colonel Wiswell, in his 1986 article, "The Composite Fighter Wing: A New Force Structure and Employment Concept Needing Logistical Attention," puts these costs into four main areas: relocation, facilities, spares, and manpower. In his opinion, the cost of relocation can easily be handled, but the last three are "more formidable and, without the application of innovative logical approaches, could be fiscal show-stoppers" (16:14).

The first cost is a direct result of the restructuring effort. Aircraft, people, supplies, equipment, munitions, and a host of other support material must be moved. Colonel Wiswell argues these moves could "be phased, accommodated, and afforded," meaning they would have little impact on performance (16:14).

Next, comes the facilities construction needed "to combine two or more types of fighter aircraft at one base. Unique aircraft, engine, and avionics repair capabilities would have to be dispersed and deconcentrated to composite installations" (16:14). The proposed formation of centralized intermediate repair facilities under the two-level main-

tenance concept may ease this requirement somewhat, but centralization of these facilities is not keeping pace with the formation of the TAF Composite/Objective Wings (4).

The need to increase spare parts holdings, to compensate for the loss of base-level intermediate repair capability under the two-level maintenance, is another cost. General McPeak feels this cost will be small for systems like the F-15C and F-16C, "where (our) reliability and maintainability efforts are beginning to show a return in the form of sharply lower break rates" (9:9-10). It is not the purpose of this research to debate the reliability and maintainability (R&M) issue, but consideration must be given to the other aircraft weapon systems the Air Force is operating. At present, the TAF has no intention of establishing two-level maintenance for any F-15 model aircraft because the F-15 is considered too LRU dependent (2). Furthermore, budget cuts prevent the replacement of older aircraft weapon systems by newer, R&M engineered ones. However,

> Money is already flowing toward the upgrade market. Fiscal 1992-93 budget requests for U.S. military procurement included at least 19 modification programs that, together, will consume about $2.3 billion in Fiscal 1992 and another $2.7 billion in Fiscal 1993. (13:42)

Two examples of TAF upgrade programs in the include the following:

> The Mid-life Update Program for General Dynamics F-16 fighters. Approximately 530 F-16A/B aircraft operated in Belgium, Denmark, Norway, the Netherlands and the U.S. will be updated with a new avionics suite under this $2-billion effort. (13:43)

> The McDonnel Douglas F-15 multistaged improvement program (MSIP). A $1.5-billion program, MSIP is upgrading 15 line replaceable units (LRUs) in the Hughes APG-63 radar and other key avionics systems to extend the fighter's air superiority capability into the next century. (13:43)

In any case, the Air Force will be compelled to sustain spares for both old and new aircraft weapons systems. While a problem with spares stockage is already a reality for the Air Force, it is complicated by the "higher cost of stocking, at composite bases, smaller quantities of high value items for each aircraft type. Overall, more spares may be required to cover more bases" (16:14). "Thus, another problem is created--one of extended transportation needs to move spares both inter-theater and intra-theater" (11).

The final issue is one of people. Colonel Wiswell points out "breaking up homogeneous wings into composite outfits would probably demand overall increases in maintenance manpower, since overhead and intermediate repair would be duplicated at more sites" (16:14). However, if the proposed two-level maintenance concept is adopted it may alleviate this problem since it calls for reductions in overhead and the consolidation of intermediate repair facilities. Again, the statement must be made that two-level maintenance concept is lagging the creation of composite wings.

Aircraft Maintenance Issues In Summary

1. Today, logistics planners are facing two new challenges, one financial and the other political. These two challenges are driving changes in the structure of the Air Force. Within the TAF aircraft maintenance community, the most significant challenges have been the adoption of Rivet Workforce, a proposed move to the concept of two-level maintenance, and the creation of two types of new wings; the TAF Composite Wing, and the TAF Objective Wing.

2. Rivet Workforce was the result of a 1984 Air Force study of aircraft maintenance. Under Rivet Workforce, technicians are aligned to a specific aircraft type or system throughout their career. The Air Force outlined several benefits of Rivet Workforce, such as: the creation of weapon systems experts; flexibility in technical training (like IVD continuation training); and allowing technicians to better plan their careers. TAC believes it will meet the Air Force goal of having complated Rivet Workforce training for 85% of its personnel by late 1992.

3. The Air Force is moving toward the concept of two-level maintenance. This eliminates intermediate maintenance from the operating base and either centralizes it at regional locations, based on aircraft/system type, or turns it over to the depot. The success of this concept is firmly based in system and component R&M. Not all of TAC's systems meet the high R&M standards demanded by the two-level maintenance system. TAC is currently performing a limited two-level maintenance test at Hill AFB, UT., and will present its five-year Alternatives to Maintenance plan to Air Force by 1 October 1991.

4. Another 1990s Air Force concept is the TAF Composite/Objective Wing. Only about four wings will become composite wings, with the remaining wings structured as objective wings. The only real difference between these two types of wings is the mission. The TAF Objective Wing is representative of today's fighter wing, organized under a streamlined management structure. Production oriented maintenance activities are located under operations, and maintenance support activities are located under logistics. There are several problems associated with the TAF Objective Wing including:

- the cost of moving aircraft, people, supplies, equipment, munitions, and a host of other support material;

- the construction of the facilities needed to combine two or more types of fighter aircraft at one base;

- the higher cost of stocking smaller quantities of high value items for each aircraft type at several bases; and,

- the demand for overall increases in maintenance manpower since overhead and intermediate repair would be duplicated at more sites.

Two-level maintenance has been offered as a panacea for all of these problems, but it is unable to keep pace with the creation of TAF Objective Wings.

Afterword

This chapter explored the most recent changes in the TAF which have been stimulated by changes in political and economic conditions world-wide. The next few years will pit the TAF against some tough obstacles along its path to maintaining its readiness goal. How successful the TAF will be in meeting its goal is yet to be known, and the same may be said about aircraft maintenance. The TAF aircraft maintenance organization must mirror the modifications made in operations; that is the fate of any support organization. The final chapter draws together facts presented in previous chapters to provide a basis for examining past success of the TAF aircraft maintenance organization when faced with such organizational changes.

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X. Summary, Analysis and Recommendations

Summary of the Aircraft Maintenance Issues

The following pages summarize the issues aircraft maintenance personnel have faced over the 90 years covered by this study. The summary is broken into sections with each section representing one of the chapters II through VIII.

Beginnings 1900-1920. The military had no official interaction with the development of aviation prior to 1907. In those years, the pilot/owner performed all of his own aircraft maintenance. The creation of the Aeronautical Division of the US Army Signal Corps signalled the beginning of the military's involvement in manned, powered, and controlled flight.

Pre-World War I. The beginning three-man Aeronautical Division was charged with keeping pace with developments in aviation. The Division-sponsored competition for the first manned, powered, and controlled aircraft to be purchased was won by the Wright brothers. The Wrights also introduced the first dedicated aircraft maintenance mechanic--Charley Taylor, in 1908.

In 1914, the Aeronautical Division became the Aviation Section, and boasted an authorized manning level of 320 men. The 1st Aeronautical Squadron was formed within the Section. The squadron consisted of 20 pilots and 12 aircraft, divided into three companies of four aircraft each. Each company, headed by a captain, was further divided into four sections. Each section consisted of a first lieutenant, a crew chief, a

sergeant, three first class privates, and one private all of whom performed the aircraft maintenance.

Since the aircraft, and mechanization in general, was so new to Americans, the recruiting of aircraft mechanics was difficult, resulting in a shortage of aircraft mechanics. By 1915, the Aviation Section decided any enlisted man could become an aircraft mechanic if he could pass a stringent hands-on airframe and engine test. These mechanics had little available documentation to serve either as reference or for historical reporting. Aircraft discrepancies were reported to the mechanics through oral debriefing with the pilot. Initially the pilots trained the mechanics until a sufficient cadre was built up which could conduct on-the-job training for new mechanics. The aircraft mechanic did all the maintenance on the aircraft and there was no specialist group to support him. Once the mechanics were trained it was difficult to retain them because when trained and experienced they became valuable to the budding civilian aviation industry.

World War I. The entry of the United States into the European War quickly changed the shape of the Air Service. With the advent of more advanced aircraft and aerial tactics, the pilot moved away from aircraft maintenance, placing more emphasis on the mechanic and his qualifications. The addition of new aircraft systems led to the creation of the aircraft maintenance specialist. Recruiting of mechanics again became a problem as the draft drained off many skilled civilian mechanics.

