DOCUMENTED BRIEFING

RAND

Assessing Unit Readiness

Case Study of an Air Force Mobility Wing

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Project AIR FORCE

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PREFACE

In the second half of the 1990s, the United States Air Force began to report a decline in the readiness levels of its combat support forces. A combination of complex, long-term operations and fiscal constraints raised the stress endured by Air Force personnel and their aging equipment. At the same time, the Air Force lacked a truly integrated framework for assessing, predicting, reporting, resourcing, and remedying current and future readiness problems.

In 1997, General John Jumper, then Deputy Chief of Staff, Air and Space Operations, asked Project AIR FORCE (PAF) to define a high-level, overarching system for managing the military readiness of the United States Air Force. The PAF project, entitled "Defining an Integrated System for Assessing and Managing Air Force Readiness," was a multi-year effort sponsored by the Air Force Operational Readiness Division.

In the context of this effort, PAF in 1999 undertook an in-depth review of readiness problems in an active-component operational fighter wing—the 388th Fighter Wing at Hill Air Force Base in Utah. The broad context was given by ongoing allegations of problems with readiness in the current environment of constrained resources and demanding contingency requirements. PAF's aim was to characterize the effects of this environment on a representative operational unit and to capture the generalizable features in a readiness management system designed for senior decisionmakers. This research was reported in Carl J. Dahlman and David E. Thaler, *Assessing Unit Readiness: Case Study of an Air Force Fighter Wing*, DB-296-AF, Santa Monica: RAND, 2000.

In 2000, PAF turned its focus to the mobility community. With the support of the Air Mobility Command (AMC), PAF initiated readiness-related research at the 60th Air Mobility Wing (AMW) at Travis Air Force Base, California. The 60th AMW maintains and operates a fleet of C-5 Galaxy airlift and KC-10 Extender tanker aircraft.

This documented briefing examines the simultaneous, competing pressures facing the wing on almost a daily basis:
(1) demands for airlift and tanker support that ebb and flow dramatically at times; (2) requirements for upgrade and continuation training for both aircrew and maintainers; and (3) serious resource and retention problems. Based on conversations with many experts throughout the Air Force, the findings in this report point to pressures facing operational mobility wings throughout the Air Force.

We conducted much of the research in this study before the events of September 11, 2001. Where possible, we have updated observations to reflect the operational environment that the 60th AMW has faced since then. It is important to note that a number of measures expressing the "health" of the pilot, maintainer, and aircraft inventories have improved as a result of post-9/11 operations and "wartime" policies (e.g., stop-loss and partial mobilization). Despite this, the systemic problems identified in this report are likely to surface again—possibly with even greater force—as operations conclude and "wartime" policies are rescinded.

This study should be of interest to analysts and decisionmakers at the wing, major command (MAJCOM), and Air Staff levels with responsibility for allocating resources to readiness-related activities.

PROJECT AIR FORCE

Project AIR FORCE, a division of RAND, is the Air Force federally funded research and development center (FFRDC) for studies and analyses. It provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future aerospace forces. Research is performed in four programs: Strategy and Doctrine; Aerospace Force Development; Resource Management; and Manpower, Personnel, and Training. This research was performed in the Resource Management Program.

ACKNOWLEDGMENTS

The command and staff of the 60th AMW at Travis Air Force Base were exceptionally gracious and forthcoming in their assistance to our effort. We are grateful for their support and information as well as for the precious time they took in answering our many questions. They work very hard to provide security to the nation, and we can only hope that our research will contribute in some way to the betterment of their lives.

First and foremost, we would like to thank Colonel Paul Selva, former commander of the 60th Operations Group, and Colonels Edward Connolly and Ronald Blickley, current and former commanders, respectively, of the 60th Logistics Group, for opening their organizations to us. Many others at the 60th dedicated time and energy to our effort. We are indebted to Lieutenant Colonel Teresa Walters, Lieutenant Colonel Jim Hannon, Major Leif Johnson, Captain Karl Dolson, Captain Timrek Heisler, Captain Barry Roeper, Chief Master Sergeant Ronald Ammerman, Chief Master Sergeant Michael Dogan, Senior Master Sergeant Stephen Kingrey, Senior Master Sergeant Jerry Lutheran, and Rod Hersom.

We are further indebted to the numerous pilots, enlisted aircrew, and maintainers who sat with us at Travis and helped us understand the challenges they face. We are also deeply grateful to the hundreds of maintainers who took the time to respond to our questionnaire on their daily activities.

A number of individuals at Headquarters AMC offered us invaluable advice and data. We are especially thankful to Colonel Karl Lewandowski, Colonel Jim Russell, Lieutenant Colonel (Ret.) Craig Vara, Phil Widincamp, Dave Albers, and Michael Nelson.

Finally, several RAND colleagues guided and supported our efforts. We are indebted to John Stillion for his technical review of this report; his comments helped us greatly improve its clarity. We received support and encouragement from Bob Roll, Director of PAF's Resource Management Program. Boichi San, SAS programmer extraordinaire, queried and manipulated large manpower and personnel databases; much of the work in this document would not have been possible without her. Bob Kerchner conducted the experience mix analysis. Gary Massey and Judy Mele provided advice related to the manpower and personnel databases.

ABBREVIATIONS

2LM	Two-Level Maintenance
A/L	Air/land
A1C	Airman First Class
AC	Aircraft commander
ACC	Air Combat Command
AFMC	Air Force Materiel Command
AFSC	Air Force Specialty Code
AGE	Aerospace Ground Equipment
AGS	Aircraft generation squadron
AMC	Air Mobility Command
AMW	Air Mobility Wing
API	Aircrew Position Identifier
AREP	Aircraft Repair Enhancement Program
ART	Air reserve technician
AWACS	Airborne Warning and Control System
BO	Boom operator
CAFSC	Control Air Force Specialty Code
COMBS	Contractor-Operated Main Base Supply [liaison]
CP	Copilot
CRS	Component repair squadron
EMS	Equipment maintenance squadron
FE	Flight engineer
IP	Instructor pilot
IQ	Initial qualification [training]
ISO	Isochronal
LCOM	Logistics Composite Model
LM	Loadmaster
LSS	Logistics support squadron
MAF	Man-hour availability factor
MAJCOM	Major command
MC	Mission-capable [rate]
MDS	Mission design series
MQT	Mission qualification training
MRT	Maintenance repair team
Msgt	Master Sergeant
O&M	Operations and maintenance
OJT	On-the-job training
OPTEMPO	Operational tempo
PAF	Project AIR FORCE
PAFSC	Primary Air Force Specialty Code
PAMS	Pilot Absorption Management System

PE	Producer equivalent
RACC	Repairable Assets Control Center
RPI	Rated Position Identifier
SrA	Senior Airman
SSgt	Staff Sergeant
TDY	Temporary duty
TNMCM	Total non–mission capable due to maintenance
TNMCS	Total non–mission capable due to supply
TODO	Technical Order Distribution Office
Tsgt	Technical Sergeant
TWCF	Transportation Working Capital Fund
UDM	Unit Deployment Manager
UPT	Undergraduate pilot training
WCF	Working Capital Fund

Outline of Briefing

- Readiness Concepts and the Mobility Context
- Defining a Healthy Wing: Setting Standards
- Assessing the Wing's Day-to-Day Environment
- Summary

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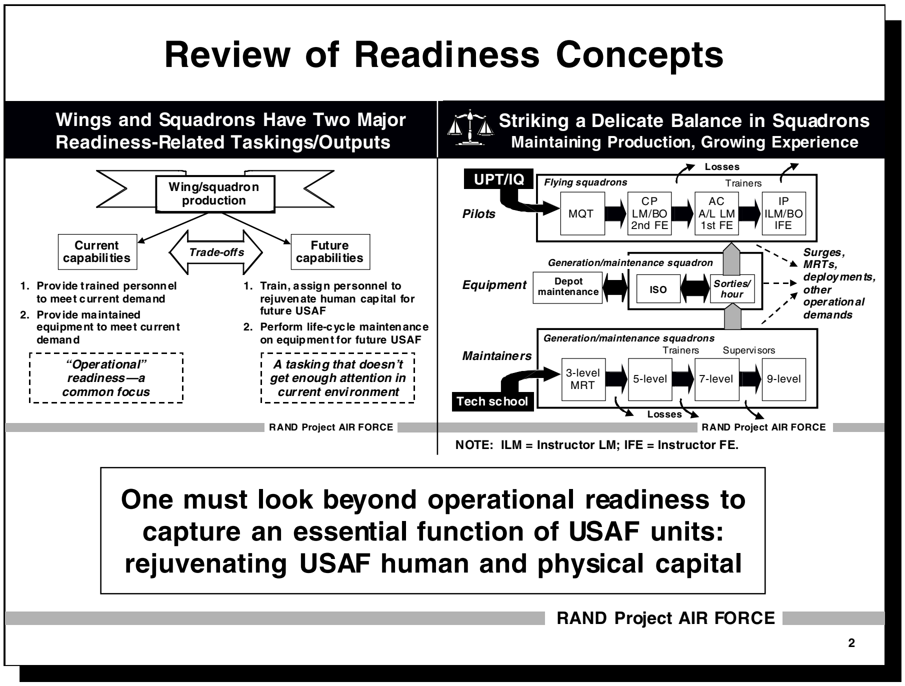
In this documented briefing, we first explain a concept of readiness that goes beyond the common emphasis on operational readiness. We then review standards for manning the pilot, enlisted aircrew, and maintainer forces and briefly describe how these standards relate to the overall "health" of a wing. The briefing then assesses the challenges facing the 60th Air Mobility Wing (AMW) at Travis Air Force Base, California, in sustaining the force over time. We conclude by summarizing the wing's overall ability to sustain its readiness.



The chart above provides a brief review of readiness concepts introduced in recent Project AIR FORCE (PAF) research.[1]

As depicted in the diagram on the left, operational units in the Air Force are responsible for accomplishing two basic tasks. First, they must be prepared to meet the current operational requirements of the unified commanders. Units maintain operational readiness by ensuring that experienced personnel and reliable equipment are available to respond to operational demands at the required time. Second, units are tasked to continuously renew the knowledge base of the Air Force (via on-the-job training [OJT] and formal training) to ensure that commanders will have an experienced personnel inventory from which to draw in the future. In addition, units undertake maintenance actions that serve to keep equipment healthy for those future commanders. This second task can be termed "rejuvenation."

The diagram on the right portrays rejuvenation in a mobility wing. Both aircrew and maintainers enter the unit as inexperienced personnel, and through training and experience they upgrade to higher skill levels. Pilots enter the squadron from undergraduate pilot training (UPT) and initial qualification (IQ) training and pursue mission qualification

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[1]See Carl J. Dahlman and David E. Thaler, *Assessing Unit Readiness: Case Study of an Air Force Fighter Wing*, DB-296-AF, Santa Monica: RAND, 2000, pp. 2–6.

training (MQT). With experience and training, they go on to become copilots (CPs), aircraft commanders (ACs), and instructor pilots (IPs). Enlisted aircrew—loadmasters (LMs), boom operators (BOs), and flight engineers (FEs)—move up to become air/land (A/L) LMs and BOs and 1st FEs and then proceed to instructor status. Likewise, maintainers are assigned to units as 3-level apprentices and, through training and experience, become 5-level journeymen, 7-level craftsmen, and 9-level supervisors. In addition to being the primary producers in the unit, the senior aircrew and maintainers are the OJT trainers.

The unit must strike a delicate balance between producing the flying hours pilots and aircrew need, providing time and resources for maintainer OJT, and performing scheduled maintenance—such as isochronal (ISO) inspections and depot maintenance—while meeting external demands for existing capability. External demands may include surges, deployments, and maintenance repair teams (MRTs). Imbalances can affect future capabilities. For example, shortfalls in training resources combined with high exit rates on the part of experienced personnel can leave the force less experienced and less productive in the future.[2]

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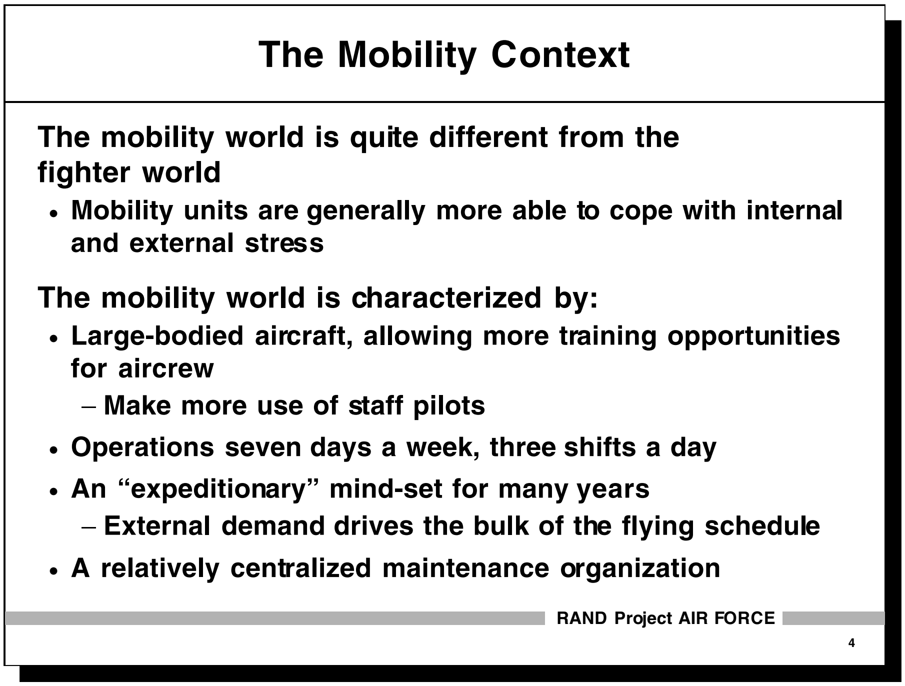
[2]A number of observers argue that the U.S. military has experienced about a decade of such chronic shortfalls. See Eric Larson et al., *Defense Planning in a Decade of Change: Lessons from the Base Force, Bottom-Up Review, and Quadrennial Defense Review*, MR-1387-AF, Santa Monica: RAND, 2001; and Donald Kagan and Frederick W. Kagan, *While America Sleeps: Self-Delusion, Military Weakness, and the Threat to Peace Today*, New York: St. Martin's Press, 2000.



