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LEVERAGING MAINTAINER EXPERIENCE TO INCREASE AVIATION READINESS

December 2020

By: **Scott A. Hatzung**
David B. Welborn

Advisor: **Chad W. Seagren**
Co-Advisor: **William D. Hatch**
Second Reader: **Edward D. McCabe**

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This research examined the correlation between maintainer experience and F/A-18 readiness and how it can be leveraged through the creation of a specialist rate from within the existing manpower structure. This approach was derived from the naval aviation maintenance community's ongoing manpower deficiencies, which have led to a decline in the average years of experience in enlisted maintenance personnel. This experience issue is further complicated by rapid changes in technology. The resulting experience gap has placed an increased emphasis on training and a reliance on civilian contractors for technical expertise in order to reduce the impact on aircraft readiness.

Causal forecasting models were used to determine the existence of a significant positive correlation between experience and readiness. We accomplished this by focusing on two quantitative datasets that contain a detailed two-year historical compilation of aviation maintainer experience levels and readiness numbers of F/A-18 Super Hornet squadrons. We then explored ways to leverage experience in the Naval Aviation Enterprise by comparing current policy with historical approaches, specialization in the DOD, and industry practices.

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LEVERAGING MAINTAINER EXPERIENCE TO INCREASE AVIATION READINESS

Scott A. Hatzung, Lieutenant, United States Navy
David B. Welborn, Lieutenant Commander, United States Navy

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Approved by: Chad W. Seagren
Advisor

William D. Hatch
Co-Advisor

Edward D. McCabe
Second Reader

Eddine Dahel
Academic Associate, Graduate School of Defense Management

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ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

A2AD	Anti-Access Area Denial
AAS	Aircraft Armament Systems
AC	Active Component
ACE	Air Combat Element
AD	Aviation Machinist's Mate
AE	Aviation Electrician's Mate
AIMD	Aviation Intermediate Maintenance Department
AM	Aviation Structural Mechanic
AMD	Activity Manning Document
AME	Aviation Structural Mechanic-Safety Equipment
AMEX	Aviation Maintenance Experience
AMSRR	Aircraft Maintenance Readiness Report
AO	Aviation Ordnanceman
AOR	Area of Responsibility
AS	Administrative Support
ASM	Advanced Skills Management
ASVAB	Armed Services Vocational Aptitude Battery
ASW	Anti-submarine Warfare
AT	Aviation Electronics Technician
AWOTF	Air Wing of the Future
AWSE	Armament Weapons Support Equipment
AZ	Aviation Maintenance Administrationman
BA	Billets Authorized
BBD	Billet Based Distribution
BRS	Blended Retirement System
BUPERS	Bureau of Naval Personnel
CDI	Collateral Duty Inspector
CDQAR	Collateral Duty Quality Assurance
CENTCOM	U.S. Central Command
CM	Corrective Maintenance

CMS-ID	Career Management System-Interactive Detailing
CAN	Center for Naval Analyses
CETS	Contractor Engineering Technical Services
CNAF	Commander, Naval Air Forces
CNEC	Critical Navy Enlisted Classification
COB	Current On Board
CONUS	Continental United States
COMFAIRFWD	Commander, Fleet Air Forward
COMFRC	Commander, Fleet Readiness Center
COMMARFOR	U.S. Marine Forces Command/Pacific
COMMARFORES	U.S. Marine Forces Command Reserve
CSG	Carrier Strike Group
CVN	Aircraft Carrier Fixed Wing Nuclear Powered
CVW	Carrier Air Wing
DEMOT	A combination of critical enlisted manning rate abbreviations: A(D), A(E), A(M), A(O), A(T)
DoN	Department of the Navy
DOTMLPF-P	Doctrine Organization Training Materiel Leadership and Education Personnel Facilities-Policy
DRRS-N	Defense Readiness Reporting System-Navy
ELARS	Engineering Technical Services Local Assist Request
ETS	Engineering and Technical Services
FAD	Force Activity Designator
FDNF	Forward Deployed Naval Forces
FLTMPS	Fleet Training Management & Planning System
FLIR	Forward Looking Infrared
FM	Facilities Maintenance
FMC	Full Mission Capable
FRS	Fleet Replacement Squadron
FTS	Full Time Support
FYDP	Future Years Defense Program
HERO	Hazards of Electromagnetic Radiation to Ordnance