By the end of 1918 the Army Air Service had experienced a phenomenal period of growth. This forced a change in the structure of aircraft maintenance to the echelon system. First and second echelon maintenance

was flightline, or on-equipment, maintenance. Third echelon maintenance was base level off-equipment maintenance, and fourth echelon maintenance was off-base, depot level maintenance. Maintenance forms were also taking shape and the aircraft mechanics had to do paperwork as well as "real" work.

The Interwar Years 1920-1938. America was convinced the European War was the last war it would be involved in. This led to the immediate reduction of the military forces. This reduction revived the system of aircraft maintenance where the mechanic was trained to sustain the bulk of his aircraft. The Air Corps opened a technical training school at Chanute Field, Illinois where the crew chief went through a tough six-month course. As the American economy began to prosper, in the late 1930s, industry was able to lure the trained aircraft mechanics away from the Air Corps. From 1929-1937, the Air Corps lost 15.6 percent of its enlisted corps, and three-quarters of those were trained aircraft mechanics.

The maintenance units initiated the use of aircraft maintenance record keeping. Aircraft status was documented through several reports. This use of aircraft forms was quite a departure from World War I. The introduction of all metal, monocoque aircraft resulted in a change in depot overhaul procedures. Aircraft now rotated into the depot on a regularly scheduled basis. The interval for inspections was changed from an isochronal concept to a phased concept of maintenance, based on hours of operation. Preventive maintenance also received a great deal of attention. The emphasis was placed on anticipating and preventing system failures and malfunctions.

From Isolationism to World Power 1939-1945. American maintenance personnel faced some pretty tough challenges in World War II. They kept aircraft flying in regions of the world most of them had never even heard of. They braved the elements, supply shortages, and a lack of training and experience, and came through with flying colors. The success of the aircraft maintenance operation in World War II, given the sheer number of aircraft and personnel placed in diverse operating conditions, is a testament to the leadership and dedication of the aircraft maintenance troops.

The draft brought many unskilled personnel into the maintenance units, forcing changes in organizational structure and training. Although the four echelon maintenance system of World War I remained, it was altered. The main difference was the inclusion of the requirement that certain equipment be air transportable. Maintenance units below depot level were expected to be highly mobile and capable of working in unimproved conditions. First and second echelon ground crews were grouped into their specialties in some theaters of operation to maximize their use. This meant many mechanics might work on the airplane simultaneously under the general control of the crew chief. This was a direct departure from the crew chief concept of maintenance practiced in World War I.

Two branches were formed to perform squadron level maintenance in some theaters and the CONUS Air Training Command. The Flying Line Maintenance Branch, like today's AMU, performed servicing, pre-flight, light inspections, and other daily tasks. The Production Line Maintenance Branch, or off-equipment maintenance unit, performed the more time consuming and technically complicated tasks not directly involved with

the day's flying. The process of formalizing this concept of maintenance laid the foundation of the maintenance organization that still exists today.

The requirements for skilled maintenance personnel exceeded their availability. Training courses were shortened and the crew chief method of training was replaced by one of more specialized training--narrower tasks and quicker training. The crew chief was assisted by specialists. The mechanics were identified to a particular type of aircraft although they really possessed little in-depth knowledge of it.

A Short Respite: From World War II to Korea 1946-1950. The years following the World War II brought radical changes to aircraft maintenance. Many of the decisions made during this period are reflected in the maintenance organization as it stands today.

The adoption of the Hobson Plan, in 1947, was an important first step toward standardization and stabilization of the maintenance organization. This plan made the wing headquarters the highest echelon on a base and created four subordinate groups including the combat, and maintenance and supply groups. These groups were responsible for first, second, and third echelon maintenance within the wing.

Manpower shortages, brought on by an improved civilian economy, created concern over the Air Force's ability to expand its combat capability in times of war. The concern then was that there was no counterpart in industry to the military aircraft maintainer.

The reliability and maintainability (R&M) of an aircraft were not principle design considerations at this time. Although some consideration was given to this area, the Air Force gave little more than lip service to the R&M concepts.

Specialist maintenance was reborn in a slightly different format. The new maintenance concept, developed by SAC, placed specialists in an off-equipment setting. This provided a situation where the specialist could be kept busy with backlog maintenance. Although it took some years for this concept to catch on, it served, until very recently, as the core of the Air Force maintenance organizational concept.

The Korean War 1950-1953. The overall scale of the conflict aside, the Korean War presented some unique challenges to aircraft maintenance. First, the Korean War was the first "jet" war ever fought. This alone contributed heavily to the problems faced by maintenance. The Korean War was also one of give-and-take. The lack of permanent, adequate bases of operation coupled with the need for constant mobility took a grievous toll on manpower, equipment, and supplies.

Despite dramatic efforts to increase personnel numbers, the Air Force was not able to provide all the specialized personnel Far East Air Forces (FEAF) requested. This forced the use of OJT in the combat theater and hurt the combat capability of the units. This situation was further complicated by the 12 month tour-of-duty in Korea. About the time the maintainer got accustomed to the aircraft, or equipment, he was rotated out of the theater. The policy of frequent rotation prevented the development of experienced maintenance organizations, and negated the modified crew chief system because the it stripped the units of skilled crew chiefs. In addition, manpower shortages often forced highly skilled personnel to perform low-skill tasks. The immediate result was a loss of a valuable resource and a further deterioration of the maintenance complex.

The living and working conditions for maintenance personnel were not good. Pre-fabricated buildings or tents were used as alternates to permanent construction. This lack of permanent buildings limited maintenance personnel to performing rudimentary maintenance during cold weather periods. Inadequate maintenance caused the deterioration of aircraft sooner than expected. Runway and taxiway surfaces were destroyed by the smaller, high pressure tires and exhaust blast of the jet aircraft. Since the landing gear and tires on the jets were not as sturdy as their conventional counterparts the rough surfaces caused them to fail faster than expected. Equipment problems, caused by the runway conditions, forced maintenance to rely very heavily on supply support to keep the aircraft flying. Unfortunately, supply faced its own share of problems and was not able to always meet maintenance demands.

To overcome the shortage of parts maintenance resorted to cannibalization. Cannibalization doubled the maintenance workload and contributed to a reduction in component reliability. Shortages of tools and equipment provided another challenge for maintenance. Much of the equipment was of World War II vintage requiring constant attention. Even new equipment could not stand up to the rigors of the Korean environment, so aircraft often went without maintenance other than that essential to combat mission flight.

All of these maintenance problems were complicated by the frequency of unit movements. Equipment, buildings, and any other facilities of possible use to the enemy were destroyed as units retreated. The moves also took a toll on the equipment and supplies that were evacuated from the bases. Later, under combat advancing conditions, the re-captured bases had to be almost reconstructed.

Aircraft maintenance personnel faced other barriers such as extreme weather conditions, inadequate transportation, the threat of enemy attack, fuel contamination, and other difficulties. In response to some of these problems the rear echelon combined maintenance operation (REMCO) system was formed. REMCOs were usually located in Japan where they could take advantage of facilities and equipment outside the combat zone. Commanders sometimes complained their maintenance and supply personnel at the REMCOs were unhappy and felt they were not contributing to combat success. At times, maintenance personnel of less than sterling quality were assigned to the REMCOs. This caused the FEAF to intervene and approve all personnel assignments to the REMCOs. On the whole the REMCOs were very successful.

Post-Korea Through the Vietnam War 1954-1973. Most of the issues facing the aircraft maintenance community, from 1954-1973, were founded in changes in maintenance policy. America's participation in the Vietnam War resulted in few unexpected maintenance problems. The "normal" logistics challenges such as limited facilities, inadequate supplies, and problems organizing maintenance were more or less expected. These kind of challenges are as old as war itself. This is not to say these problems were not important but rather to point out they carried less weight in an Air Force which had not reduced its numbers, nor ceased to prepare for war. The United States had made a commitment to a strong national defense and the public had supported that pledge with tax dollars. Thus, the challenges faced in these nearly 20 years were those inflicted on maintenance by changes in policy and organization.