Although the fighter and mobility communities must both accomplish the two aforementioned tasks, the environment and missions each faces present somewhat different challenges. For example, fighter units with single-seat cockpits (e.g., the F-16C, F-15C, and A-10) must fly separate sorties for the teacher and for the student. In contrast, tanker and airlift units can accommodate several students and a teacher on a single flight. Moreover, mobility units have long made extensive use of pilots on wing staffs to teach inexperienced CPs, whereas fighter units have not. Recently, however, diminishing experience in fighter squadrons has necessitated that greater use be made of staff-assigned, experienced pilots as trainers.

In addition, the mobility wing operates seven days a week, whereas fighter wings generally fly sorties five days a week. The mobility wing constantly responds to external demands for cargo delivery and aerial refueling and has done so for many years. The challenge for fighter wings involves more sporadic rotational deployments, which are a more recent phenomenon.

Finally, the sortie generation function in the fighter wing resides in fighter squadrons. In the mobility wing, maintainers man aircraft generation squadrons that are separate from flying squadrons.

Next we discuss standards for aircrew and maintainer manning and experience.

Setting Standards for AMC Aircrews

The number of crews is determined by wartime requirements

AMC then determines training requirements for experiencing and maintaining currency

- Carefully tracks the "copilot aging rate"—the rate at which CPs are progressing to aircraft commander
- An experienced C-5 pilot has 1300 hours; the unit mix should be 57 percent experienced

FEs, LMs, and BOs train within the context of flying hours

- OJT on flights and (for FEs) with pilots in simulators
- The aging rate is not tracked as closely as it is for pilots
- There is no standard for experience mix

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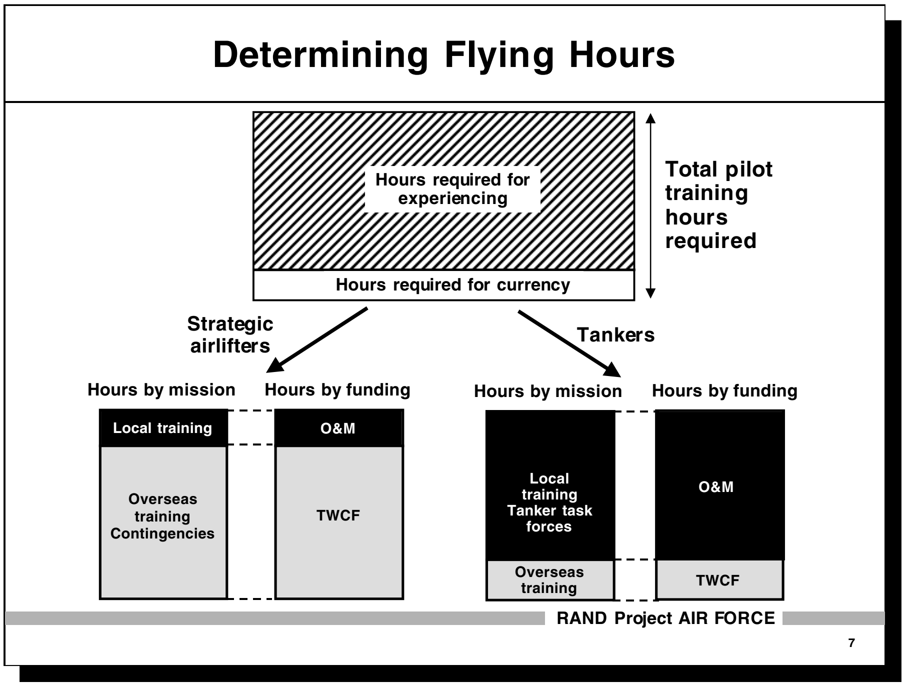
The number of aircraft crews a wing is authorized depends on the number of aircraft it possesses and on the wartime-required crew ratio and crew complement. The crew ratio for the C-5 is 1.8 per aircraft, whereas that for the KC-10 is 2.0. The crew complement for the C-5 is 2.0 pilots (an AC and a CP), 2.0 FEs, and 2.5 LMs. The KC-10's crew complement is 2.0 pilots, 1.25 FEs, and 1.0 BO.

The Air Mobility Command (AMC) standard for the pilot experience mix in a flying squadron is 50 percent "experienced"; AMC aims for higher experience (57 percent) to account for upgrade delays. "Experienced" in the C-5 had until recently been defined as 1400 total flying hours; this was also the level required to be eligible to upgrade to AC. In early 2002, AMC lowered the hours required for experience to 1300 hours and the hours for AC eligibility to 1200 hours. Thus, it is possible to be an "inexperienced" AC.

New pilots normally begin their assignments with roughly 300 hours and are expected to become experienced during their three-year tour. Thus, to gain the additional 1000 hours within that time, pilots need about 28 hours per month. AMC tracks "copilot aging rates" in great detail through its Pilot Absorption Management System (PAMS).

Flying hours are generally based on experiencing and currency requirements. After upgrading to AC, pilots must maintain currency by completing required yearly events. Simulator hours are included in the mix and help alleviate the requirement for flying hours in the aircraft. Some experiencing and most currency activities can be accomplished in the simulator. The exceptions include training for inexperienced personnel, such as first-year CPs, and certain currency events, such as aerial refueling.



AMC determines flying hours for each aircraft type by estimating the total training hours needed to "experience" CPs and to maintain the currency of ACs and staff pilots. Experiencing constitutes the bulk of flying hours.[3]

The command then determines how those hours are to be flown, whether on local training missions, Joint Airborne/Air Transportability Training, overseas training, or contingency flying. The mix of flying hours is different for strategic airlifters (e.g., the C-5, C-17, and C-141) than for tankers (e.g., the KC-10 and KC-135). Airlifters fly most of their hours overseas on channel missions and contingency operations. Tankers fly more local training missions and support Air Force, Navy, and Marine exercises in the United States in addition to supporting contingency operations. Programmers ensure that all pilot experiencing and currency requirements can be met within this mix of missions, supplemented by simulator time.

The type of hours flown by strategic airlifters and tankers defines the funding source. For airlifters, hours for local training are funded by the operations and maintenance (O&M) budget, while the Transportation Working Capital Fund (TWCF) generally supports

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[3]For a description of the flying hour programs for airlifters and tankers, see Air Force Audit Agency, *Airlift and Air Refueling Aircraft Flying Hour Programs: Report of Audit*, Project 98058023, Washington, D.C., August 31, 1998.

airlift training (e.g., channel missions) and contingencies.[4] The TWCF, a part of the overall Working Capital Fund (WCF) concept, is generated and paid for by customer demands for cargo and passenger movement. Flying hours for airlifters are financed largely by the TWCF. Tanker hours are predominantly funded by O&M.

[4]FY 2002 decisions have moved C-5 TWCF hours to O&M, and some overseas sorties will be covered under O&M beginning in FY 2004.

Setting Standards for AMC Maintainers

Like the Air Combat Command (ACC), AMC uses LCOM to establish requirements for many maintenance manpower positions

- **Simulates peacetime and wartime sorties and details associated maintenance actions**
- **Uses USAF manpower rules that limit man-hour availability**

Current manpower processes are deficient

- **Some problems are with the application of LCOM, but LCOM is not the main problem**
- **Processes do not adequately account for critical sources of a maintainer's workload—OJT, out of hide, high operational tempo (OPTEMPO), and other maintenance, such as excessive canning**
- **A key impetus for RAND questionnaire**

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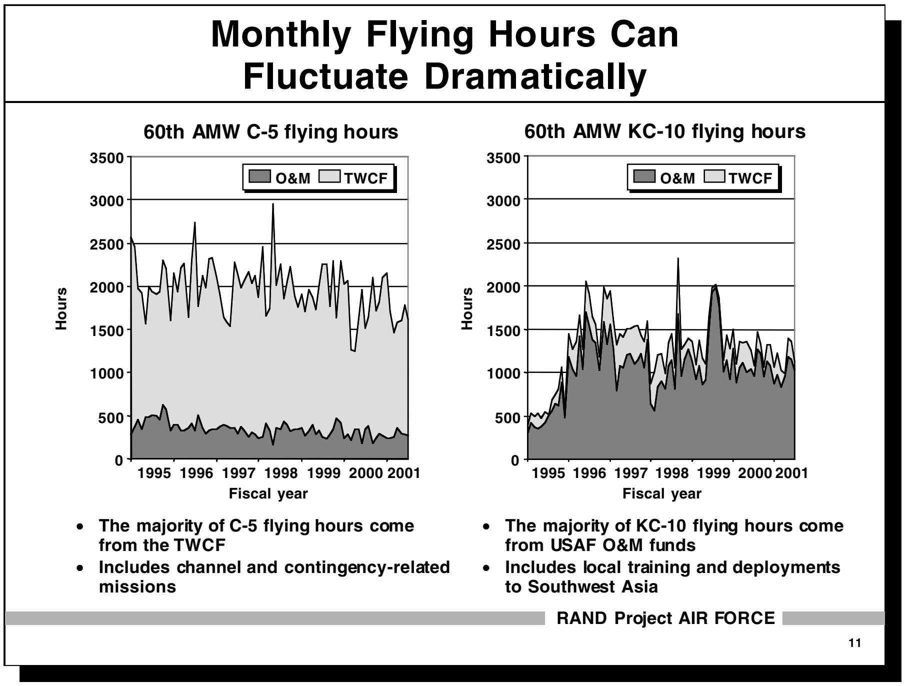
Requirements for maintenance manpower are currently determined by processes that feature the Logistics Composite Model (LCOM) in combination with a set of Air Force–wide manpower rules. Suffice it to say here that there are critical problems with the process by which maintenance manpower is determined.[5] There are, for example, a number of important activities in which field maintainers engage that are neither accounted for nor tracked. To evaluate these activities at Travis, RAND administered a questionnaire in spring 2000 that asked technicians about their hours, their level of effort on various activities, and a number of other issues. RAND received more than 900 responses that provided a foundation for the maintenance analysis in this report.[6]

Generally, standards for maintenance manning and experience are incomplete. The goals against which maintenance manning should be assessed are to (1) provide sorties to meet the operational requirements of the unified/specified commanders, from major theater war to rotational deployments; (2) provide sorties over time to yield the

[5]For a detailed, critical assessment of this process, see Carl J. Dahlman, Robert Kerchner, and David E. Thaler, *Setting Requirements for Maintenance Manpower in the U.S. Air Force*, MR-1436-AF, Santa Monica: RAND, 2002.

[6]An initiative at AMC to apply activity-based costing techniques at the wing level should provide more detailed insight into the range of activities that occupy field maintainers during duty hours.

flying hours required to upgrade and sustain an experienced pilot inventory; (3) upgrade and sustain an experienced maintainer inventory over time through OJT and formal training; (4) sustain a healthy inventory of equipment over time; and (5) meet other Air Force tasks as required.



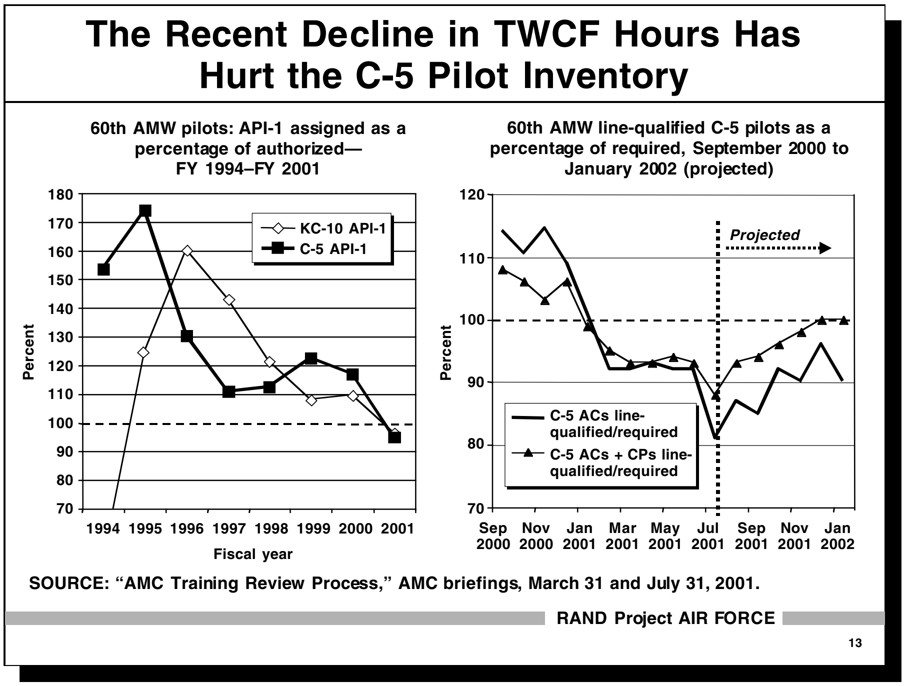
We now turn to the conditions and challenges facing the 60th AMW at Travis. The 60th AMW is authorized 37 C-5s and 27 KC-10s.