HSC	Helicopter Sea Combat Squadron (HM-60S Knighthawk)
HSM	Helicopter Maritime Strike Squadron (HM-60R Seahawk)
HYT	High Year Tenure
IETM	Interactive Electronic Technical Manual
JCIDS	Joint Capabilities Integration and Development System
LASER	Light Amplification by Stimulated Emission of Radiation
LHA	Landing Helicopter Assault
LHD	Landing Helicopter Dock
LOE	Lines of Effort
LOS	Life of Service (used interchangeably with YOS)
LS	Logistics Support
MAW	Marine Aircraft Wing
MHE	Materials Handling Equipment
MHRS/FLTHR	Maintenance Man-Hours per Flight Hour
MILPERS	Military Personnel
MILPERSMAN	Military Personnel Manual
MO	Maintenance Officer
NAE	Naval Aviation Enterprise
NALCOMIS	Naval Aviation Logistics Command Management Information System
NALDA	Naval Air Systems Command Logistics Data Analysis Database
NAMP	Naval Aviation Maintenance Program
NAR	Notice of Ammunition Reclassification
NAS	Naval Air Station
NATEC	Naval Air Technical and Engineering Services Command
NAVAIR	Naval Air Systems Command
NAVMAC	Navy Manpower Analysis Center
NAVPERS	Navy Personal Command
NEC	Navy Enlisted Classification Code
NEOCS	Navy Enlisted Operational Classification System
NETS	Navy Engineering and Technical Services
OCONUS	Outside Continental United States

OFRP	Optimized Fleet Response Plan
OHE	Ordnance Handling Equipment
OJT	On-The-Job Training
OOMA	Optimized Organizational Maintenance Activity
OOR	Out of Reporting
OPTAR	Optimized Fleet Response Plan
PAA	Primary Aircraft Authorized
PPBE	Planning Programming Budget Execution
PQS	Personnel Qualification Standard
PR	Aircrew Survival Equipmentman
QAR	Quality Assurance Representative
QPA	Qualified Professional Apprentice
QPJ	Qualified Professional Journeyman
RADAR	Radio Detection and Ranging
RBA	Ready Basic Aircraft
RFT	Ready for Tasking
ROC/POE	Required Operational Capability/Projected Operational Environment
RSL	Ready Service Lockers
SA	Support Action
SFF	Safe-For-Flight
SMD	Ship Manpower Document
SME	Subject Matter Expert
SORTS	Status of Resources and Training System
SQMD	Squadron Manpower Document
SRA	Shop Replaceable Assemblies
SRB	Selective Reenlistment Bonus
TIR	Time-In-Rate
TFMMS	Total Force Manpower Management System
T/M/S	Type/Model/Series
TYCOM	Type Commander
UAS	Unmanned Aerial System

UCAV	Unmanned Combat Aerial Vehicle
UT	Utility Tasking
VAQ	Electronic Attack Squadron (EA-18G Growler)
VAW	Airborne Early Warning Squadron (E-2D Hawkeye)
VFA	Strike Fighter Squadron (F/A-18E/F Super Hornet, F-35 Lightning II)
VRC	Fleet Logistics Support Squadron (C-2A Greyhound)
VRM	Fleet Logistics Multi-Mission Squadron (CMV-22B Osprey)
WRA	Weapons Replaceable Assemblies
YOS	Years of Service (used interchangeably with LOS)

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EXECUTIVE SUMMARY

Manpower deficiencies within naval aviation maintenance have led to a decline in the average years of experience among enlisted maintenance personnel. Rapid technology changes further complicate the experience decline, and the Navy's response has been increased emphasis on training and reliance on civilian contractors for technical expertise to reduce the impact on aircraft readiness.

The purpose of this research was to determine the correlation between the experience of aviation maintainers and squadron readiness in order to leverage the connection between them. The scope of our research was narrowed by limitations in available Aviation Maintenance Experience (AMEX) data, and as a result it focused exclusively on F/A-18 Super Hornets.

We reviewed the education, training, and rank structure of aviation production ratings to establish a baseline for current methods of creating and utilizing experience for comparison with historical practices in the Navy, specialization throughout the DoD, and approaches from civilian industry. The AMEX system is described in detail to establish its role in measuring experience and explain its use in our regression models. Learning curve models are briefly discussed to emphasize the connection between task repetition and improved performance. Finally, emerging technology and how it relates to the aviation maintenance is provided prior to our analysis.