The Air Force emerged from the Korean war as the predominant power among America's armed-forces. During the expansion programs which

followed the war, the USAF took steps to modernize the force and procure more jet aircraft. To the maintenance man this meant there was less of a drawdown in the force and an actual improvement in the overall outlook for maintenance. Unlike times past the Air Force was not forced to drastically reduce manpower after the Korean War. Although active duty strength declined from 977,593 in 1953 to 690,999 in 1973 it was a gradual decline. The procurement of more jet aircraft meant the phasing out of older aircraft. Although some of these new aircraft were not the maintenance person's dream, they certainly were a step up from the Korean War era jet and reciprocating engine aircraft.

Until TAC published its own maintenance manual in 1957, its aircraft maintenance organization remained under the Hobson Plan of 1947. This plan created two aircraft maintenance areas of responsibility. Combat squadrons were responsible for first and second echelon maintenance on assigned aircraft, and a maintenance squadron handled third echelon maintenance on assigned aircraft and all maintenance on base flight and transient aircraft. This approach placed the specialists in the maintenance squadrons allowing them to work on lower priority reparables when they were not needed on the flightline.

The Air Force published its specialized maintenance manual, AFM 66-1, in September 1956, but did not make its use mandatory. AFM 66-1 installed the Chief of Maintenance as the top maintenance manager, gave him a staff, assigned the aircraft to maintenance, centralized control but decentralized maintenance, and provided for mechanized maintenance data collection.

TAC published its own TAC Manual 66-1 in 1957. TACM 66-1 also provided for the chief of maintenance but went beyond the AFM 66-1 by

providing a strong crew chief system. The crew chief was responsible for supervising all maintenance performed on his assigned aircraft and the entire maintenance organization was designed to assist him in fulfilling his responsibility.

In 1959 the Air Force revised AFM 66-1 and made it mandatory for maintenance management throughout the Air Force. This new AFM 66-1 directed specialized maintenance concepts be adopted Air Force wide. It also moved the scheduling of all aircraft to the Chief of Maintenance staff. The benefits realized under this new version of AFM 66-1 included:

- the creation of a standardized maintenance organizational structure for all commands;

- the bringing together of some 50 years of aircraft maintenance experience into one document, thereby stabilizing the maintenance complex;

- the setting of USAF standards, goals, and objectives for the maintenance structure to meet;

- and finally, the enhancing of the maintenance data collection (MDC) system first introduced in the 1956. The MDC data were then used primarily to procure spares and equipment, track weapon system reliability and maintainability, determine manpower needs, set a budget, and for many other purposes.

In 1966, TAC reorganized its maintenance structure under a program called 'TAC Enhancement" and published TAC Manual 66-31 as guidance for the new structure. This program provided the tactical squadron commander with a self-contained maintenance capability for squadron deployments.

TAC faced some maintenance problems in the Vietnam War, including:

- an initial lack of maintenance facilities was overcome by fairly large mobile maintenance vans;

- the performance of heavy, non-organizational level maintenance in the Philippines or in Japan in direct conflict with the Air Force policy of base self-sufficiency;

- the lack of a sufficient supply system which resulted in the use of an expensive aerial resupply system;

- a serious shortage of trained maintenance personnel which forced TAC to undertake a massive maintenance training program;

- and, the use of more semi-skilled personnel by TAC caused by the rise in demand for replacements during 1966.

Post-Vietnam War budget cutbacks, and training problems created by the clash of the two maintenance management systems--AFM 66-1 and TACM 66-31--called for the standardization of management systems in a cost effective organization. In response to this problem USAF launched project RIVET RALLY in January 1972. RIVET RALLY was aimed at centralizing base level maintenance organizations, standardizing functions within those organizations, and developing a common maintenance management directive for use by all commands. RIVET RALLY culminated in a new AFM 66-1 with provisions to limit supplementation by the major commands.

Changing Times 1973-1983. This chapter represents 10 years in the development of Air Force aircraft maintenance. New concepts were tried, modified, accepted, used, and discarded. Of the nearly 137,000 base level aircraft maintenance personnel in the Air Force in 1977 approximately 16% were in overhead or management positions above the flight chief of work center supervisor level. The need to increase sortie

production forced the Air Force to reconsider the supervisory structure of the maintenance organization.

The scarcity of defense dollars in the post-Vietnam era forced both inter-command and intra-command maintenance consolidations. To develop new ways to perform maintenance with diminishing numbers of personnel the Chief of Staff, USAF, created the Maintenance Productivity Improvement Program (MPIP). MPIP's executive board considered many key areas, such as: manpower, training, modernization of equipment, maintenance organization, etc. . . . The end result of TAC's participation in MPIP was the Production Oriented Maintenance Organization (POMO).

POMO took advantage of the natural "on" and "off" equipment split in maintenance. Specialists were taken out of the shops and assigned to the flightline organization--Aircraft Generation Squadron (AGS). Within the AGS three separate Aircraft Maintenance Units (AMUs) were established. Specialists not needed for direct flightline production were divided into two off-equipment units--Equipment Maintenance Squadron (EMS), and Component Repair Squadron (CRS). The key to the POMO concept was to cross-train the flightline specialist to perform many aircraft general type tasks while still retaining his primary specialty. POMO did not achieve the desired increase in sortie production rates. TAC felt this was due to the disparity between having the responsibility to produce and having the authority to enforce production. This led TAC to enhance POMO through the creation of the Combat Oriented Maintenance Organization (COMO).

COMO promoted unit competition and used other techniques--such as the dedicated crew chief and expanded awards programs--to "foster motivation, pride, and responsibility." As part of COMO, TAC implement-

ed a system of annual and monthly goals to act as achievement benchmarks. Control over how to schedule to meet year-end sortie goals was placed in the unit. TAC also improved the maintenance facilities through programs like "New Lock, Smart Look, and Bright Look." The goal here was to create "a feeling of pride and a sense of quality in the maintenance technicians" (7:34). In its 14 years of operation, COMO has been very successful.

New Challenges 1984-1991. Today, logistics planners face two new challenges, one financial and the other political. These two challenges drive changes in the structure of the Air Force. Within the TAF aircraft maintenance community, the most significant challenges have been the adoption of Rivet Workforce, a proposed move to two-level maintenance, and the creation of two types of new wings; the TAF Composite Wing, and the TAF Objective Wing.

Rivet Workforce was the result of a 1984 Air Force study of aircraft maintenance. Under Rivet Workforce, technicians were aligned to a specific aircraft type or system throughout their career. The Air Force outlined several benefits of Rivet Workforce, such as: the creation of weapon systems experts; flexibility in technical training (like IVD continuation training); and allowing technicians to better plan their careers. TAC believes it will meet the Air Force goal of having completed Rivet Workforce training for 85% of its personnel by late 1992.

The Air Force is moving toward two-level maintenance. This eliminates intermediate maintenance from the operating base and centralizes it at several regional locations, and the depots, based on aircraft/system type. The success of this concept is firmly based in

system R&M. Not all of TAC's systems meet the high R&M standards demanded for the two-level maintenance system. TAC is currently performing a limited two-level maintenance test at Hill AFB, UT., and will present its five-year Alternatives to Maintenance plan to Air Force by 1 October 1991.

Another 1990s Air Force concept is the TAF Composite/Objective Wing. Only about four wings will become composite wings, with the remaining wings structured as objective wings. The only real difference between these two type of wings is the mission. The TAF Objective Wing is representative of today's fighter wing, organized under a streamlined management structure. Production oriented maintenance activities are located under operations, and maintenance support activities are located under logistics. There are several problems associated with the TAF Objective Wing including:

- the cost of moving aircraft, people, supplies, equipment, munitions, and a host of other support material;

- the construction of the facilities needed to combine two or more types of fighter aircraft at one base;

- the higher cost of stocking smaller quantities of high value items for each aircraft type at several bases; and,

- the demand for overall increases in maintenance manpower since overhead and intermediate repair would be duplicated at more sites.

The conversion to a two-level maintenance system has been offered as a panacea for all of these problems, but it has been unable to keep pace with the creation of TAF Objective Wings.

Analysis of Aircraft Maintenance Development

The following tables provide a summary of the cause and effect relationships of the variables which effect the structure and function of the aircraft maintenance organization. Table 1 outlines the basic relationships as they have occurred through time. Table 2 then draws together the common threads which run through the time periods. Figure 4 is a pictoral representation of the relationships outlined in Table 2.