The flying hours for the 60th AMW's C-5s and KC-10s are shown above in the left and right charts, respectively. KC-10 flying hours climbed steeply in FY 1996 as the mission design series (MDS) was introduced to Travis during that period; at the same time, the wing's C-141 airlifters were retired. Flying hours are depicted through April 2001.

The charts above emphasize two important points. First, flying hours can fluctuate dramatically from month to month. A more extreme example of this occurred in late 1999, when C-5 flying hours dropped by nearly 40 percent between November and December. Second, average hours per month have declined for both MDSs since the beginning of FY 2000. Hours since then were 86 to 87 percent of those flown during the previous four to five years. There was a drop in TWCF customers in FY 2000.

The effect is particularly acute for the C-5s, which underflew programmed hours by an average of 5 percent between December 1999 and April 2001. Travis C-5s flew fewer than 90 percent of planned hours 40 percent of the time. Since September 11, however, flying hours for both the C-5 and the KC-10 have dramatically increased in support of Operation Enduring Freedom in and around Afghanistan.

On average, the 60th AMW possesses only about 30 C-5s and 22 KC-10s. At any one time, seven C-5s and five KC-10s—or roughly 20 percent of authorized—are undergoing depot or contractor maintenance off station and are thus not available to the wing.



We next examine the 60th AMW's pilot and enlisted aircrew inventory over time. The chart on the left shows fill rates—assigned as a percentage of authorized—for 60th AMW Aircrew Position Identifier–1 (API–1) pilots.[7] API–1 pilots are generally those assigned to flying squadrons. Pilots perennially have been assigned in numbers greater than 100 percent of the number authorized, a common practice across the Air Force pilot inventory. The wing has had to absorb the additional pilots without commensurate flying hours because hours are based on authorizations. In the mid-1990s, the fill rates for pilots of both aircraft were quite high. The training pipeline for KC-10 pilots was in full swing as the aircraft entered the wing. Fill rates were especially high for less experienced C-5 CPs but these rates declined between FY 1995 and FY 1997 as CPs either upgraded or left the wing.

The wing encountered a new problem between FY 2000 and FY 2001, when C-5 and KC-10 pilot fill rates dipped below 100 percent. The C-5 pilot inventory was cause for great concern. In FY 2001, the fill rate for experienced C-5 pilots dropped below 80 percent, down from 112 percent in FY 2000. The wing lost experienced pilots to the civilian

[7] "Aircrew Position Identifier" replaces the previous term, "Rated Position Identifier" (RPI), and includes officers in nonrated aircrew positions such as weapon controllers aboard the E-3 Airborne Warning and Control System (AWACS).

sector, a phenomenon that slowed in summer 2001 as airline hiring declined.

Moreover, with the wing underflying programmed hours owing to the drop in TWCF sorties, CPs could not age fast enough to replace the losses. In FY 2000, CPs were averaging about 25 hours per month compared with the 30 hours per month needed at that time to meet the target aging rate and gain 1400 hours in a three-year tour. At 25 hours per month, CPs would take three years and eight months to become experienced (accounting for the 300 hours they would bring from UPT). Pilots thus entered their second tour still inexperienced, thereby creating a training burden for the wing to which they were assigned during their second tour. In addition, the uneven monthly flying means that squadrons must play "catch-up" during months when flying hours are more numerous.

The chart on the right shows AMC's analysis of C-5 pilot experience in the 60th AMW between September 2000 and July 2001 (when the AMC analysis was completed); it also shows projected experience through January 2002. The graph depicts line-qualified ACs (the solid line) and ACs plus CPs (the line with triangular data points) available as a percentage of the number required. Normally these metrics exceed 100 percent, meaning that there are more line-qualified pilots than required. However, both showed steep drop-offs in the first quarter of FY 2001 as the wing felt the full effects of AC separations and inadequate flying for experiencing. By February 2001, the lines had dipped below 100 percent, declining to 81 percent for ACs and 88 percent for ACs plus CPs.

A slight tendency toward more junior pilots could be seen in the experience mix among C-5 pilots at Travis. Line-qualified ACs should be 50 percent of total line-qualified pilots. Between September 2000 and January 2001, they averaged 53 percent, a rather healthy mix. Between February and July 2001, however, the proportion of ACs fell to an average of 49 percent. While certainly not dramatic in absolute terms, this trend was a sign of potential problems.

To increase the number of ACs in flying units, AMC told its wings beginning in June 2001 to "fly out the program"—despite the reduction in TWCF customers—by flying planned channel missions with reduced loads. AMC also worked with the personnel community to limit the number of AC assignments to keep experience within the squadrons.[8] As a result, AMC expected that the number of line-qualified C-5 pilots in the 60th AMW would rise. However, AMC did not expect the levels to approach those seen in late 2000 within the time frame of the projection. Moreover, the proportion of ACs to total line-qualified pilots was expected to continue dropping slightly to 46 percent between August and January 2002.

The summer 2001 flying-hour initiative and personnel actions, combined with the increased flying, partial mobilization, and stop-loss policies that followed September 11, allowed AMC to deem the pilots at Travis "healthy" again.[9] In fact, with CPs flying at nearly twice normal levels, many pilots were ahead of the desired aging rate. Thus, the experience problem with C-5 pilots at Travis has been remedied in relatively short order.

KC-10 pilots remained healthy, with the more experienced aircraft commanders reaching a 110 percent fill rate. The fill rate for junior KC-10 pilots had remained at about 85 percent from FY 1999 to FY 2001—a rate that will need to increase if a healthy experience mix is to be maintained in the future.

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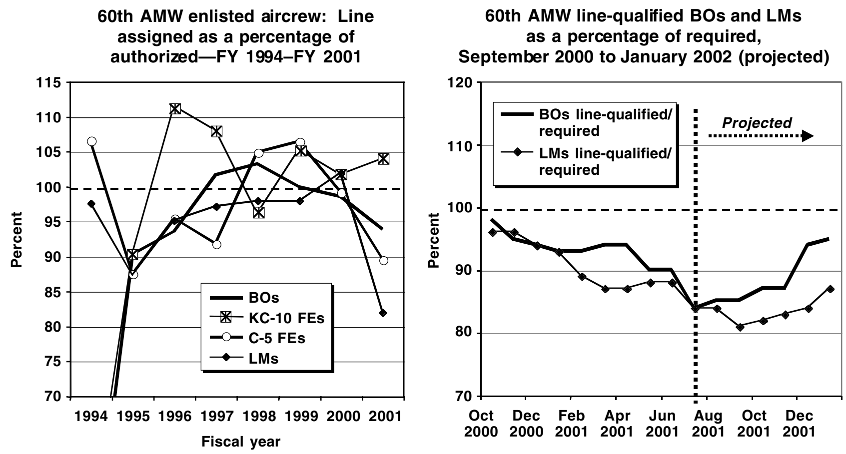
[8]Extending the tours of experienced pilots in operational units is by no means free. It is done at the expense of staffs that are already short of pilot expertise.

[9]"Stop-loss," defined on an emergency basis after September 11, was a policy that prevented personnel from exiting the Air Force. It is applied to specific career fields and, as its name implies, stops the loss of experienced personnel as a way of maintaining high levels of operational capability. Such a policy was also in effect during the war in Kosovo in 1999.

The Enlisted Aircrew Inventory Is Suffering from a Relatively Dry Training Pipeline



SOURCE: "AMC Training Review Process," AMC briefings, March 31 and July 31, 2001.

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The left-hand chart above displays fill rates for enlisted aircrew at Travis. For the first three to four years of the period graphed, changes in the wing's C-141 and KC-10 force structure caused some turbulence in fill rates. By FY 1998, fill rates had begun to stabilize to between about 95 and 105 percent.

Between FY 2000 and FY 2001, however, fill rates for BOs, C-5 FEs, and LMs decreased significantly across the Air Force. The reduced flying hours were less of a problem than the dearth of new blood coming into the wing. Across the Air Force, all four fields saw a steep decline in the ability to meet training pipeline quotas as a result of a drop-off in recruitment to these positions. Too few junior personnel were entering the force, and their numbers were inadequate to fill the ranks as senior crew members left the force. Fill rates for KC-10 flight engineers were high, but this was due to changes in skill mix and authorizations (the fill rates of more experienced 7-levels in particular declined from 112 to 73 percent).

Some fields, particularly that of LMs, have suffered more from experience lost to separations and retirements. The average number of months in their current control Air Force Specialty Code (AFSC)—a surrogate for experience—dropped from 30 to about 21 since the mid-1990s. Moreover, LM instructors averaged only a little more than a year's experience in that duty, down from more than two years in FY 1998. For these reasons, LMs were more affected by reduced flying hours than were other enlisted aircrew.

The graph on the right shows line-qualified BOs and LMs assigned as a percentage of line-qualified personnel required. The overall fill rate of 5- and 7-levels in these fields was only about 67 percent in FY 2001. As illustrated, both aircrew categories saw a decline in line-qualified personnel as a percentage of required, dropping from nearly 100 percent in September 2000 to 85 percent in July 2001. The LM inventory was expected to deteriorate further before turning around, while BOs were projected to approach their FY 2000 levels of line-qualified aircrew by January 2002. C-5 and KC-10 FEs were expected to maintain line-qualified crews near or above 100 percent of required (despite a C-5 FE fill rate of 90 percent).

By summer 2001, the Air Force Recruiting Service had succeeded in turning the pipeline problems around; the student pipelines for LMs and BOs were filled beyond capacity. An influx of inexperienced personnel was expected to arrive at the operational wings by spring 2002. At that time, the 60th AMW would be challenged to train and upgrade them.

60th AMW Aircrew Summary

C-5 pilot training shortfalls at Travis were alleviated by operations and policies resulting from 9/11

- Increased flying, stop-loss quickly improved experience mix
- Pilots were having trouble getting hours required for experience in three-year tour
  - Required hours were lowered as a result
- The movement of TWCF hours to O&M hours will dampen volatility
  - Pilot aging will be less beholden to the customer base that drives TWCF

Junior enlisted aircrew will enter the ranks in 2002

- The inventory will remain out of balance until they are upgraded
- It will be a challenge to train while meeting operational requirements

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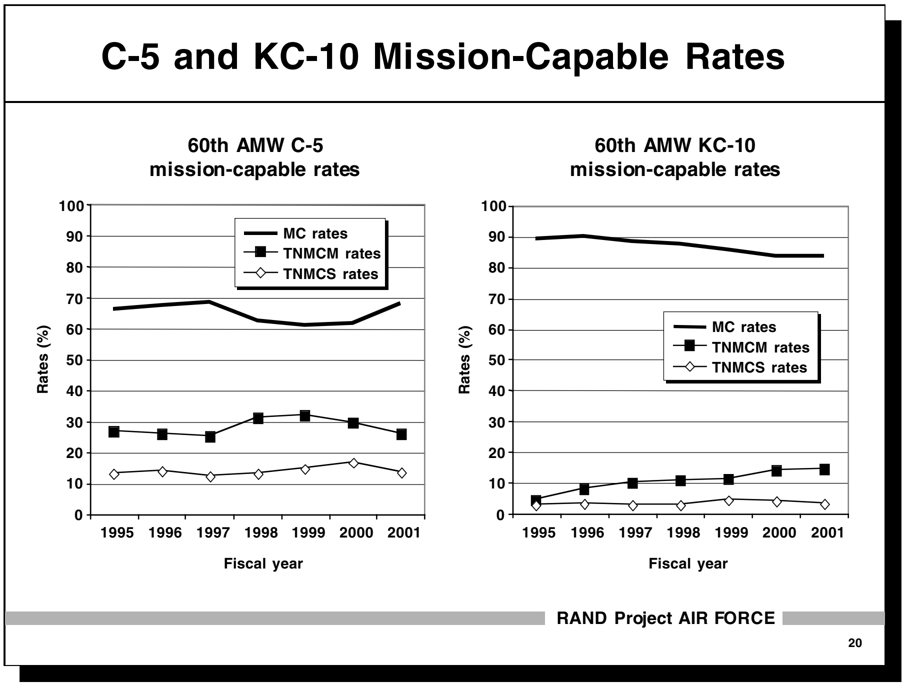
While C-5 pilot experience problems were being alleviated through added TWCF missions, it took a major operation and "wartime" policies to reach the levels of health seen before FY 2000. Reducing the upgrade/experience requirement from 1400 to 1300 hours quickly improved the situation, at least on paper. Average levels of "proficiency," however, would diminish for those pilots termed "experienced." Pilots already had concerns that not enough proficiency was gained even at 1400 hours.

In the meantime, trainers had attempted to get the most "bang for the buck" out of every flying hour by training multiple students on each sortie. Without careful management, this can reduce the quality of training events for each student and shorten the time at the controls. Unfortunately, no tool seems to exist for tracking quality, so it is up to the trainers to make judgments about this. The movement of funds from TWCF to O&M will help maintain pilot training in times of low operational and customer demand.

Greater use of simulators could also help, but the simulators at Travis and elsewhere were said to be "maxed out." Moreover, simulators have some downsides, according to pilots. Pilots complain, for example, that simulators run scenarios by the book (unlike in the aircraft), do not play out emergencies to their conclusion, and cannot maintain a normal "flow" of time, since ten hours of flying time are packed into one hour and 45 minutes. Despite these complaints, nearly all training events can be done in the simulator; there are simply not enough simulators.

The enlisted aircrew at Travis, as well as those across the Air Force, seemed to be experiencing an imbalance in their inventories. Fill rates were low because of shortfalls in the number of recruits in the training pipeline. In addition, some of the more senior personnel were separating or retiring, leaving less seasoned "senior" FEs, BOs, and LMs. Since summer 2001, however, the training pipeline seems to have recovered. As more junior aircrew are assigned to the wing, training requirements will surely rise. Gaining and maintaining a balanced inventory will be a challenge. If flying hours and retention rates can be kept strong, this challenge will be easier to meet.