Analysis focused on the relationship between aviation maintainer experience levels and readiness numbers of F/A-18 Super Hornet squadrons from August 2018 to August 2020. We used multivariate linear regression models to determine the existence of a significant positive correlation between experience and readiness. We were able to show a highly significant correlation between the experience of aviation maintainers and squadron readiness rates, finding an AMEX coefficient of 5 percentage points on RBA rate while accounting for the covariates of each operational phase (Table 1).

Table 1. Models 3, 4, and 5

Model	3	4	5
R Square	0.178	0.193	0.268
Observations	708	708	708
Parameter estimates			
Intercept	0.624***	0.530***	
AMEX	0.100***	0.099***	0.059***
number_aircraft		0.009***	-0.002
Basic			0.673***
Deployed			0.7515***
Integrated			0.706***
Maintenance			0.628***
Sustain			0.733***

Pr (>|t|) Significance Codes:

*** = 0 to 0.001 / ** = 0.001 to 0.01 / * = 0.01 to 0.05 / . = 0.05 to 0.1 / blank = 0.1 to 1

Findings were tested for fixed and random effects, and found that the answers were not quantitatively different, thus answering our primary research question by proving a correlation between experience and readiness exists.

Research of industry and DoD methods of leveraging experience compared a wide variety of options, all of which utilized specialization in one form or another. Industry's emphasis that not everyone needs to be a manager provides the flexibility to retain talented personnel with critical skills employed in critical areas where they are best utilized. The most relevant version of this is American Airlines' technical crew chief, which consists of an experienced aviation technician whose entire career focuses solely on fixing aircraft and does not merge into management. This position provides the Naval Aviation Enterprise (NAE) with an active model to use as the basis for creating and using a specialist; while the Army's historical use of a specialist rank provides an example of how to incorporate a specialist into our rank structure.

In our opinion, Naval Air Technical and Engineering Services Command (NATEC) represents the Navy's current practice of leveraging experience; but it has notable constraints, which include limited availability during deployments. Figure 1 shows an upward trend in usage of NATEC by the Super Hornet community, and seems to indicate an increased need for experts with specialization.

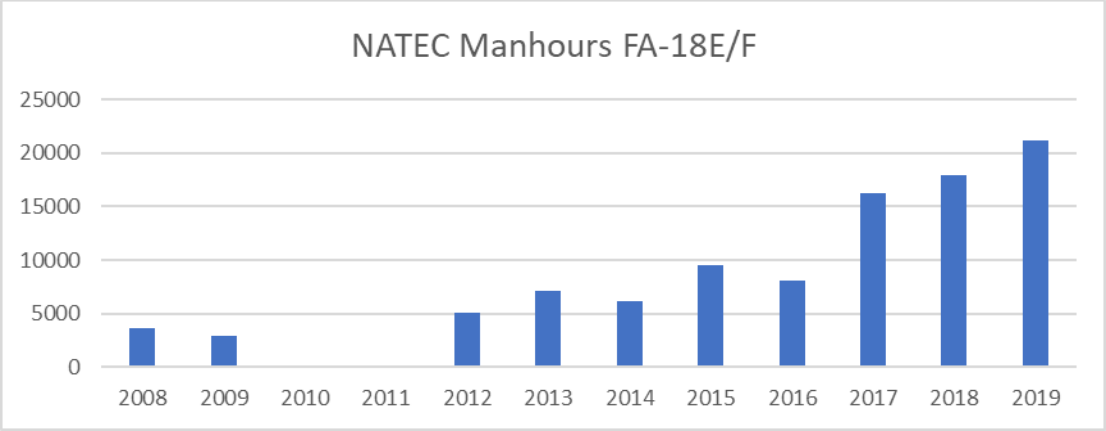

Figure 1. NATEC Manhours for F/A-18E/F from 2008 to 2019. Source: Adapted from NATEC data (2020).

Our recommendation is that the NAE invest in further research toward a cost-benefit analysis of creating specialists that would be managed by NATEC and sent to squadrons with the exclusive intent of resolving complex aircraft issues without the limitations that deployment places on civilians. Selection as a specialist would be conducted through a highly competitive and incentivized screening process, which includes a one-year probationary trial period. Full designation would consist of assigning a closed loop Navy enlisted classification code with a high year tenure waiver and a rating change to either AV or AF depending on their previous rating.