Table 1

Summary of Aircraft Maintenance Development

TIME PERIOD	EFFECT	RESULT
Pre-WWI	Few, simple aircraft, simple maintenance	Maintenance done by the pilot
	Aircraft numbers increase	Some enlisted aircraft mechanics needed--generalized "crew chief" system of maintenance
WWI	Increased threat--Rapid growth in size of force and aircraft numbers	Four echelon system of maintenance
	More complicated aircraft increases need for trained, enlisted aircraft mechanics	Specialized system of maintenance
Post-WWI	Return to isolationism--reduction in aircraft and aircraft maintenance personnel	Generalized "crew chief" system of maintenance
	Better economy lures trained aircraft mechanics to civilian sector aviation	
	Reduction in aircraft maintenance personnel	Loss of technical training facilities

Table 1

Continued

TIME PERIOD	EFFECT	RESULT
WWII	Increased threat--rapid manpower expansion increased the need for training	Specialized system of maintenance
	More aircraft, more complicated aircraft	
	Need for more mobility	Added the requirement for aircraft maintenance equipment to be air transportable
Post-WWII	Decreased "active" threat--massive manpower demobilization	Shortage in trained, experienced enlisted aircraft maintenance technicians
	Good post-war economy	
	Loss of interest in maintaining a standardized system of aircraft maintenance	Hobson Plan implemented making the wing the highest echelon on base with subordinate maintenance and supply group plus others
	Shortage of trained enlisted aircraft mechanics	SAC created the specialized maintenance organization with OMS, FMS, AMS, and Maintenance Control with a modified crew chief system
	Complicated aircraft to meet "Cold War" technology needs	
	Return to "peacetime military"	Creation of an aircraft maintenance bureaucracy
		Increased non-aeronautical maintenance workload

Table 1

Continued

TIME PERIOD	EFFECT	RESULT
Post-WWII	Haphazard reassignment of aircraft to the CONUS required more specialists, spare parts, support equipment, and facilities at several bases	Consolidation of like aircraft at a single location to minimize diversity in support required
	Rising rate of aircraft out of commission affected combat capability	Shift in policy from equipping the force to manning and maintaining the equipment
Korean War	Increased threat--manning doubled by end of the war, but not in aircraft maintenance	Continued need for specialized aircraft maintenance
	Jet aircraft	
	Shortage of qualified aircraft maintenance specialists	Forced maintenance to work seven days per week with no time off for 10-15 days
		Some aircraft specialties were manned at 100%; others were critically short
		Specialists may be trained on a conventional aircraft, but assigned to a jet
		On-the-job training was conducted in the combat theater which undermined unit combat capability
		Forced skilled personnel to perform low skill tasks
	12-month tour of duty rotation	Prevented development of experienced aircraft maintenance organizations

Table 1

Continued

TIME PERIOD	EFFECT	RESULT
Korean War	Combination of the 12-month tour of duty rotation and frequent unit movements	Called for a more mobile, less manpower intensive front-line maintenance force which ended the manpower intensive modified crew chief system
	Poor runway and taxiway conditions hastened aircraft deterioration	Increased the wartime demand for spare landing gear struts and tires
	"Peacetime" supply provisioning and inadequate storage facilities	High cannibalization of aircraft, high out-of-commission rates, lower reliability
	Shortages of adequate tools and equipment	Undermined aircraft maintenance effort
	Inadequate living and working facilities	
	Overall poor operating conditions	Creation of REMCOs
	REMCOs	Initially gave a place for undesirable aircraft maintenance personnel to be dumped
		Left aircraft maintenance and supply people feeling left out of the mission
		Caused some aircraft scheduling and communication problems with mobile units
		Overall very successful

Table 1

Continued

TIME PERIOD	EFFECT	RESULT
Post-Korea	Continuing threat of communist aggression	American people supported the buildup of military forces
		Modernization of TAC aircraft
		No big reduction in manpower
	Development of TAC aircraft maintenance	Initially functioned under 1947 Hobson Plan
		TAC Manual 66-1: 1957 placed maintenance under tactical squadrons
		AFM 66-1: 1959 centralized the maintenance organization
		TAC Manual 66-31: 1966 decentralized the maintenance organization (again)
Vietnam War	Increased threat--stable manning and aircraft numbers	No rapid buildup of manning and aircraft
	12-month tour of duty rotation	Increased need for technically trained replacements
		Dependence on semi-skilled maintenance technicians
Post-Vietnam War	Loss of defense dollars	RIVET RALLY creates cost effective, standardized maintenance system under AFM 66-1 used by all commands
	Non-standardized maintenance system under AFM 66-1 and TAC Manual 66-31	

Table 1

Continued

TIME PERIOD	EFFECT	RESULT
Changing Times (1973-1983)	Loss of popular support by the American people for the military	Large scale personnel drawdown
		Loss of defense dollars
	Continuing threat of communist aggression	Shift to defense of Western Europe, Middle East, and Third World countries
		AF drives for a high state of readiness
	Loss of defense dollars	Consolidation of maintenance at every level to reduce numbers of personnel, equipment, and supplies
	Demand for high state of readiness	POMO provides quasi-decentralized maintenance system to cut management overhead
	Poor sortie production under POMO	COMO--fully decentralized maintenance system
New Challenges (1984-1991)	TAC desire to reduce maintenance manning	Rivet Workforce combines many AFSCs
	Loss of Soviet threat--loss of defense dollars	Move to two-level system of maintenance to cut overhead
		Creation of TAF Composite/Objective Wing combines forces under single commander

Table 2

Common Threads in Aircraft Maintenance Development

CAUSE	EFFECT	RESULT
Low/decreased threat	Low defense dollars	Small force
		Consolidation/restructuring of the aircraft maintenance organizations
		Shortage of trained, experienced maintenance personnel
	Return to "peacetime" military	Increased non-maintenance workload
		Increase in maintenance bureaucracy
Low technology	Less need for specialized maintenance	Generalized aircraft maintenance system
	Less need for advanced training	Loss of training facilities
Increased threat	More defense dollars	Large force
	Large force	Increase in training facilities and trainers
Increased technology	Need for specialized maintenance	Specialized aircraft maintenance system
	Need for more advanced training	Increase in training facilities and trainers
Good civilian economy	Drain off of skilled maintenance personnel	Retention, training, and recruiting problems hampers mission capability
Short tour of duty	Increased need for trained specialists	Increase in number of training facilities and trainers
	Inhibits creation of experienced maintenance organizations	Combat capability, mission effectiveness undermined