In order to keep flying hours high over the long term, pilots and enlisted aircrew must have access to mission-capable aircraft. The availability of mission-capable aircraft depends in turn on readily accessible aircraft parts and on a healthy and productive maintenance force. We now turn from the operations side of the wing to the maintenance side.



One measure of maintenance trends over time lies in mission-capable (MC) rates—or the number of hours aircraft are mission capable divided by the total hours aircraft are possessed. The higher the MC rate, the more hours aircraft are available to fly. Total non–mission capable due to maintenance (TNMCM) and total non–mission capable due to supply (TNMCS) define the two major factors that affect MC rates. TNMCM is affected by maintenance manpower availability and experience and by the prioritization of maintenance actions, including scheduled inspections. TNMCS is affected by the availability of aircraft parts and supplies. Lower TNMCM and TNMCS rates mean higher MC rates.

MC rates both at Travis and Air Force–wide have come down for both the C-5 and the KC-10, although the C-5 saw an improvement in FY 2001. The graphs above show average monthly rates for each year. Generally, TNMCM rates for both MDSs have risen more sharply than those due to supply (TNMCS).

The AMC standards (goals) for the C-5 are 75 percent mission capable, with a 21 percent TNMCM and an 8.5 percent TNMCS. Travis's C-5 did not meet these standards during the period. The KC-10s have only recently dipped below standards. The TNMCM rate for Travis KC-10s—a much newer aircraft—failed to meet the AMC standard of 11 percent beginning in FY 1999, while the MC rate fell below the 85 percent standard for the first time in FY 2000. The KC-10 TNMCS rate has always met the 5 percent standard.

When combined with the fact that 20 percent of authorized C-5s are in depot at any one time, the C-5 MC rates suggest that only 18 to 20 C-5s can potentially be used to fly missions. Three aircraft are normally removed from the possessed pool for ISO inspection, cannibalization, and other needs. Moreover, with a number of the remaining aircraft on overseas or other off-station missions at any given time, only seven to ten aircraft are actually available on station to support the day's flying schedule. With such a small pool of C-5s, any deviation in available aircraft (such as a sudden break or an air abort) can wreak havoc with the flying schedule. Providing the required number of aircraft under these circumstances is therefore an ongoing challenge for the wing's maintenance force.

Nonavailability of Aircraft Parts: An Ongoing Problem for the C-5

C-5 Tiger Team (AMC, AFMC) report, end of FY 2000

- **"Nonavailability of parts is a major contributor to low MC rates and is impacting the amount of time required to return an aircraft to flyable status."[a]**

Sources of nonavailability include the following:

- **Tools for forecasting needed parts do not support the C-5 profile**
- **Competition with a large unplanned repair workload forces into lower priority those parts whose need has been forecast**
- **The WCF is inadequate to support C-5 spares**
- **The sporadic demand for many C-5 parts means it is difficult and time-consuming to fill "infrequent contract/orders for small quantities of old technology"**

The KC-10 has had fewer parts problems

- **Newer, commercially derived (DC-10), contractor-supported**

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[a]*C-5 Tiger Team Report*, United States Air Force, March–August 2000, pp. 3–4. 22

Let us look first at the supply side. A C-5 Tiger Team constituted in 2000 by AMC and the Air Force Materiel Command (AFMC) identified the nonavailability of parts as a major factor in low C-5 MC rates.[10] The team pointed to a number of sources of low TNMCS rates.

The team concluded that the Air Force has a "one size fits all" approach toward forecasting the requirements for aircraft parts. This approach is most appropriate for a large fleet of aircraft with a continuously high demand for parts. The C-5 does not fit this profile. With 104 C-5s in the primary mission aircraft inventory (including the guard and reserve), the fleet is relatively small. Moreover, the demand for spares can be sporadic. As a result, many parts are not in stock and must be ordered. Unfortunately, the availability of parts is a necessary condition to support the Air Force's Two-Level Maintenance (2LM) concept, whereby intermediate-level maintenance actions are accomplished at the depot rather than at the wing. If the wing cannot fix parts on its own through intermediate maintenance and the part is not available in base stocks, the wing must wait days or weeks for the depot to repair it. At the depot, the part competes for priority with scheduled and unscheduled repairs. At the wing, this results in the need to expend precious man-hours cannibalizing another aircraft or grounding the aircraft altogether.

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[10]See *C-5 Tiger Team Report*, United States Air Force, Washington, D.C., March–August 2000.

The Tiger Team found that the financial process underlying the WCF negatively affected the availability of parts. Under the WCF concept, congressionally appropriated funds for parts and maintenance services are allocated to consuming units—i.e., wings. Wing maintenance organizations use the funds to purchase items from provider organizations such as Air Force supply and maintenance depots and the Defense Logistics Agency (for various consumable items). Customers have long complained about excessive and unstable prices that have served as a disincentive to building up needed parts stocks. When combined with a customer perception that depot repair times are too long, there is a greater incentive for wings and squadrons to rely more heavily on organic repair capabilities and thereby increase the wing maintenance workload.

Finally, the C-5 is an aging aircraft with sporadic demands for parts. It is very difficult to attract bidders on contracts for small quantities of old-technology components. Once work orders are awarded, it is also a challenge to give contractors incentives to allocate their resources to meet desired delivery dates. Sometimes companies with the proprietary rights to needed parts no longer exist, and considerable effort is required to secure these rights.

In contrast to the C-5, the contractor-supported KC-10 has enjoyed relatively low TNMCS rates. Newer than the C-5, the KC-10 is derived from the commercial DC-10 and has many parts in common with that aircraft. Parts are therefore more readily available.

Nonavailability of Parts Is a Key Source of Increased Workload in the Wing

Cannibalization is consuming more man-hours

- "Cann" actions greatly increase the number of tasks, time
- Ten technicians spend about 24 days recovering a C-5 "cann bird" every 90 days
- Three 5-/7-levels are required full time on C-5 cann bird management
- Sixty 7-levels (15%) average 10 hours per week on cann administration

Intermediate-level maintenance is on the rise

- Manufacture items in wing that are unavailable outside
- Develop, execute aging-related inspections that depot should do
- Exacerbated by loss of manpower in backshops (60th EMS, CRS)
  - Manpower drawn down owing to C-141 reduction, introduction of contractor-supported KC-10, 2LM
  - But backshops support KC-10 anyway as well as other MDSs (e.g., C-17 metals) and bases (e.g., Altus)

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The nonavailability of parts has a real effect on the maintenance workload in the wing. Two such effects are high rates of cannibalization and increased intermediate-level maintenance.

When parts are unavailable and sorties need to be flown, maintainers often cannibalize parts from other aircraft. Certain aircraft may be designated as "cann birds" when under repair and not available for the flight line. When specific components are breaking often and supplies of those components are perpetually low, maintainers must also cannibalize parts from aircraft that are undergoing scheduled maintenance or inspections; from "hard-broke" aircraft; or, in extreme cases, from a second or third cann bird. Sometimes, for example, jets will enter ISO inspection in the equipment maintenance squadron (EMS) already canned by the aircraft generation squadron (AGS), which forces the backshop to cannibalize the cann bird in order to work on the ISO jet.

Cannibalization actions can be highly time-consuming activities. Ideally, a technician would identify a bad part, remove it, order and retrieve a replacement part from the on-base supply shop, and then place the new part in the aircraft. Frequently, however, when the on-base supply shop reports the part out of stock, the maintainer must go to the cann bird to acquire the needed part. This can involve removing incidentals such as panels and other components in order to reach the part to be canned. Once the part is removed from the cann bird, the technician may need to perform other tasks, such as cleaning up the work area and checking the operation of the part ("ops checks"). Moreover, the technician must often complete additional paperwork to enable tracking of the cann action and of all parts that have been canned from the cann bird. He must then replace the part in the good jet.

Efforts to return cann birds to a flyable condition are manpower intensive as well. At Travis, the length of time during which a specific C-5 is designated a cann bird is about 90 days, after which it is returned to operational status and replaced by a new cann bird. The 60th AGS reports that a team of seven recovery personnel plus two to four specialists work 12 days in 12-hour shifts to bring the cann bird to a status at which it can be towed. The team then tows it to a parking spot and spends another 12 days on eight-hour shifts to complete the recovery.

Even the administrative duties required to track cannibalizations consume man-hours, especially for large-bodied aircraft with many thousands of parts. Three experienced technicians (two 7-levels and a 5-level) manage the C-5 cann bird full time. About 60 other 7-levels across the wing, responding to our questionnaire, reported that they spend an average of ten hours per week tracking cann actions. Thus, at least 15 percent of total primary-assigned 7-levels at Travis average two hours per day just on cann administration.[11]

The backshops (the EMS and the component repair squadron, or CRS) have taken on more intermediate-level maintenance responsibilities than were envisioned under 2LM. The structural repair flight in the EMS, for example, is doing more aging-related repairs and inspections. The squadron has had to increase its in-house manufacturing of C-5 parts owing to lack of supply; in some cases, the parts are no longer available elsewhere. At times, the parts must be canned from other aircraft just to keep planes flying while the squadron manufactures replacements. All this additional workload has created thousands of hours of backlogs in structural maintenance. Maintainers in other flights have reported similar problems.

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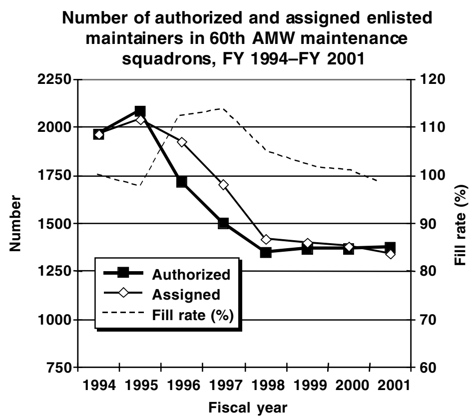
[11]See also U.S. General Accounting Office, *Air Force Inventory: Parts Shortages Are Impacting Operations and Maintenance Effectiveness*, GAO-01-587, Washington, D.C., June 2001; and U.S. General Accounting Office, *Air Force Supply: Management Actions Create Spare Parts Shortages and Operational Problems*, GAO/NSIAD/AIMD-99-77, Washington, D.C., April 1999.

60th AMW Maintenance Squadron Authorizations, Assignments, and Fill Rates—3-, 5-, 7-Levels



- 60th AGS
- 660th AGS
- 60th EMS
- 60th CRS
- 602nd AGS (historical)

Key events:

- C-141s depart, KC-10s arrive
- Possessed aircraft fall ~ 20 percent
- 2LM instituted

In addition to enlisted, ~130 ARTs/civilians

- Downsized as C-141s left

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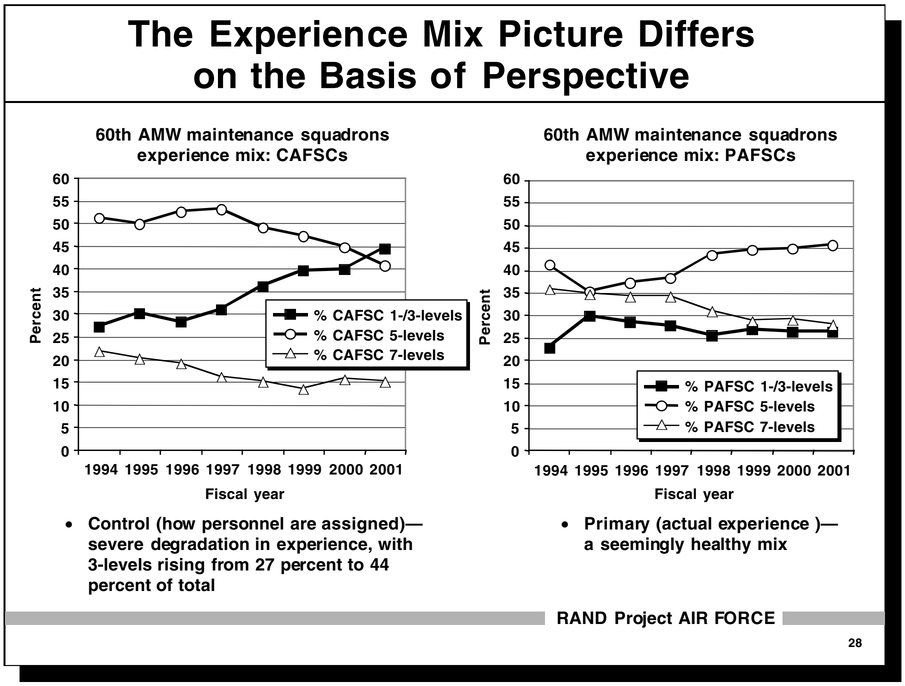
Next we focus on the maintainers of the 60th AMW. First we review the changes in manning at Travis since the mid-1990s. We focus on 3-level, 5-level, and 7-level maintainers in the three AGSs (60th AGS, 660th AGS, and 602nd AGS), the 60th EMS, and the 60th CRS. Generally, the AGSs launch and recover aircraft and conduct flight-line maintenance. The 60th AGS is responsible for the C-5s, while the 660th AGS generates the KC-10s; the 602nd AGS was disbanded when the C-141 left Travis in 1997. As the wing's backshops, the EMS and CRS conduct heavier maintenance, such as ISO inspections, engine maintenance, and structural repair.

The 60th AMW was a wing in transition during this time, with the KC-10 arrival and C-141 departure adding to the turbulence created by the Air Force–wide manpower drawdown. By FY 1998, authorized and assigned maintainers at Travis had declined to about 70 percent of their mid-decade levels.