In short, our research found a significant correlation between aviation maintainer experience and aircraft readiness of CONUS based F/A-18 Super Hornet squadrons, then determined that the creation of a specialist rating, formed from within existing manpower, would be the best method of leveraging the correlation. Additionally, unlike many other plans that aim to do more with less, we propose doing more by restructuring what we already have available.

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I. INTRODUCTION

A. PREFACE

The Naval Aviation Maintenance community has struggled with proper manning levels for the last decade. Rapid technology changes have created gaps in experience levels, and the emergence of 5G, artificial intelligence, and machine learning are expected to accelerate this change, possibly moving faster than the Navy can train its Sailors. Billet Based Distribution (BBD) has taken aim at the manning issue; but, despite this effort, in the NAE squadrons rely heavily on contractors and technical representatives to bridge the technology gap and address the most pressing technological issues on aircraft. Contractors are associated with high cost and utilizing them becomes complicated when Air Wings are deployed to locations like the South China Sea where it is not optimal to receive parts or fly civilians to location. This complication is further compounded by the protective measures required during the COVID-19 pandemic.

The authors of this MBA project are both Aviation Maintenance Duty Officers (AMDO) with a combined total of more than 30 years of enlisted and officer experience. They can attest to the challenges the naval aviation community faces in keeping pace with technology changes and attaining sufficient aircraft readiness numbers while constantly under manned and inadequately resourced. The NAE historically attributes readiness issues to improper manning levels or lack of availability for critical repair parts. However, it is the authors' opinion that in addition to these well-known and researched issues there is an additional problem in how we utilize and manage the skills of our personnel. The NAE has some of the most talented technicians in the world, and research of this project identifies a connection between experience and readiness that can be leveraged to enhance the availability of the fleet.

A review of various industry leaders found different approaches and methods, but all of them had a common thread to address manpower utilization. For example, Silicon Valley leadership focuses on management while its engineers and technology specialists focus on their area of expertise. This creates two separate career paths that both have the

same goal of providing the best possible end item for their company. If this is how current industry is leveraging their employee strengths, it is worth examining potential corollaries in the NAE. The Navy's current promotion system takes technicians on a pathway that puts increasing emphasis on leadership and management skill over technical prowess. It assumes their current technical ability is a permanent baseline on which to build a technology adept leader and manager. This project addresses the unintended consequences of rewarding technicians at the peak of their proficiency with a management job. Not only do the technicians stop learning new technology enhanced by new skills, but also those older skills no longer reach the aircraft as frequently.

What if, like civilian industry, the NAE developed a divergence in career paths that created two separate areas of emphasis? One being the traditional route that develops technicians into managers well versed in the aircraft and the other being a specialist route that continues to develop technicians' technology-based maintenance acumen. Could leveraging the experience of maintenance personnel in this way solve the NAE's perceived manning issues while simultaneously increase readiness? Before we can approach this question, we must first know the degree to which experience and readiness are connected.

The overall assumption in the NAE is that higher experience levels of a squadron equate to higher readiness numbers. Standards are set on the minimum qualifications necessary for deployment that ensure sufficient experience is available within the squadron. Our primary question takes aim at this assumption and attempts to quantitatively answer it. If this assumption holds true, would creating a specialist career path to leverage experience lead to increased readiness? The NAE is challenged today by emerging technology such as artificial intelligence and unmanned aircraft, and at this juncture it is important to know the measurable degree to which experience matters on the flight line.

B. PURPOSE

The successes and failures in an organization can be traced back to decisions it made in the past, and we believe this is just as true for manpower as it is for any other variable. Recruiting and retaining the best and brightest individuals is an age-old challenge for any organization. Over the last few decades, the competition over personnel working

in cutting-edge, technology-based industries has been extremely fierce. Meanwhile the Navy has struggled to retain Sailors by using an ebb and flow of personnel cuts and incentives to balance manning levels, while doing very little to modernize how it utilizes Sailors.

This MBA project investigates if experience matters in the increase or decrease of readiness of the Super Hornet Fleet. If this experience does matter and positive correlation is statistically viable, how then can the NAE better leverage that experience in the future? Looking to industry and other branches of the military, best practices were sought out in an attempt to identify opportunities to leverage talent. The benefit of this study is to ascertain whether business practices used by industry leaders to leverage the experience and skill sets of their personnel can or should be applied within the NAE.

C. RESEARCH QUESTIONS

Below are the questions this project attempts to answer:

1. Primary Research Question

To what degree does the experience level of an aviation maintainer affect the readiness of an F/A-18 Super Hornet squadron?