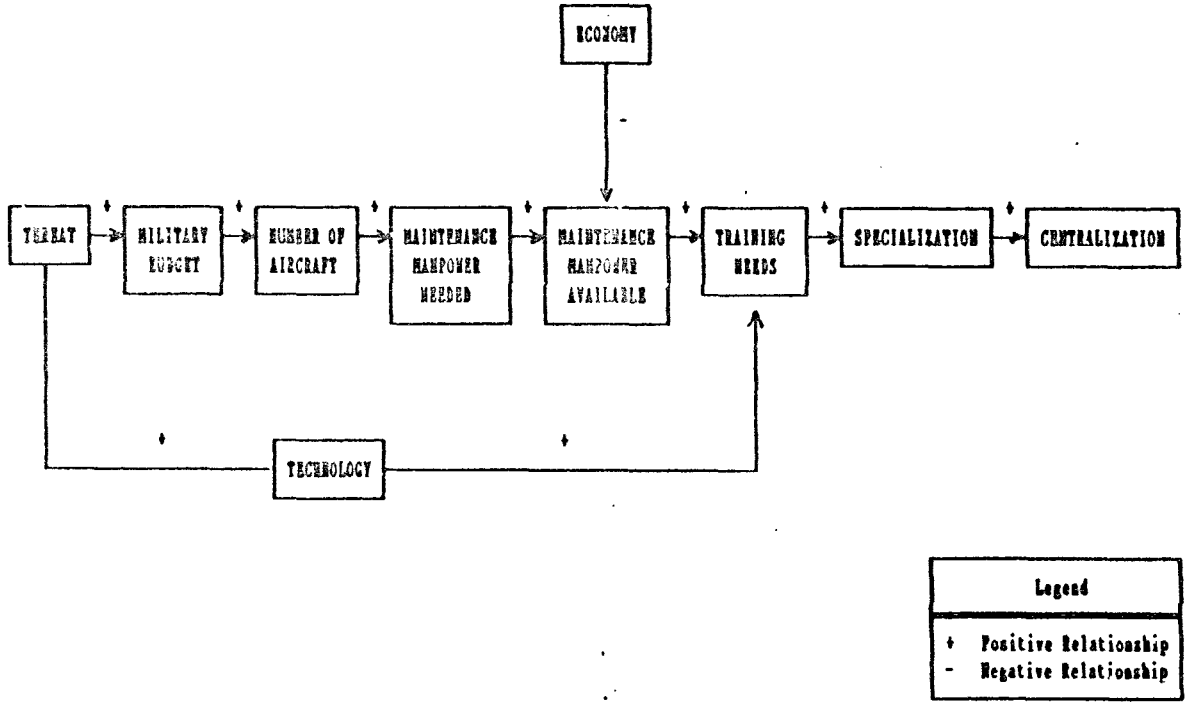


Figure 4. Interrelationships in Maintenance Development

History's Lessons. Several generalizations can be drawn about the process of aircraft maintenance development over the last 90 years. In the early years, aircraft were simple enough to be maintained by a crew chief and his assistants. As the aircraft became more complicated the specialist evolved as an essential member of the maintenance team. However, the degree to which the aircraft maintenance organization supported this specialized system fluctuated based on other inputs.

For example, if there was no perceived threat to national security, manning levels in the Air Force were low which equated to fewer aircraft maintenance personnel. These smaller numbers usually provided the Air Force the opportunity to provide more in-depth training for aircraft maintenance personnel which, in turn, allowed for a more centralized, and generalized system of aircraft maintenance with little or no specialist involvement in on-equipment maintenance. However, when the nation discerned an increase in the threat to national security it supported an increase in the size of the Air Force. This expansion affected the concept and the tasks of the aircraft maintenance organization for several reasons.

First, expansion equated to more defense dollars which, in turn, supported a larger aircraft fleet. As the number of aircraft increased so did the number of maintenance personnel required to support them. Second, an escalation in the threat also led to more sophisticated aircraft which required significant specialist support. (Recall that reliability and maintainability (R&M) engineering was not the priority in earlier aircraft development as it is today.) Most often, training could not keep pace with the rapid expansion and that resulted in more

fragmented, specialized training. These trends are consistent with those of today.

Recent History. Since World War II, and even more so since Korea, the purpose of America's defense machine has been to combat the Communist threat. In fact, the bulk of defense is based on the support of the Triad--long-range nuclear bombers, sea-based nuclear submarines, and land-based nuclear intercontinental ballistic missile systems, along with the support of a large-scale, conventional European war scenario. In recent history, defense doctrine also began to include support for the concept of more limited, tactical war. This led to the creation of multi-service expeditionary forces such as the Rapid Deployment Force, now known as the U.S. Central Command (USCENTCOM). Yet, the threat of Soviet nuclear attack remained alive in the back of the Air Force tactician's mind. Consequently, the aircraft maintenance structure mirrors this duality of planning.

In TAC, as in other commands, the maintenance organizations are built to respond to both the large-scale, conventional and tactical battle plans. Wings are organized around a particular mission; i.e. pilot replacement training, air-to-air, close air support, and each unit has its tasking for an area, or areas, of response. All of this information is built into planned, pre-sized deployment packages called Unit Type Codes, or UTCs. The UTCs include both the operations and maintenance personnel needed to support a particular number of aircraft under varying conditions. If more, or less, personnel are needed the UTC can be "tailored." This way, all, or part, of the unit may be deployed based on need. The UTC system has been relatively successful. At least

it gives planners a base-line for consideration when designing logistic support plans.

The maintenance organization within the UTC includes both on- and off-equipment maintenance personnel. The goal is to provide enough personnel, in the right specialties, to perform "normal" organizational and intermediate maintenance at the deployed location. While the advent of the Rivet Workforce program has somewhat altered the UTCs, the basic premise has remained the same.

Conclusions

The United States defense "market" has changed dramatically. The biggest threat to national security, the Soviet Union, has agreed to call a truce to the Cold War. Based on the lessons of the past, the reaction to this loss of threat is predictable. The number of dollars the American public is willing to commit to defense is shrinking, and as the defense dollars abate, so will the size of the force. To aircraft maintenance this downtrend indicates a move to a more centralized organization with a more generalized work force.

This is exactly what is happening in the TAF. First, Rivet Workforce has created a more generalized maintenance population. Specialists still, and will, continue to exist but their base of technical responsibility has broadened. Second, the TAF is investigating a further consolidation of specialist maintenance through the Alternatives to Maintenance, or two-level concept. As more R&M engineered and modified systems become commonplace, more off-equipment specialists will disappear from the base-level maintenance organiza-

tions. Finally, the TAF Objective Wing proposes a radical restructuring of the maintenance organization. This new structure may be considered both centralized and decentralized. First, it is centralized in the respect that the wing will become the central command structure on the base with all operations and support functions organized in one of four groups. Second, for maintenance, the TAF Objective Wing centralizes the bulk of the off-equipment "support" specialists under one squadron--EMS, and the bulk of the overhead support functions under the Logistics Group. The TAF Objective Wing is decentralized in that it disperses the on-equipment "production" functions under each flying squadron, thus removing them from the control of a single maintenance squadron--AGS.

The move to a TAF Objective Wing structure is neither new, nor unexpected. Following the massive demobilization of World War II, the Air Force responded with a centralization of maintenance organizations under the 1947 Hobson Plan. Though the scale of the demobilization then was more dramatic, the basic situation of today is similar. The force is declining yet the need to maintain a viable Air Force organization remains. For the TAF, the wing restructuring mirrors the philosophy which led to the creation of the TAC unique maintenance system in 1966. TAC undertook the TAC Enhancement program to provide the tactical squadron commander with a self-contained maintenance capability. The resulting system, under TAC Manual 66-31, placed the production functions within the tactical squadron. The new TAF Objective Wing simply combines these two designs into one centralized, yet flexible system which takes into account the constraints faced by the TAF.

Most people are resistant to change, especially major change, and this time it is no different. However, consideration must be given to

who this change will affect. The on-equipment aircraft maintenance technician will experience the least negative impact from the reorganization. As Colonel Wiswell pointed out, the most annoying problem is likely to be the expected shortage of spare parts and facilities (49:14). The group most likely to be hurt is the off-equipment aircraft avionics maintenance technicians. As the Alternatives to Maintenance concept takes hold, these off-equipment avionics specialists will experience changes in the structure of their career fields. However, the move to two-level maintenance will not happen overnight so there is time to develop an orderly plan for phasing out the off-equipment specialist. Perhaps those who stand to lose the most are the intermediate-level officer and enlisted aircraft maintenance managers. The TAF Objective Wing structure calls for the elimination of much of the overhead supervisory positions often held by these mid-level managers. The clear path to advancement is now cluttered by this unexpected turn of events, and it will undoubtedly take some time for the chaos to subside. Yet if everyone focuses on doing her or his part to ensure the success of the mission, the TAF Objective Wing can become another positive example in history.

Recommended Future Research Topics

The world political situation, particularly in respect to the Soviet Union and the Middle East, remains volatile. American troops have just returned from nearly a year of military actions, as part of a multi-national peacekeeping force, in response to Iraq's invasion of Kuwait in August 1990. Even more recently, the world took a front row

seat to witness the attempted overthrow of Soviet Union President Mikhail Gorbachev's reformist government. From 19 August to 21 August 1991, hardline Communists staged a coup against Gorbachev, but were unsuccessful in their bid to take control of the nation. These two developments raise some concerns about the dangers and risks involved with the new TAF structure. The assessment of some of these factors may be done through future research of two major areas; the two-level maintenance and TAF Composite Wing concepts.