At the same time, the total number of Travis-possessed aircraft declined only about 20 percent. Air Force–wide implementation of the 2LM concept may be one reason manning declined more than possessed aircraft. In fact, total manning in the 60th AMW backshops declined by over 40 percent (with senior 5-level and 7-level manning diminishing by 52 percent and 46 percent, respectively), while AGS manning came down by about 20 percent.

About 130 air reserve technicians (ARTs) and civilians supplement the enlisted maintainers in the 60th AGS, the EMS, and the CRS. They are mostly 5- and 7-levels.



The experience mix among 3-, 5-, and 7-levels can be portrayed in quite different terms depending on whether the portrayal is based on Control Air Force Specialty Codes (CAFSCs) or on Primary Air Force Specialty Codes (PAFSCs). The personnel system employs CAFSCs to assign individuals to wings. An individual's CAFSC is "a management tool used to make airman assignments, to assist in determining training requirements, and to consider individuals for promotion" (Department of the Air Force, *Classifying Military Personnel [Officer and Enlisted],* AFI36-2101, Washington, D.C., April 30, 2001, p. 50). An airman's PAFSC is "the awarded AFSC in which an individual is best qualified to perform duty" (AFI 36-2101, p. 51). An individual may have a CAFSC that identifies him as a 3-level apprentice, but at a given time he may have completed the prerequisites for a 5-level journeyman. Thus, he might be awarded a 5-level PAFSC at that time and be given 5-level responsibilities, yet his CAFSC remains a 3-level as far as the personnel system is concerned.

It is important to understand the differences between CAFSCs and PAFSCs. The experience mix looks much worse when based on CAFSCs than when predicated on PAFSCs. As the graphs above show, the decline in experience based on CAFSCs has been disastrous at Travis since the mid-1990s. The proportion of 3-levels has increased from 27 percent to 44 percent, with the number of 5- and 7-levels declining by 48 percent.

On the other hand, the share of PAFSC 3-levels has increased only 3 percent, from 23 percent in FY 1994 to 26 percent in FY 2001. The 5-level share has increased relative to 7-levels.[12]

CAFSCs do not adequately portray the *functional* experience mix actually found on the flight line or in the backshop. For the purposes of defining the capabilities of the wing, the PAFSC is a better description of existing capabilities. Because our intent here is to express actual conditions below the wing level, we use PAFSCs throughout the rest of the paper.[13]

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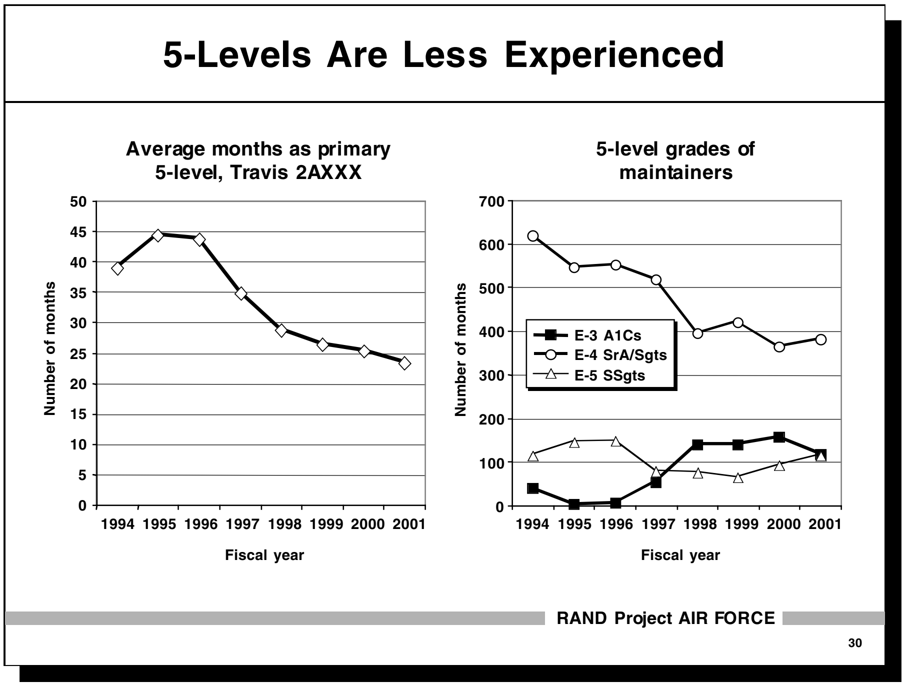
[12]Assigned 1-levels are included in the 3-level totals.

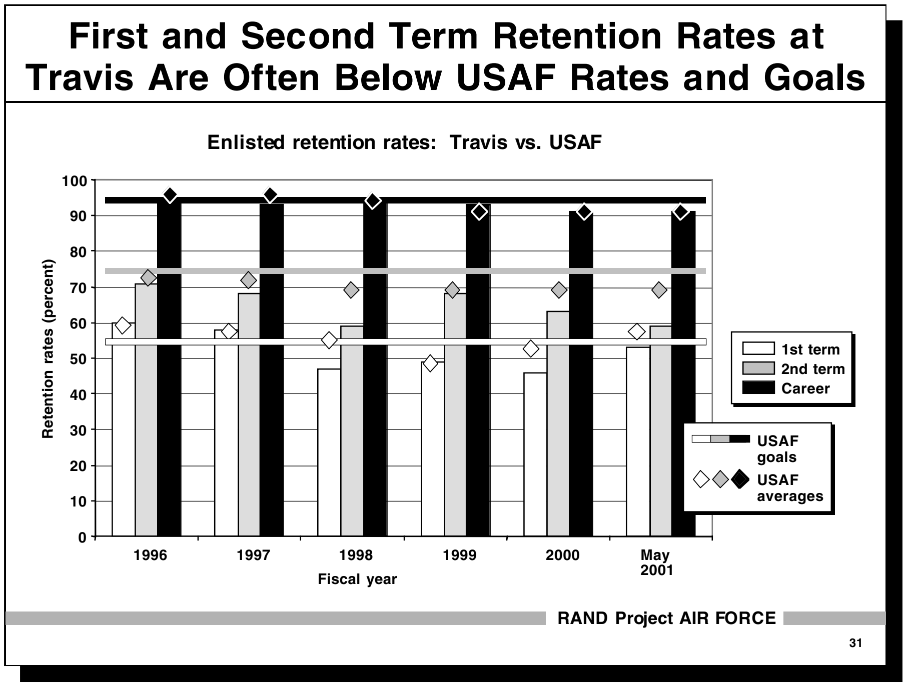
[13]Understanding the differences between CAFSCs and PAFSCs is also important in determining manpower requirements. As we argue elsewhere, manpower requirements reflect the focus on career progression inherent in the use of CAFSCs. However, in skill-intensive career fields such as maintenance, the functional needs of maintenance should be at least as important—if not more so—in driving authorized experience mix. For a more complete exposition of this argument, see Dahlman, Kerchner, and Thaler, 2002, Chapter 7.



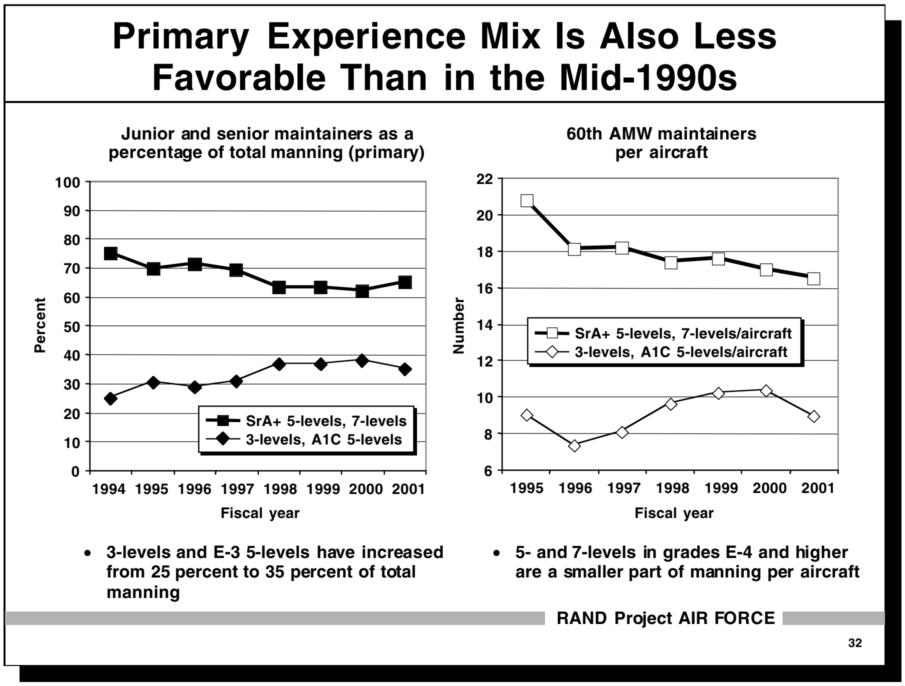
A closer look at primary 5-levels, however, reveals what appears to be a disturbing trend. The average 5-level at Travis is less experienced than he has ever been in the recent past. The left-hand graph above depicts by year the average number of months 5-levels have held that skill level. After rising slightly between FY 1994 and FY 1995, average experience has declined 47 percent from 44.0 months to 23.5 months.

This trend also appears when one looks at the number of 5-levels by grade in the right-hand graph. As the number of experienced E-4 Senior Airmen (SrAs) and E-5 Staff Sergeants (SSgts) has declined, that of E-3 Airmen First Class (A1Cs) has risen to roughly 18 percent of the 5-level force from about half a percent in FY 1995.

Thus, while primary 5-levels increased as a percentage of the force between FY 1995 and FY 2001, they also became younger and less experienced.



Retention rates provide one important reason for reduced 5-level experience at Travis (and throughout the Air Force). The bars in the graph above show first-term, second-term, and career retention rates at Travis; the diamonds and the lines depict Air Force–wide retention rates and goals, respectively. The graph shows that Air Force–wide second-term retention rates consistently fail to meet the Air Force goal. It also shows that second-term retention rates at Travis have been lower than the Air Force rates. This means that many senior airmen (E-4s) are deciding not to make a career in the Air Force. The valuable experience of the E-4s, who constitute the bulk of the 5-level workforce, therefore leaves with them.



In light of this deeper assessment of manning at Travis, we find that the experience mix among maintainers has indeed become less favorable since the middle of the last decade. There are fewer of what we might term "senior" maintainers—5-levels with at least a grade of SrA, and 7-levels. The combination of 3-levels and A1C 5-levels ("junior" maintainers) has increased from roughly 25 percent to 35 percent of total manning. Additionally, the number of senior maintainers per aircraft has fallen some 20 percent since FY 1995.

In the presence of such manning trends, senior maintainers in particular are challenged to sustain high levels of production while ensuring that junior maintainers are adequately trained. These challenges are addressed in the following pages using a combination of 60th AMW products and results from the RAND survey of Travis maintainers.[14]

It should be noted that the stop-loss policies in effect since September 2001 have temporarily increased the experience mix at the wing. This should help maintainers meet a more demanding sortie generation schedule to support ongoing operations. Once stop-loss is lifted, however, many experienced maintainers can be expected to leave the force, creating a situation similar to that observed pre-9/11.

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[14]Products of the 60th AMW were collected and the RAND questionnaire was administered in 2000. To maintain consistency with this time frame in the following discussions, FY 2000 personnel data are used.

Nonmaintenance Out-of-Hide Duties Reduce the Fill Rate of Primary 5-Levels from 79 Percent to 74 Percent

Out-of-hide position	Maintainers assigned	Average grade	Commitment	Source of requirement
Training manager/monitor	9	SSgt	F/T	S, F
Hazardous waste technician	8	SrA	F/T	G, S
SP augumentee READY	8	A1C	P/T	W
Computer systems	7	SSgt	F/T	S, F
Self-help team	5	TSgt	F/T	G
Dorm/facility manager	4	MSgt	F/T	W, S
Production superintendent	4	MSgt	F/T	S
Quality adviser	4	SSgt	F/T	S
RACC	4	SSgt	F/T	F
Safety	4	TSgt	F/T	G, S
Vehicles	4	SSgt	F/T	S
AREP operations	3	TSgt	F/T	W
Other administration	3	SrA	F/T	G, S, F
Resource adviser/manager	3	SSgt	F/T	S
Unit deployment manager	3	TSgt	F/T	S
Assistant UDM	2	SrA	F/T	S
Environmental management	2	SSgt	F/T	W, F
Museum	2	MSgt	F/T	W
Protocol	2	SSgt	F/T	W
TODO	2	SSgt	F/T	S
COMBS liaison	1	TSgt	F/T	G
Honor guard	1	SrA	F/T	W
Retention manager	1	SSgt	F/T	S

- **86 maintainers from 60th AMW maintenance squadron are assigned out of hide**
- **The average grade of out-of-hide position is SSgt**
- **Wing (W), group (G), squadron (S), flight (F) requirements**

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SOURCE: 60th LSS.

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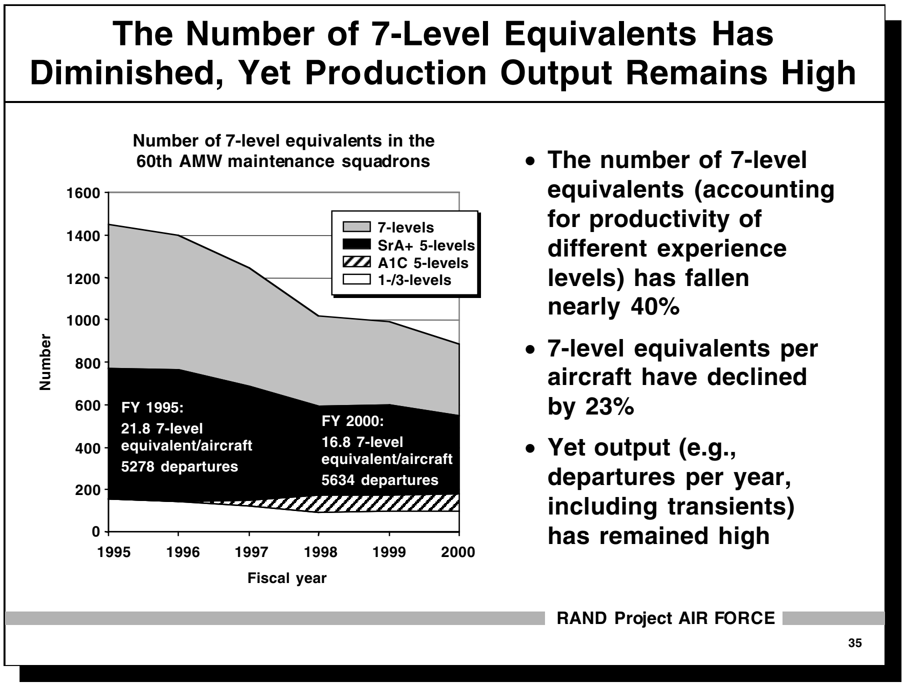
Manning levels are further affected by “out-of-hide” activities—i.e., positions that are not funded but that need to be filled from the available manpower pool. Because they constitute a large occupational group on Air Force bases with aircraft, maintainers fill many of the out-of-hide positions. Many of the positions are not even germane to maintenance, although they may be deemed necessary for the efficient operation of an organization.

Data from Travis (collected by the 60th Logistics Support Squadron [LSS] in 2000) indicate that out-of-hide activities can be an important drain on maintenance manpower. Although only 86 maintainers are in out-of-hide positions (out of a maintenance force of approximately 1500), they tend to be more experienced technicians. The average grade is SSgt, typically a senior 5-level or a 7-level technician, because most of these duties cannot be assigned to junior personnel. Out-of-hide duties in FY 2000 thus resulted in an effective reduction in senior maintainers from 62 percent (as shown in the left-hand graph on the previous page) to 57 percent of assigned maintainers.

Crew chiefs were the largest source of manpower for these duties, filling about half of the out-of-hide positions held by maintainers, while engine troops were the second largest source at 14 percent.

In late 2000, the Air Force Directorate of Installations and Logistics sampled eight bases in the Air Combat Command (ACC) and AMC and found that about 4 percent of the maintenance population at these bases was assigned out of hide. Experienced maintainers may constitute more than 90 percent of the total in out-of-hide positions. With about 50,000 assigned 5- and 7-levels, more than 2600 experienced maintainers could potentially be returned to the flight line and to duties as OJT trainers.

Out-of-hide thus constitutes a highly significant drift of people away from maintenance and sortie generation. For those who remain, the effect is a higher workload and an increase in duty hours. Moreover, the organization loses an important pool of trainers. Since crew chiefs have one of the highest manpower utilization rates in LCOM, their reassignment to nonmaintenance tasks may have a disproportionate effect on the remaining crew chiefs.



The changes in manning and experience mix have affected the productivity of maintainers at Travis. Generally, experienced 7-levels are more productive than senior 5-levels, who are more productive than junior 5-levels, while junior 5-levels are more productive (and are qualified to do many more maintenance tasks) than 3-levels. When the force becomes less experienced, overall productivity falls. We can measure raw productivity simply by multiplying the number of available technicians in each skill level by a "productivity factor" for each skill level. The factors we employ are derived from our survey of senior maintainers at Travis and are expressed in terms of "7-level equivalents":

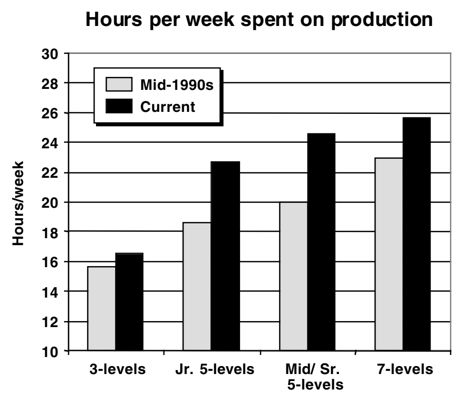
- 7-level = 1.00
- Senior 5-level (SrA and above) = 0.91
- Junior 5-level (A1C) = 0.54
- 3-level = 0.27

As seen in the chart above, total raw productivity has fallen by about 39 percent from 1995 levels; the drop is more pronounced in the maintenance squadrons (42 percent) than in the generation squadrons (35 percent). Because of the change in experience mix, raw productivity from senior maintainers (senior 5-levels and 7-levels) has declined 40 percent, while productivity from junior maintainers has risen 13 percent (due to the increase in A1C 5-levels among "junior" technicians). Junior maintainers rose from 11 percent of total productivity to 20 percent.

Despite the unfavorable trends in experience mix, maintainers at Travis are managing to sustain a high level of production output. Although MC rates have fallen, total aircraft departures from Travis (60th AMW plus transient aircraft) reached nearly 5300 in FY 1995 and more than 5600 in FY 2000.

To understand how a depleted maintenance force is able to maintain a high level of output, we turn to our survey of maintenance technicians.

Maintainers Spend More Time on Production Activities



- **The survey suggests that hours and share of time dedicated to production have risen since the mid-1990s**
- **Includes activities related to direct maintenance actions (repair, generation, inspection, etc.) and supervision of these activities**

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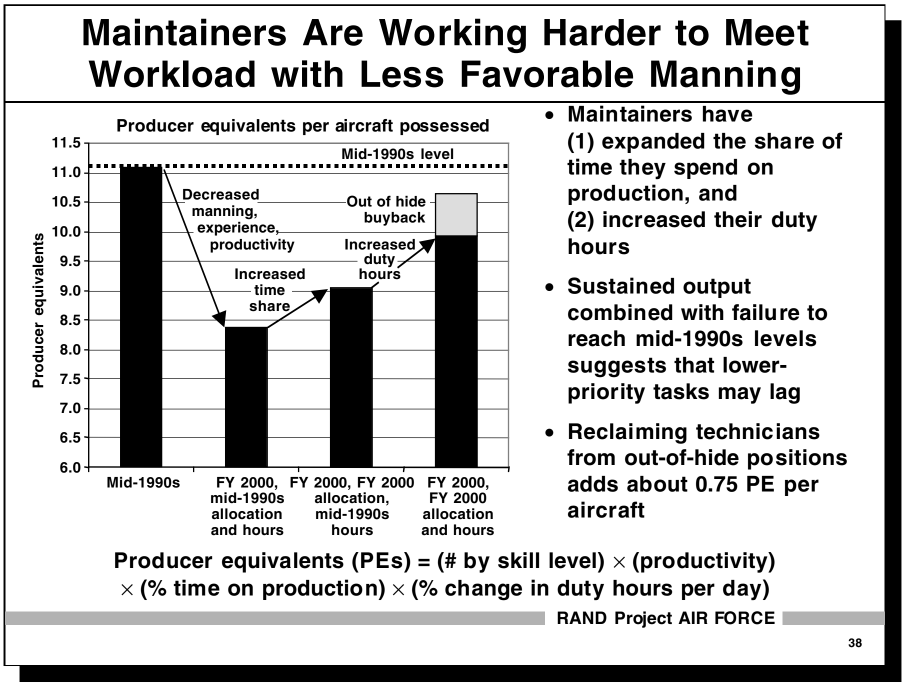
In our questionnaire, we asked each 3-level, 5-level, and 7-level to estimate his duty hours per week three to five years ago (if they were in a mobility wing, at their then-year skill level) and currently under conditions of "normal" operational tempo, or OPTEMPO (a typical day without major external demands). We also asked how they distribute their time among several key activities:

- Production;
- Supervision of production (which we combine with production);
- Teaching OJT;
- Learning OJT;
- Formal education and training;
- Ancillary training;
- Administrative tasks (e.g., entering actions into maintenance tracking system); and
- Other (including out of hide).

Clearly, personnel at all skill levels are spending more time on production-related activities than they recall having done in the mid-1990s. The largest increase can be found among the more experienced 5-levels, who spend 23 percent more time on production. They are followed in order by junior 5-levels, 7-levels, and 3-levels, whose production hours have risen 22, 12, and 6 percent, respectively.



To provide some insight into the productivity effects of the increased hours, we combine the level of effort with raw productivity (expressed earlier in terms of 7-level equivalents) to calculate a comparative measure called a "producer equivalent" (PE). A PE is the product of a technician's productivity factor, the percentage of time he spends on production (generating aircraft, repairing components, and supervising production), and the percent change in his duty hours per day between time periods under comparison. Let us assume that a 3-level spends 30 percent of his time on production now as opposed to 20 percent in the year of comparison (e.g., FY 1995) and that his duty day is 5 percent longer now than it was then. With a productivity factor of 0.27, a 3-level in FY 1995 would count as $0.27 \times 0.20 \times 1.00 = 0.054$ PE, whereas in FY 2000 he would count as $0.27 \times 0.30 \times 1.05 = 0.085$ PE. A 7-level whose production time shares increased from 40 to 55 percent and whose hours rose from 8 to 10 per day would count as $1.00 \times 0.40 \times 1.00 = 0.40$ PE in FY 1995 but $1.00 \times 0.55 \times 1.25 = 0.69$ PE in FY 2000.

In the leftmost bar of the graph above, we show that there were just over 11 PEs per possessed aircraft at Travis in the mid-1990s. The second bar from the left portrays how the changes in possessed aircraft and manning alone would have affected the number of PEs in FY 2000 if production time shares and duty hours had remained constant at mid-1990s levels. PEs per aircraft drop by about

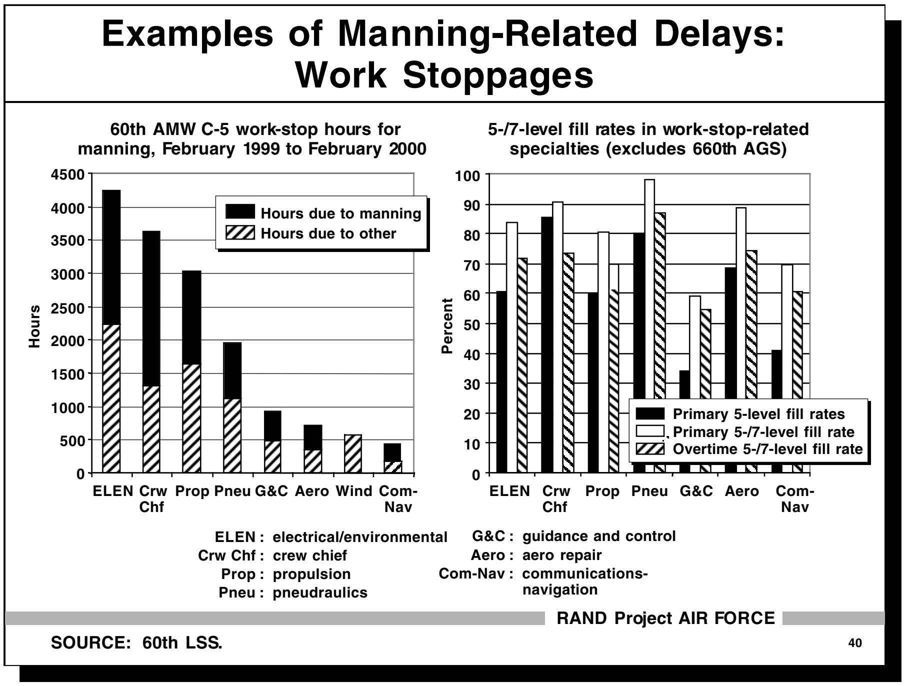
24 percent to 8.4 as a result of the reductions in experience mix and manning.

The second bar from the right shows the effect on PEs of maintainers increasing the share of their time dedicated to production. The biggest jump in time shares is in senior 5-levels, who increased their share of time by 18 percent—from 48 percent of their duty hours to 56 percent. This results in an additional 0.66 PE per aircraft.

Maintainers gain yet another 0.88 PE per aircraft—to 9.9—by increasing their overall duty hours in addition to increasing time shares dedicated to production (rightmost bar). This is especially true of senior 5-levels and 7-levels. The average duty week of a senior 5-level in the mid-1990s was about 42 hours, but this increased to 45 hours in FY 2000—representing a 7 percent rise. The duty week of 7-levels rose 13 percent, from 41 hours to 46 hours.

However, Travis technicians do not achieve the levels of PEs per aircraft seen in the mid-1990s. An additional 0.73 PE per aircraft could be recovered by moving 86 maintainers from out-of-hide positions to direct maintenance positions on the flight line or in the backshops. Recall that the average grade in out-of-hide positions is SSgt, and that these technicians are senior 5-levels and junior 7-levels—critical components of the workforce who spend large portions of their time on production-related activities.

Even without the need to fill out-of-hide positions, however, production capacity still would not achieve mid-1990s levels.



One possible result of the reduction in PEs per aircraft is that some maintenance tasks are delayed or not accomplished at all. This was corroborated by the maintainers themselves and could help explain the seeming inconsistency between rising TNMCM rates and sustained high departure rates.

The left-hand chart above provides an example of the effects of manning shortfalls. It illustrates the top eight most time-consuming work stoppages over a 12-month period. Work stoppages are maintenance actions that have been halted after they have been initiated because a key resource is unavailable. The chart serves to focus on work that had to be stopped because the appropriate expertise was unavailable at the time. Electrical/environmental work stoppages were the most extensive type, with about 4240 hours. Of these, work was delayed 47 percent of the time because an experienced electro-environmental technician (2A6X6) was required but unavailable. Of the 3635 hours of crew chief–related work stoppages, some 2334 hours (64 percent) occurred because a crew chief was unavailable.