Assessment of the impact of the loss of transportation on the success of two-level maintenance is an area requiring research. The success of two-level maintenance rests not only on the R&M of the aircraft systems and components, but on adequate transportation as well. Spare parts must be delivered to the right place at the right time. The reduction in defense dollars is forcing cutbacks on the already ailing logistics air (LOGAIR) system. Loss of deployment flexibility under two-level maintenance is another concern which bears some examination. As two-level maintenance evolves, many of the full-time technicians may be civilians. The questions is, how will the TAF support its forward operating locations with non-deployable civilian labor? One final area of interest is the possible long-term effects of two-level maintenance on avionics and other aircraft maintenance career fields. Is the move to two-level maintenance signalling an even more generalized aircraft maintenance workforce? What effects will two-level maintenance have on training? Will flightline avionics maintenance personnel become mere black-box pullers? Will intermediate avionics maintenance training become very specialized? Rivet Workforce has already altered the opportunity to exchange on- and off-equipment maintenance experience,

but at least the various AFSCs were still co-located on the same base. What happens to flightline production when the intermediate maintenance technicians are reassigned to regional repair facilities and the opportunity to exchange maintenance experience ends?

Rivet Workforce is another area of concern within the TAF Objective Wing. As part of Rivet Workforce, aircraft maintenance technicians were "married" to their weapons system. If the TAF Objective Wing has more than one type of aircraft assigned it may be prudent to cross-flow like technicians between the systems. Although that action violates one of the basic premises of Rivet Workforce it may offer some economies. The creation of TAF Objective Wings raises the issue of combat survivability. An Objective Wing--such as the one proposed for Mountain Home AFB, Idaho--centralizes many assets at one location, thereby creating a lucrative target. Since one goal of the TAF Objective Wing is to reduce command, control, and communications it may be interesting to evaluate the shift in tactical responsibility should one TAF Wing be immobilized, or destroyed.

One last concern, common to both programs, is their potential influence--either positive and negative--on the work attitudes of the force. One area of investigation is the effect of two-level maintenance on job satisfaction, particularly for avionics maintenance technicians. Another area includes the potential abuse of mid-level management. As the new concepts take hold, mid-level managers--both enlisted and officer--are likely to bear the brunt of the changes. How the TAF handles the recruitment, training, promotion, and retirement of these managers will have a lasting impact on the entire aircraft maintenance organization.

Appendix A: United States Air Force Personnel Levels (46:40)
(1907-1992)

YEAR	STRENGTH	YEAR	STRENGTH
1907	3	1951	788,381
1908	13	1952	973,474
1909	27	1953	977,593
1910	11	1954	947,918
1911	23	1955	959,946
1912	51	1956	909,958
1913	114	1957	919,835
1914	122	1958	871,156
1915	208	1959	840,028
1916	311	1960	814,213
1917	1,218	1961	820,490
1918	195,023	1962	883,330
1919	25,603	1963	868,644
1920	9,050	1964	855,802
1921	11,649	1965	823,633
1922	9,642	1966	886,350
1923	9,441	1967	897,426
1924	10,547	1968	904,759
1925	9,670	1969	862,062
1926	9,674	1970	791,078
1927	10,078	1971	755,107
1928	10,549	1972	725,635
1929	12,131	1973	690,999
1930	13,531	1974	643,795
1931	14,780	1975	612,551
1932	15,028	1976	585,207
1933	15,099	1977	570,479
1934	15,861	1978	569,491
1935	16,247	1979	559,450
1936	17,233	1980	557,969
1937	19,147	1981	570,302
1938	21,089	1982	582,845
1939	23,455	1983	592,044
1940	51,165	1984	597,125
1941	152,125	1985	601,515
1942	764,415	1986	608,199
1943	2,197,114	1987	607,035
1944	2,372,292	1988	576,446
1945	2,282,259	1989	570,880
1946	455,515	1990	535,233
1947	305,827	1991	508,558
1948	387,730	1992	486,819 *
1949	419,347		
1950	411,277		

* Projected

Appendix B: History of Army/Air Force Aviation (36)

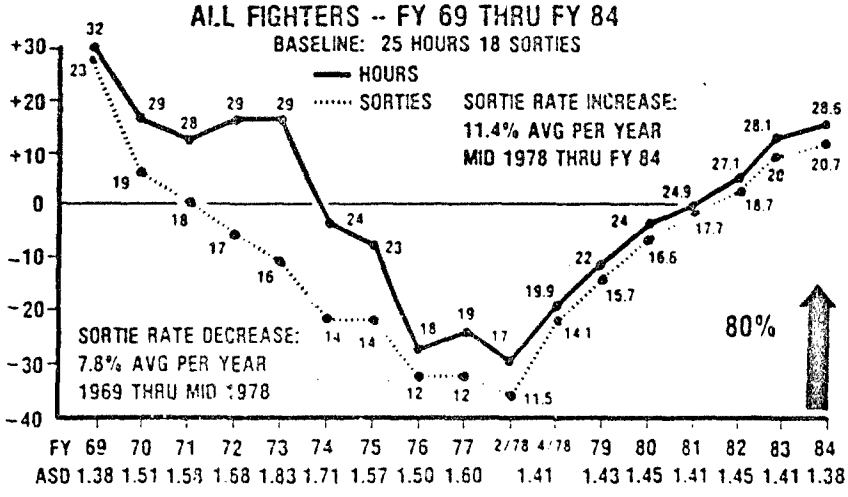
1 August 1907	Aeronautical Division--United States Army Signal Corps
18 July 1914	Aviation Section--United States Army Signal Corps
20 May 1918	Air Service--United States Army
2 July 1926	United States Army Air Corps
20 June 1941	United States Army Air Forces
18 September 1947	United States Air Force

Appendix C: Rivet Workforce Conversion Table (18:28-29)

OLD AFSC	NEW AFSC	SEI	TITLE
321X2	455X3	694	WCS
325X0	455X1	691	GUID/CONT/(A-10 assigned WCS) C-TAF
325X1		692	
328X4		693	COMM/NAV C-TAF
328X0	455X2	695	
328X1		696	
328X2	455X4		AWACS
328X3	456X1		EWS
423X0	452X5	700	TAF ECS/ELEC ON/OFF EQUIP
423X1		701	
423X2	454X2		EGRESS
423X3	454X3		FUELS
423X4	452X4	699	TAF AFG A-F-15/B-F-16 C-F-111/M-OTHERS
426X2		698	
431X1		697	
427X0	458X0	702	MACH/WELDERS
427X4		704	
427X1	458X2	703	CORR/SHEET METAL
427X5		705	
326X6	452X1	681	F-15 F/L AVIONICS
326X7		682	
326X8		683	
326X6	452X2	681	F-16 F/L AVIONICS
326X7		682	
327X8		683	

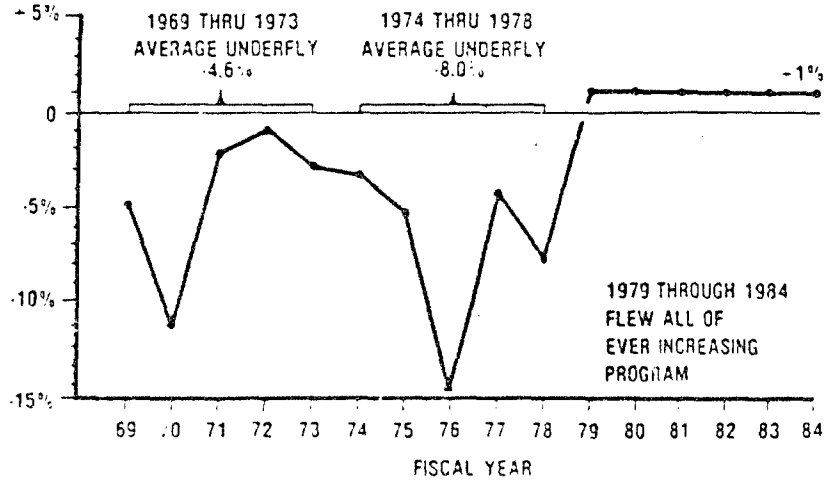
OLD AFSC	NEW AFSC	SEI	TITLE
326X6		681	
326X7	452X3	682	F-111 F/L AVIONICS
327X8		683	
326X3		686	
326X4	451X4	685	F-15 IN SHOP AVIONICS
326X5		687	
326X3		686	
326X4	451X6	685	F-111 IN SHOP AVIONICS
326X5		687	