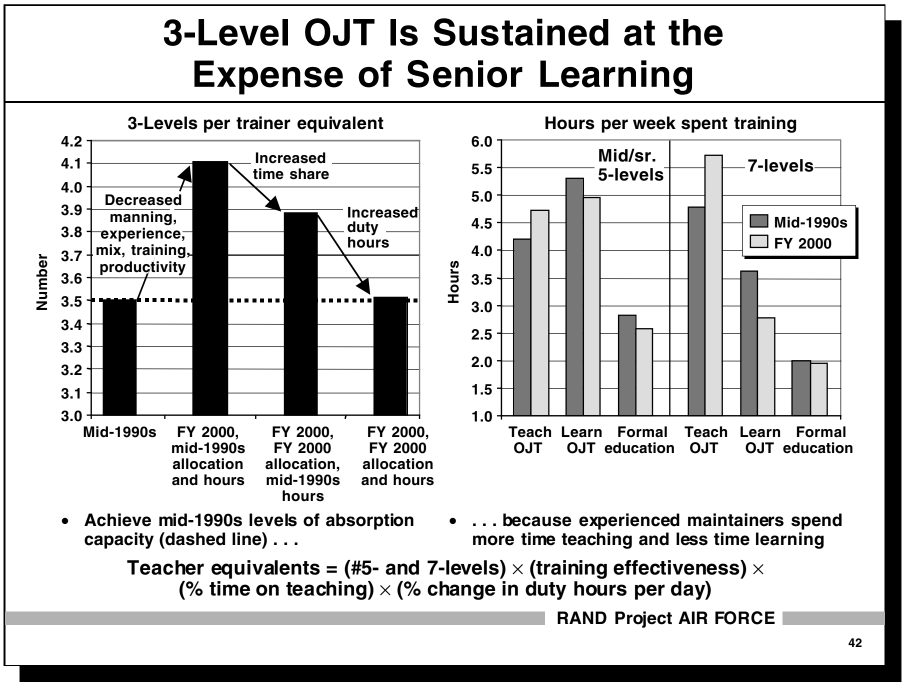
It is instructive to compare the work stoppages with 5- and 7-level fill rates (primary assigned technicians as a percentage of authorized) in each of the relevant specialties. In the right-hand chart, fill rates are given for 5-levels (the dark bar) and for 5- and 7-levels combined (the white bar) in each specialty. In addition, we calculate a combined

5- and 7-level “overtime”fill rate (the striped bar). This is a surrogate for the level of effort the maintainers are exerting. Manpower standards state that personnel should work no more than a 43-hour work week (40 hours plus 7.7 percent overtime). Respondents to our questionnaire reported their actual duty hours per week; the duty hours of technicians portrayed in the chart exceed 43 hours. The striped bar gives a sense of what the virtual fill rate would be if technicians’ duty hours did *not* exceed the standard. For example, if a specialty has an 80 percent fill rate for its 5- and 7-levels, and if maintainers in that specialty exceed the standard duty hours by 10 percent, then the “overtime” fill rate is $0.80 \times (1.00 - 0.10) = 72$ percent. This illustrates the pressure under which these technicians are working and helps emphasize the environment in which the work stoppages occur.

As is apparent, the fill rates of 5-levels—who are the backbone of the workforce—are abysmal in most of the specialties. Moreover, although some of the specialties have relatively favorable fill rates for 5- and 7-levels combined, their “overtime” fill rates suggest that they are struggling to meet the workload. For example, 5- and 7-level 2A5X1 crew chiefs enjoy a 90 percent combined fill rate, yet their “overtime” fill rate is only 74 percent because their hours exceed the standard by nearly 20 percent.

In sum, the combination of a dearth of 5-levels and the long hours put in by 5- and 7-levels can result in delayed maintenance actions. Maintainers are finding that they can no longer “throw bodies” at problems; rather, they must dedicate individuals to perform priority actions and leave other actions undone. The primary focus of the maintainers is to meet the flying schedule by ensuring that working aircraft are available at the right time. Certain maintenance actions on unavailable aircraft may thus be delayed in favor of the flying schedule.

Other important tasks may be delayed as well. We next look at how maintainers at the 60th AMW have sustained their training programs.



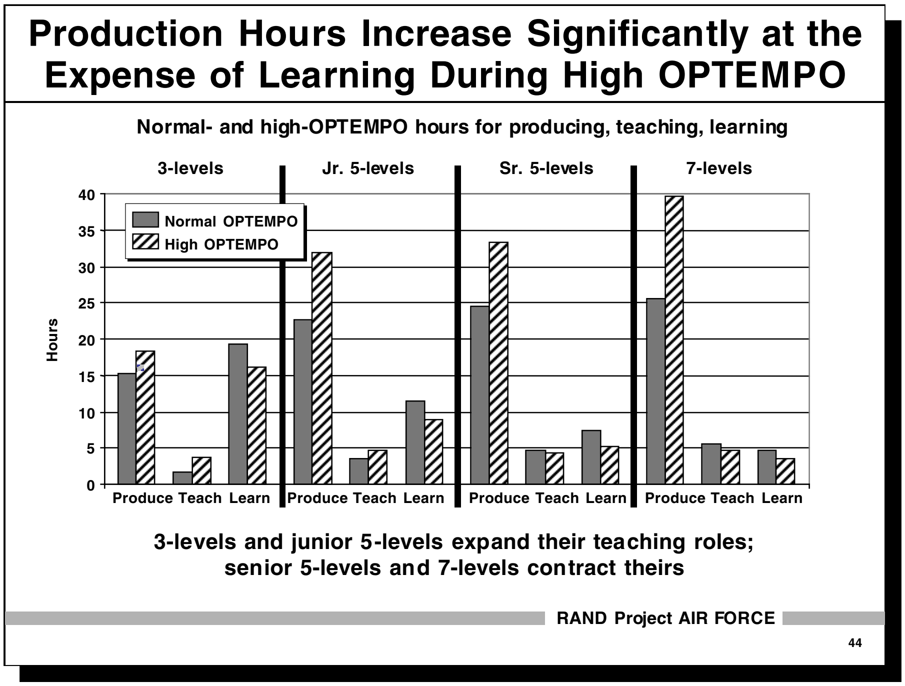
To this point, we have focused on maintenance production and supervision. As we argue in this document, however, units are also tasked to rejuvenate the human capital of the Air Force through OJT and other training. Given the increasing level of effort Travis maintainers are applying to production activities, how have they met the requirements of this second task?

The left-hand graphic above depicts the number of 3-level trainees per "trainer equivalent." Just as the PE metric is a surrogate for production capacity, the trainer-equivalent metric quantifies changes in absorption capacity. The fewer the trainees per trainer equivalent, the more systematic the training and the higher the quality. The total number of trainer equivalents in a unit is the product of the number of 5- and 7-levels, the training effectiveness of each skill level, the percentage of time spent on teaching, and the percent change in duty hours per day between the time periods under comparison. We assume that training effectiveness is equivalent to productivity at each skill level. In addition, we do not consider the OJT requirements of 5-levels, which would add to the teaching burden on the most senior 5-levels and 7-levels.

The graph above shows that despite a deterioration in experience mix and attendant training effectiveness, maintainers in the 60th AMW before 9/11 managed to maintain the mid-1990s trainee-to-trainer ratio of 3.5. In the same manner as they have done with production, senior technicians have increased the time they spend teaching OJT. Without this effort, the ratio would increase to 4.1 trainees per trainer.

As the right-hand graph reveals, senior maintainers have sustained this training capacity at the expense of their own learning. Learning via OJT and formal education for senior 5-levels came down 7 to 8 percent. While 7-levels' time on formal education dropped slightly, the time they dedicated to learning via OJT diminished 23 percent, from 3.6 to 2.8 hours per week. In sum, upgrade training for more senior technicians became a "bill payer" for maintaining a constant level of OJT for junior airmen.

ARTs and civilians provide a critical source of continuity in helping teach young enlisted technicians OJT. Those who remain after the downsizing say they are spending 12 percent more time teaching than they used to. They are an important complement to the enlisted 5- and 7-levels on the flight line and in the backshops. However, there is concern among enlisted maintainers that many ARTs and civilian technicians are reaching retirement and that younger technicians are not being groomed to take their place. A serious loss of experience may thus be looming in the not-too-distant future, potentially creating further deterioration in productivity and training capacity and putting more pressure on senior enlisted maintainers.



High-OPTEMPO conditions take a toll on maintainers' ability to produce and conduct OJT. High OPTEMPO includes preparation for, execution of, and recovery from the following types of operations:

- Contingency deployments;
- Rotational deployments;
- Exercises;
- Inspections;
- MRTs;
- Surges; and
- Activities at home station when operations involve temporary duty (TDY).

The type, frequency, and duration of high-OPTEMPO operations differ greatly among the squadrons, flights, and even AFSCs. For example, members of the 660th AGS accompany four KC-10s to the United Arab Emirates each year on a four-month rotational deployment. On the other hand, such deployments are extremely rare for the C-5s of the 60th AGS. All flights experience some type of high OPTEMPO even if operations occur on station (as with inspections and surges).

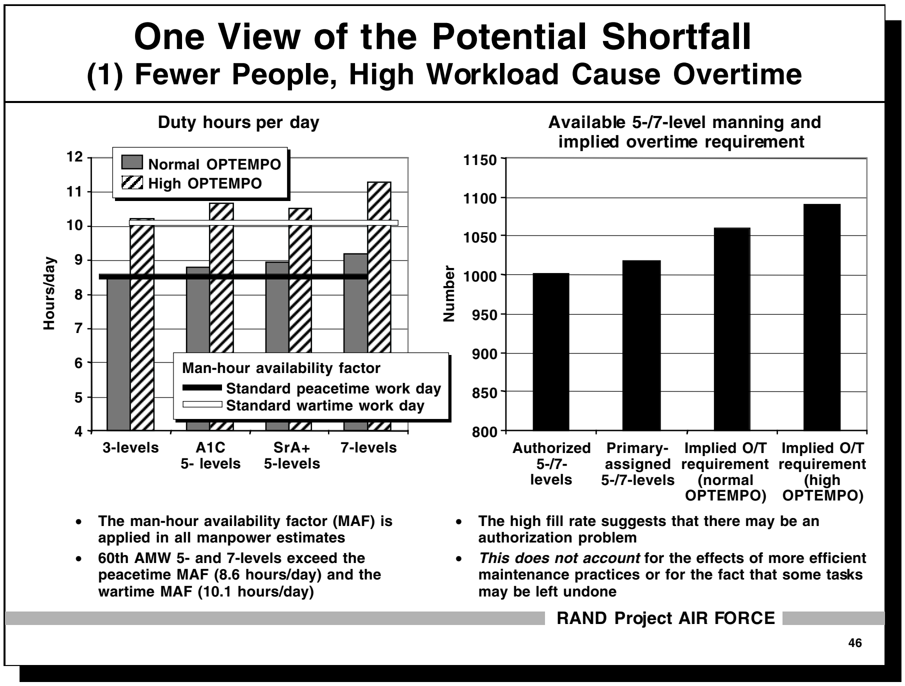
The chart above clearly shows production activities (including supervision) increasing during high-OPTEMPO periods. Production hours per week for 5-levels increase an average of 36 percent, while 7-level hours rise by 55 percent. This focus on production increases the average number of PEs per aircraft 28 percent, from 9.9 to 12.7.

This increase in production comes at the expense of OJT. The most effective teachers, senior 5-levels and 7-levels, reduce their teaching hours per week by 5 percent and 16 percent, respectively. Alternatively, 3-levels and junior 5-levels *increase* the time they spend teaching, with 3-levels actually doubling hours spent training those more junior. However, this does not appear to stem the loss in training capacity caused by senior technicians' production focus. The total number of trainer equivalents diminishes from about 107 during normal OPTEMPO to 93 during high OPTEMPO, representing a 13 percent decline. The number of 3-levels per trainer equivalent rises 21 percent, from 3.5 to 4.25. These calculations assume that all maintainers are available at home station. They do not account for the fact that key trainers (senior 5-levels and 7-levels) may at times be TDY and unavailable for teaching. This would tend to further reduce the number of trainer equivalents at home station.

Learning time diminishes by 17 to 30 percent. Reductions in learning time are steeper for senior maintainers than for junior maintainers.

It should be noted that high-OPTEMPO operations off station (such as deployments and MRTs) involve a higher proportion of senior technicians. For example, the majority of AGS and EMS technicians out on MRTs are 7-levels (the CRS technicians are mostly 5-levels). The 60th AGS has five to six people out on average, and the other squadrons have two to three. Thus, production and training capacity are degraded somewhat on a day-to-day basis. This is reinforced by the fact that for senior 5-levels and 7-levels, home station activities during periods when part of the squadron is off station rank among the top three high-OPTEMPO activities in terms of total duty hours per week. This was not the case for 3-levels and junior 5-levels.

Moreover, owing to medical or other reasons, not all senior technicians are deployable. As a result, squadrons must at times send 5-levels to fill 7-level slots. About three-quarters of survey respondents in the AGSs state that skill swapping is done, and more than two-thirds of these report that they are forced to do this more than half the time. Fewer reported skill swapping in the EMS and CRS. The vast majority in all squadrons said that the replacement of 7-levels with 5-levels somewhat degrades the ability to accomplish the mission, and a few termed the degradation "very significant."



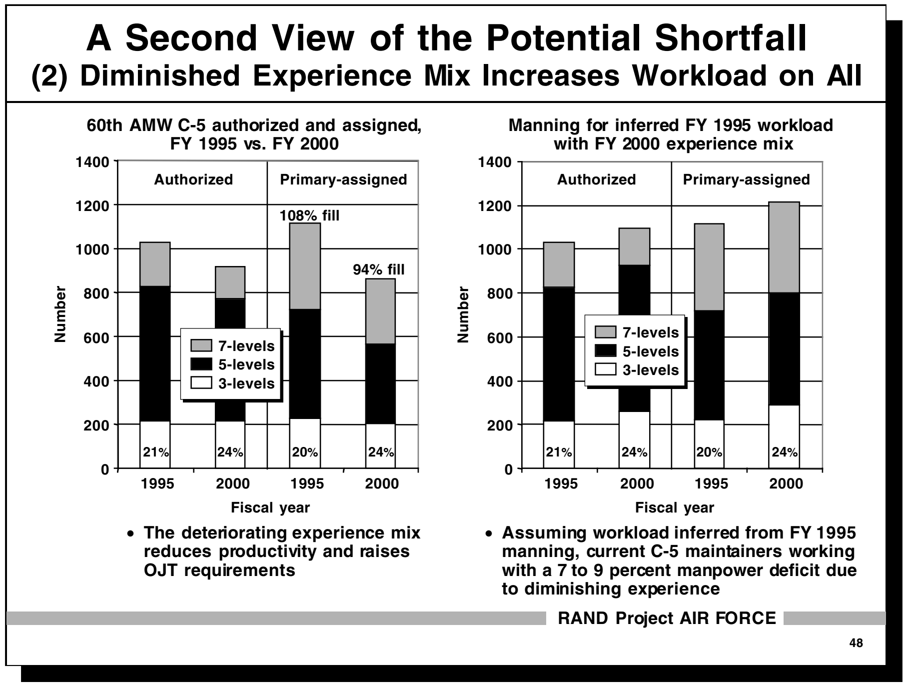
The next two graphs present analyses of potential maintenance manpower shortfalls related to two factors: longer working hours and diminished experience. Identified shortfalls in manpower should be interpreted as added, unfunded workload that existing manpower must bear—not as recommendations for increased authorizations.

First we compare the duty hours that 5- and 7-level maintainers state they are working, with the programmed hours embodied in the Air Force's man-hour availability factors (MAFs). The left-hand graph shows normal- and high-OPTEMPO duty hours per day reported by 60th AMW maintainers. The lines are Air Force standards for peacetime (8.6 hours per day) and wartime (10.1 hours per day, assuming a five-day work week). Most maintainers work longer than the standard suggests.

The first two bars from the left in the right-hand chart show authorized and primary-assigned 5- and 7-levels in the two AGSs, the EMS, and the CRS. The two bars on the right suggest the number of 5- and 7-level technicians these squadrons would need to meet the MAF standard during normal- and high-OPTEMPO conditions. They are derived by multiplying the percent overage in duty hours (4 percent in normal OPTEMPO, 7 percent in high OPTEMPO) by the number assigned and then adding the result to the number assigned. The estimates imply that if these spaces were added and filled, people would work no longer than the working hours provided in the manpower regulation.

The manpower implied in the two rightmost bars of the right-hand chart is 6 percent greater than authorizations during normal OPTEMPO and 9 percent greater during high OPTEMPO. This analysis suggests that overtime hours may be related to shortfalls in authorizations.

There are two major caveats to keep in mind. First, long duty hours may reflect inefficiencies that could be reduced by changing the way maintenance operations are organized and conducted. For example, the Air Force could reduce overall duty hours by shifting some workload to maintenance specialties that seem underutilized. Second, as argued above, maintainers may not complete all necessary tasks despite working longer hours. Some lower-priority tasks could be left undone in favor of pursuing more immediate missions such as sortie generation. Backlogs may arise, be they postponed maintenance actions or delayed, less systematic OJT. Note that inefficiencies in maintenance and the inability to accomplish all tasks tend to be offsetting influences; more efficient operations would tend to lower duty hours, while clearing backlogs would tend to raise them.



The second analysis estimates the effects of deteriorating experience mix on C-5 manning.[15] Diminished experience reduces productivity and increases OJT teaching requirements. This has occurred at Travis both in authorizations and in assignments, as depicted in the left-hand chart above. A greater burden for production and teaching then falls on a shrinking pool of senior maintainers. We attempt to answer the following: Using the mid-1990s authorized and assigned experience mixes as baselines, how much manpower would be needed, given the current experience mix, to maintain the mid-1990s level of production *and* teach and learn appropriately while completing other necessary duties?

To gain insight into the effects of lower experience, we applied a model that helps us determine the minimum manpower required, under the current experience mix, to meet the production capacity inferred from the mid-1990s experience mix. The implied training requirement must also be satisfied. The model adjusts both manpower and the time each skill level allocates to production, teaching, and administrative duties. Time allocated to learning remains constant. (Absent well-defined OJT standards and on the basis of maintainers' opinions that it takes nearly 50 percent longer to reach 5-level than it should, we assume that the "right" time share that 3-levels should dedicate to learning is around 70 percent.)

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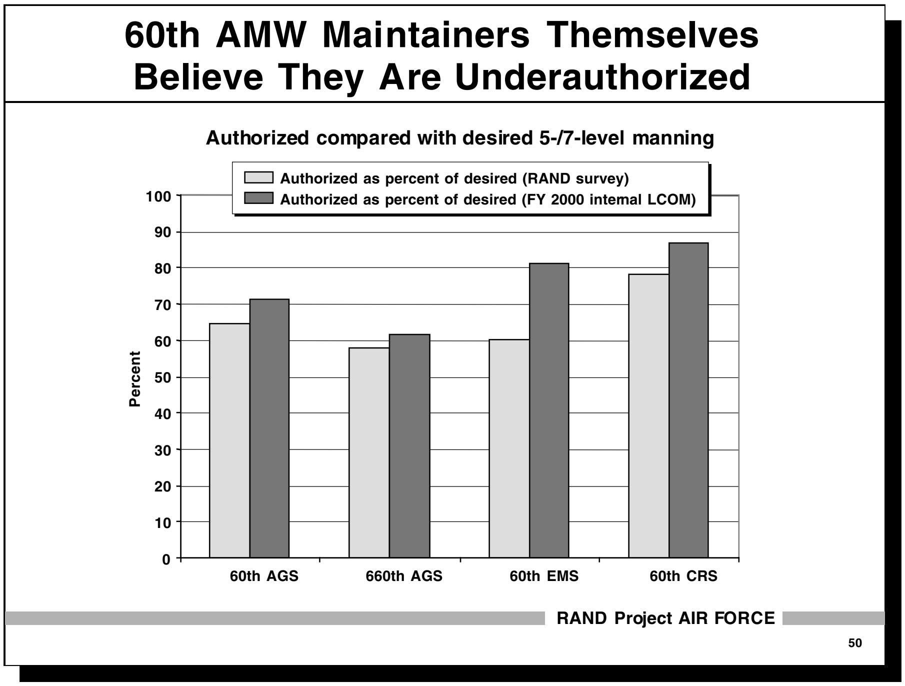
[15]Based on analysis by RAND colleague Bob Kerchner.

The analysis indicates that the less favorable experience mix observed before 9/11 caused a potential shortfall in authorized manpower equivalents—when compared with FY 1995 authorizations—of 7 percent for Travis C-5s. The experience-induced shortfall for primary-assigned maintainers is somewhat worse at 9 percent. This reflects the requirement for more PEs and more OJT as the experience mix deteriorates, and it also suggests a certain level of stress in the maintenance force.

We conducted an excursion to this analysis in which we added only 3-levels to the force. This excursion showed that production goals could be met only by accepting chronic shortfalls in the accomplishment of OJT and administrative goals. This is despite the result showing senior maintainers increasing the share of their time teaching. In the longer term, the only way to absorb the additional 3-levels would be to change the concepts for how OJT is accomplished. Moreover, we assumed for purposes of this excursion that 3-levels were able to complete all production tasks independently, although at a lower level of efficiency compared with senior maintainers. In fact, 3-levels in most maintenance career fields can do only a minority of tasks without supervision; thus, production goals would likely not be met in reality.



Maintainers themselves state that they are underauthorized by considerably more than was suggested in the previous analyses. The chart above compares FY 2000 authorizations with what maintainers at Travis say they need to meet their production, training, administrative, out-of-hide, high-OPTEMPO, and all other requirements. The two sets of bars reflect separate efforts to collect data on desired manning. The first bar for each squadron is drawn from responses to the RAND questionnaire, in which senior maintainers and supervisors were asked how many personnel they needed to make their flight "healthy." The second bar is derived from an "internal LCOM" that 60th AMW maintenance squadrons conducted in FY 2000. Each flight stated its desired authorization levels and reasons for any changes. The sources of desired increases in the AGSs were predominantly for flying crew chiefs but also included shift manning, supervisors, cann-bird workload, and out of hide. In the EMS and CRS, desired increases grew out of mobility taskings (especially for AGE and fuels), unfunded workload (KC-10 refurbishment and C-5 metals), and 7-level qualifications.

Note that for all squadrons except the CRS, survey responses were quite close to the internal LCOM. This likely results from high correlation of timing and respondents between the RAND question and the internal LCOM effort. The source of the difference in CRS answers could be the propulsion work center. Engine troops expressed a desire for a large number of additional 7-levels; the internal LCOM added 7-levels and reduced 5-levels by the same number, while respondents to the RAND question simply added 7-levels.

60th AMW Maintenance Summary

Aircraft availability continues to be a concern

- The number of aircraft possessed by depot (C-5) or contractor (KC-10) is high
- Nonavailability of parts limits the mission capability of wing-possessed C-5s

Manning, experience have declined relative to workload

- Maintainers have responded by working longer hours
- Stress may not be visible to leadership
- Diminished experience has decreased productivity and increased training requirements
  - Stop-loss has temporarily improved the experience mix
- Burden falls on senior maintainers

Training may be slipping in some specialties

- In other specialties, OJT is conducted, but at what quality?

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The maintainers of the 60th AMW have faced myriad challenges arising from declining manning, diminished experience, and heavy workload caused to some extent by parts shortages. They have attempted to meet these challenges by increasing their duty hours and adjusting the time they spend on key activities. It appears, however, that some production and training tasks have lagged. High-OPTEMPO demands serve only to exacerbate these problems. In sum, Travis technicians—especially the more senior 5-levels and 7-levels—are under constant stress.

One source of the problem appears to be a mismatch between the authorizations provided and the requirements levied on maintainers in the field. However, the problems of 60th AMW maintainers cannot be solved simply by adding manpower. Because of the need to grow maintainers from the bottom up, adding manpower would only make matters worse, even over the longer term. Remedies would have to combine selected manpower increases with alternative concepts for production and training.

Concluding Remarks: Readiness at the 60th Air Mobility Wing

Post-9/11 OPTEMPO has helped C-5 pilot inventory

- Reduced reliance on TWCF hours makes training more stable over the long term
- Lowering standards for experience begs the question of proficiency

The enlisted aircrew inventory is unbalanced

- More junior people will be coming in, but training bill will be high until they upgrade

Maintainers are facing experience problems

- Challenge to continue OJT while meeting flying demands
  - High OPTEMPO and the eventual lifting of stop-loss will exacerbate this
- Senior maintainers are sustaining production by working longer hours

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In sum, the 60th AMW is facing a number of readiness-related challenges. The challenges of maintaining the pilot and aircrew inventories are well known, and efforts are under way at Travis and AMC-wide to ameliorate these problems. Pilot problems have been remedied for the time being. Still, three issues seem to stand out. First, the reliance on TWCF hours leaves C-5 pilot and enlisted aircrew training vulnerable to dips in the customer market and in OPTEMPO generally; relying more on O&M will help alleviate volatility in flying hours. Second, even if programmed flying hours are flown, the continuing practice of assigning more pilots than are authorized will hamper the ability of Travis pilots to upgrade quickly—since flying hours are determined according to authorized pilot positions. Third, lowering required hours from 1400 to 1300 will certainly allow pilots to upgrade more quickly, but this will also lower the standard of "experience." Pilots with 1300 hours will be less proficient than those at 1400—a level that many aviators already claim does not provide adequate proficiency.

Enlisted aircrew are facing an inventory imbalance. This has shifted somewhat over the past few years. In early 2000, some personnel were lamenting the fact that new assignees used to come from other MDSs (making them easier to train) but were at that time more likely to be new recruits just coming out of tech school. By 2001, the new recruits, without whom the inventory cannot be sustained, had dried up. Enlisted aircrew positions were underfilled, and flight schedulers had to consider the availability of these personnel when planning the flying day. With the student pipeline healthy again, the wing should have new blood arriving, and the challenge will be to absorb them while supporting the flying schedule.

Maintainers have been under stress as a result of manning problems and reductions in experience levels over the past several years. This has been exacerbated by the fact that manpower requirements may not be properly set and that personnel are made unavailable because of out-of-hide positions that must be filled. Then, when OPTEMPO rises—e.g., when operational demands increase or when the wing is asked to "fly out the program"—OJT becomes a bill payer. Yet time for conducting OJT is critical to improving the long-term health of the maintainer inventory. Stop-loss has helped improve the experience mix at least temporarily; how lifting this policy will affect the experience mix at the 60th AMW remains to be seen.

Does all this mean that the wing cannot meet its flying schedule or operational demands? In the short run, no. Requirements will be met because personnel work longer hours and put off so-called lower-priority tasks. This situation is not sustainable, however, especially after OPTEMPO and policies return to "normal." Although pilot experience problems have been remedied, imbalances in enlisted aircrew and maintainer inventories will take some time to rectify. Problems facing maintainers are particularly crucial because a number of activities for which maintainers are responsible are not adequately tracked or programmed by the Air Force. Remedies to these problems will be needed to ensure that demands can be met in the future.

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