PERCENT CHANGE IN UTILIZATION RATES

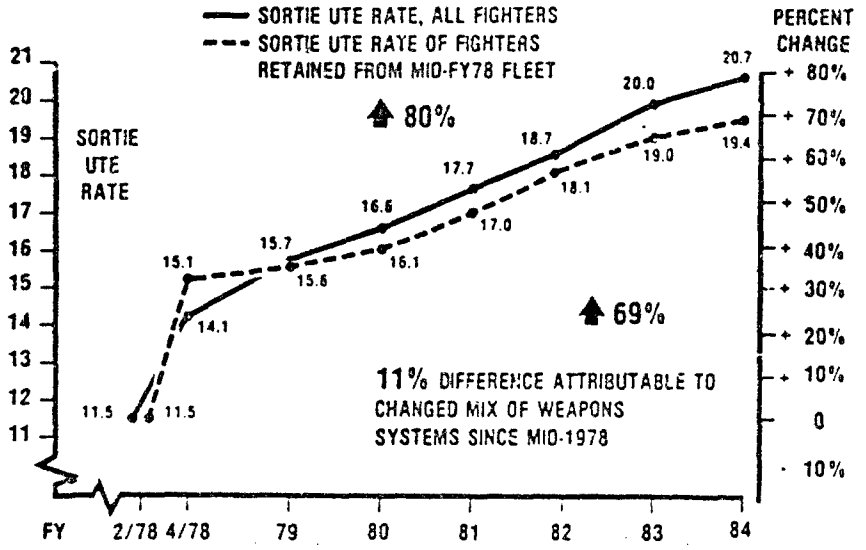


PERCENT DEVIATION FROM PROGRAMMED FLYING HOURS

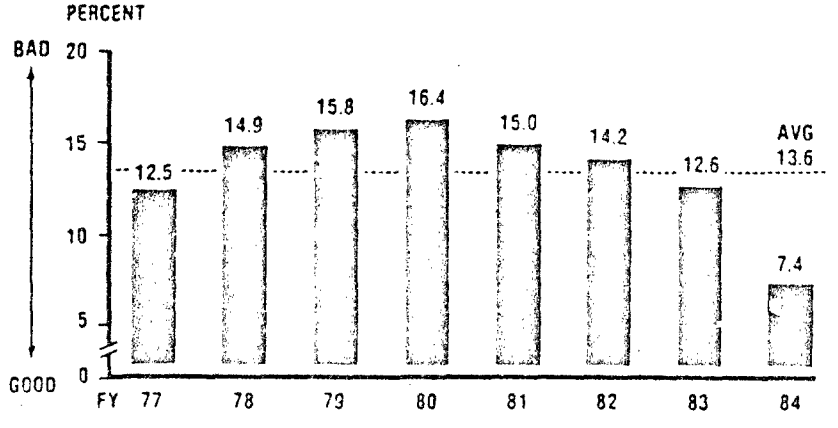
ALL TAC FIGHTERS



THE IMPACT OF NEW WEAPONS SYSTEMS ON TAC SORTIE PRODUCTIVITY

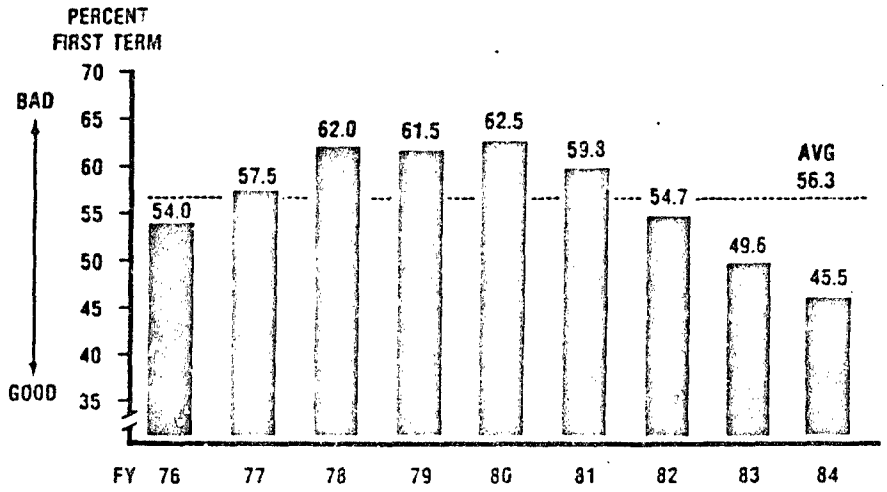


TAC FIGHTERS GROUNDED FOR PARTS



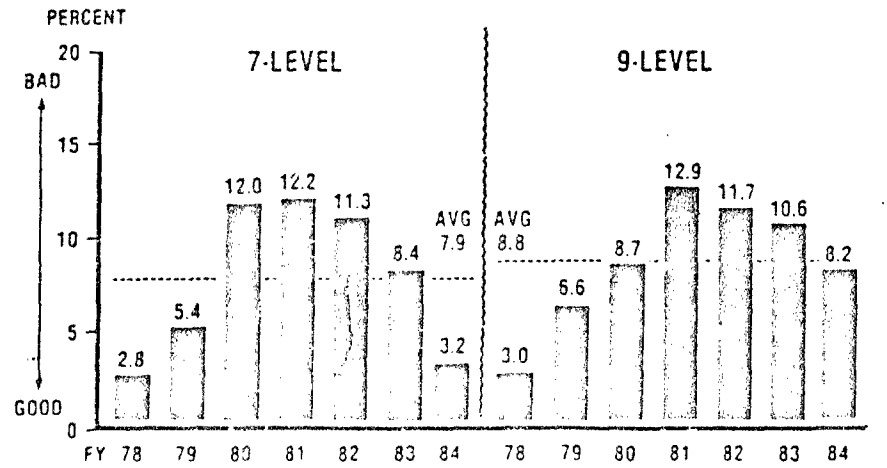
TAC MAINTENANCE FORCE EXPERIENCE

FIRST TERM VERSUS CAREER

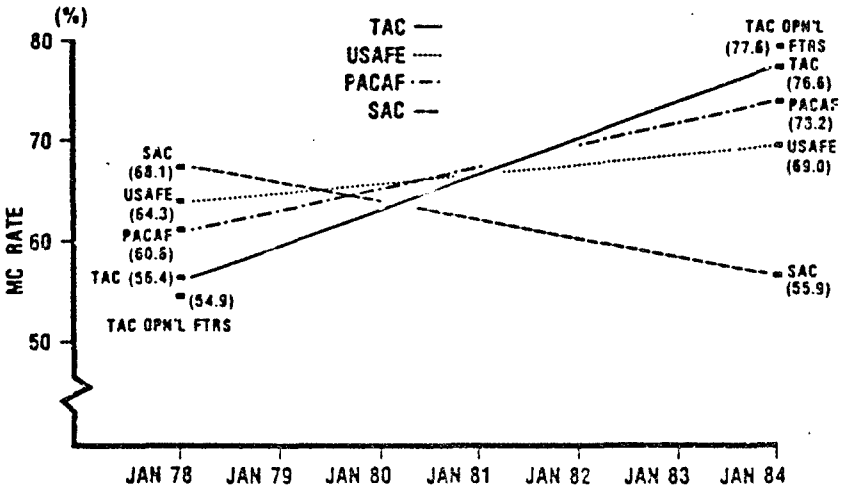


TAC MAINTENANCE FORCE EXPERIENCE

PERCENT SHORTAGES -- ASSIGNED vs AUTHORIZED



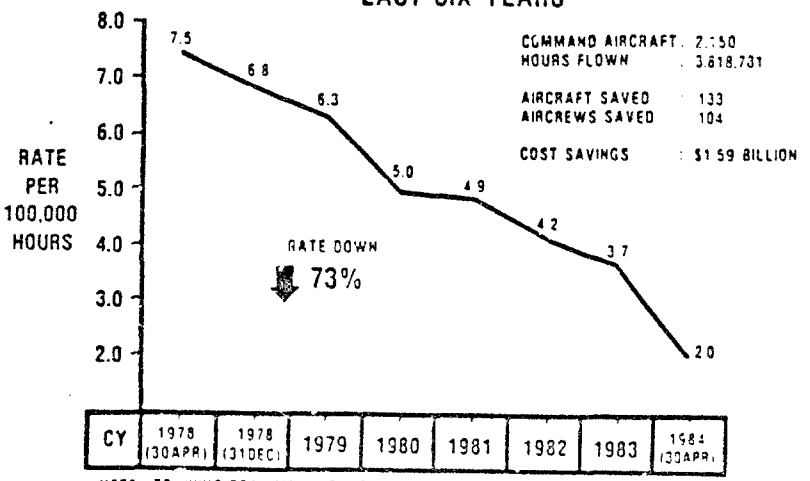
MC TRENDS: TAC, SAC, PACAF AND USAFE



SOURCE: AVISURS, INCLUDES ALL AIRCRAFT

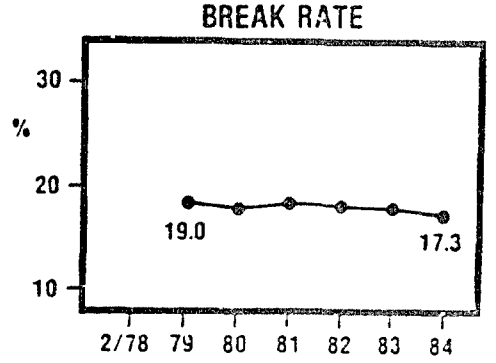
TAC MAJOR MISHAP RATE

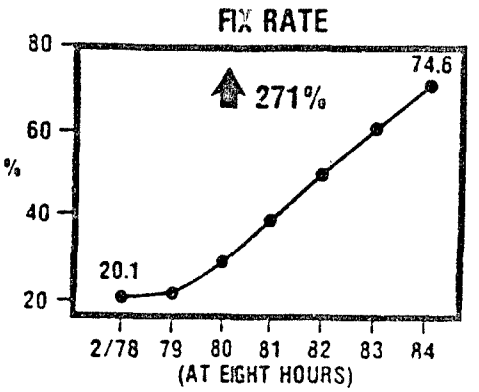
LAST SIX YEARS

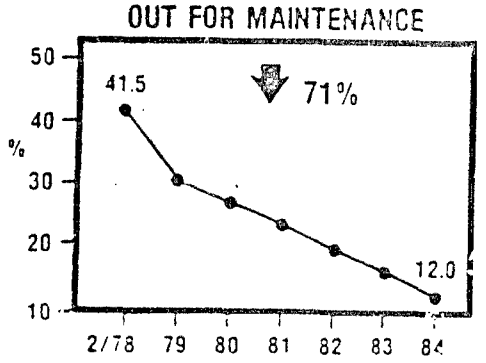


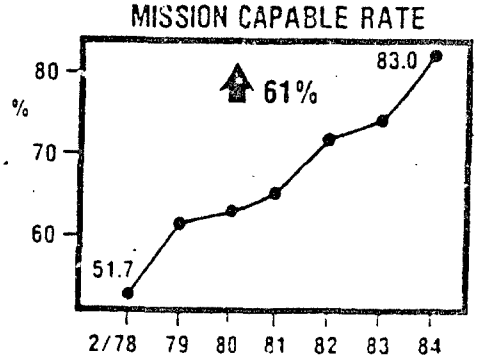
NOTE: TRAINING REALISM WAS INCREASED SUBSTANTIALLY DURING THIS SAME PERIOD - THUS INCREASING THE RISK

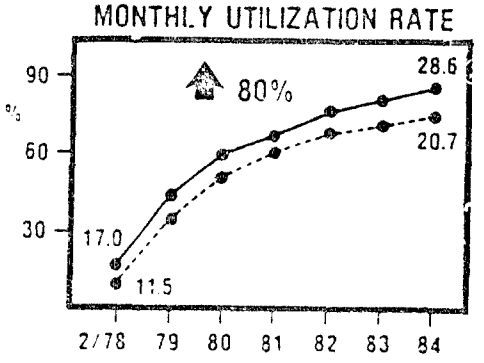
ALL OPERATIONAL FIGHTER AIRCRAFT MAINTENANCE INDICATORS











(NOTE: SEE FOLLOWING PAGE FOR EXPLANATION OF THE VARIOUS RATES)

BREAK RATE - Percent of sorties landing with the aircraft requiring maintenance before next flight ("broken")

FIX RATE - Percent of "broken" aircraft repaired and returned to mission capable status within a given time period (In this case at the 8 hour point after landing)

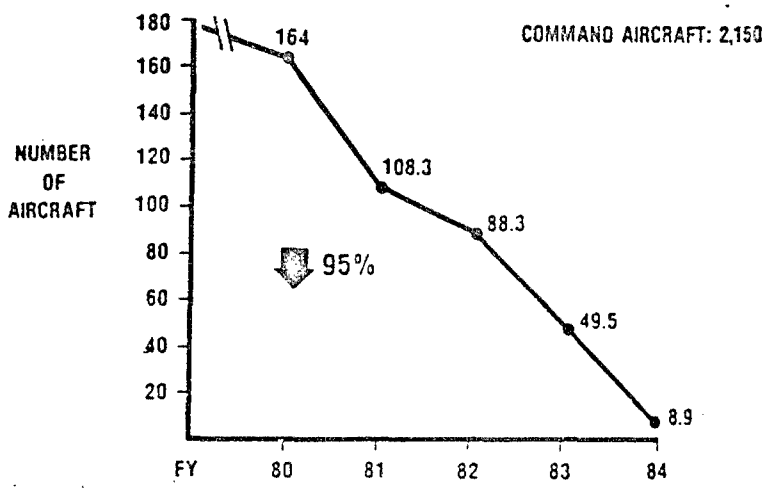
OUT FOR MAINTENANCE - Aircraft not mission capable because maintenance is required before next flight

MISSION CAPABLE RATE - Percent of aircraft capable of flight and of performing the assigned unit mission

MONTHLY UTILIZATION RATE - Sorties/hours per possessed aircraft per month (Sorties broken line; hours solid line)

TAC HANGAR QUEEN STATUS

AVERAGE BY FY'S



HANGAR QUEEN - An aircraft not mission capable for parts or maintenance for 3 weeks or more

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Vita

Captain Barbara L. Harris was born 4 May 1957 in Madison, Wisconsin. She graduated from LaFollette High School in 1975 and enlisted in the U.S. Air Force in 1977. Following basic training at Lackland AFB, Texas she attended the aircraft fuel systems specialist technical school at Chanute AFB, Illinois. Her enlisted assignments included Cannon AFB, New Mexico; Clark AB, Republic of the Philippines, and Andrews AFB, Maryland. During her assignment to Clark AB Captain Harris completed her Bachelor of Arts in Social Science. While assigned to Andrews AFB she was selected to attend Officer Training School (OTS). Following graduation from OTS she attended the Aircraft Maintenance Officer Training Course at Chanute AFB. Her first officer assignment was with the 655th Consolidated Aircraft Maintenance Squadron (MAC), Eglin AFB, Florida where she served in several positions culminating in her assignment as Chief of Maintenance for the HC-130 and UH-60 squadron. Captain Harris' next assignment was to the 325th Tactical Training Wing (TAC), Tyndall AFB, Florida. She began as the Officer-in-Charge (OIC), Propulsion Branch where she supervised engine and secondary power system repairs on the F-100 engine for the F-15 aircraft. Captain Harris was next selected as OIC, 1st Aircraft Maintenance Unit where she managed all on-equipment maintenance activities for 26 assigned F-15A and B model aircraft. Her last assignment at Tyndall AFB was as OIC, Maintenance Management Division where she served until entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1990.

Permanent Address: 7442 Chipewa Street
Panama City, Florida 32404

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13. ABSTRACT (Maximum 200 words)

This study assessed the challenges Tactical Air Force (TAF) aircraft maintenance personnel face as a result of the TAF reorganization. The goal was to provide aircraft maintenance managers a basis for evaluating and meeting those challenges. To accomplish this, emphasis was placed on documenting the concepts, events, and conditions which led to changes in military aircraft maintenance from the birth of aviation to the present. Current issues such as the proposed move to two-level maintenance and the formation of the TAF Composite and Objective Wings were also addressed. Research was conducted through the review of available historical documents, complemented by current literature and personal interviews. The TAF reorganizaton results in a more centralized maintenance organization with a generalized workforce. History shows that when faced with comparable conditions--reduced threat and loss of defense dollars, the Air Force took similar action. The on-equipment aircraft maintenance technician will experience the least negative impact from the reorganization. Those most likely to experience the greatest changes are the off-equipment aircraft avionics maintenance technicians. The TAF reorganization also eliminates many of the overhead supervisory positions held by intermediate-level officer and enlisted aircraft maintenance managers.

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