2. Secondary Research Question

How can we best leverage the connection between maintainer experience and readiness in terms of manpower in the aviation maintenance community?

D. METHODOLOGY

To answer the primary research question in this project, the authors investigate effects of experience levels on squadron readiness. Does the assumption of high levels of experience in squadron maintainers corelate in a positive manner to higher readiness levels in the F/A-18 Super Hornet community, or does the opposite hold true? CNAF-provided data is used to measure the degree to which a correlation exists or does not exist between experience levels and readiness numbers. Data is provided from the Aviation Maintainer

Experience (AMEX) and Aviation Material Readiness Reporting (AMSRR) databases, for the dates of August 2018–August 2020.

Method: Compare and contrast individual F/A-18 squadron manning/experience scores, "AMEX score" from the AMEX database, with ready basic aircraft (RBA) percentages through Aviation Material Readiness Reporting (AMSRR). Pooled regression models of the data are used to statistically prove or disprove the primary research question.

To answer the secondary research, question the authors researched industry best practices of leveraging talent and identify methods to incorporate in the NAE. Additionally, research is conducted on other military organizations that have utilized specialization of personnel such as the Army's flying warrant program.

Method: Qualitative research is conducted on published reports and data of personnel utilization practices by applicable industry leaders. Additionally, a combination of research and review of applicable service applications within the armed forces and their outcomes. Research on both approaches is used to drive a manpower recommendation of the creation of a specialist rating within the aviation maintenance community.

E. ORGANIZATION

The following is a brief description of the five chapters in which our research is presented. Chapter II is a literature review intended to provide the reader with sufficient background information on an aviation maintainer's career structure, education, and qualifications in order to understand the lengthy nature of gaining subject matter expertise. This chapter also introduces the importance of emerging technologies focusing on 5G and the impact tech will have on the acceleration of changes. Lastly, Chapter II introduces the reader to the AMEX database and literature on the value of experience in personnel. Chapter III explains the quantitative analysis used by the authors to answer the project's primary research question, "To what degree does the experience level of an aviation maintainer affect the readiness of an F/A-18 Super Hornet squadron?" We provide a detailed walkthrough of the regression models performed on datasets gathered from CNAF and NATEC to explain the correlation found between maintainer experience and readiness. Chapter IV answers the secondary question, "How can we best leverage the connection

between maintainer experience and readiness in terms of manpower in the aviation maintenance community?" This analysis takes a quantitative approach by looking at current NAE policy in comparison with civilian industry practices, historical naval approaches to changes in technology and manpower needs, and specialization attempts in other branches of the Department of Defense (DoD) in order to formulate a road map for future use. Chapter V, the final chapter, concludes the report as a summary of the project as a whole. The authors also provide recommendations based on their findings and suggest areas for further research.

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II. LITERATURE REVIEW

This focus of this project is maintainer experience, its connection to readiness, and how to leverage it. This chapter provides insight into how maintainer experience is created, managed, and evaluated by describing the training, tracking, and analyzing methods currently utilized by the Naval Aviation Enterprise (NAE). This information serves as a basis for understanding experience as a cultivated and scarce resource that is analyzed in Chapter III. Finally, the chapter concludes with a description of major technology changes on the horizon, which will impact the NAE's experience requirements.

A. AVIATION MAINTENANCE SAILORS

The following section describes the process that turns a Sailor who has recently graduated from basic training into a technician who specializes in aviation maintenance. It describes the rates employed by aviation maintenance, the standard training pipeline, a generalized career progression, and the force shaping measures used on manpower. In doing so, this section strives to describe how this process creates a vast network of experienced subject matter experts (SME) and how they are used to achieve aviation readiness standards. Understanding the process of how Sailors gain experience is an integral part of our analysis on the impact of experience on readiness, which will be discussed later in Chapter III.

1. Aviation Ratings

For the purposes of this project, the description of rates employed in aviation maintenance will be limited to the rates measured in the AMEX system. Primarily, this means excluding the Aircrew Survival Equipmentman (PR) and Aviation Maintenance Administrationman (AZ) rates, but also excludes rates that have supporting roles like the Logistics Specialist (LS), Yeoman (YN), Personnel Specialist (PS), and Career Counselor (NC), all of which would be found at any fleet squadron. It also excludes aviation specific rates that are not utilized at the organization-level (O-level, i.e., a squadron). Some of these rates include the Aviation Support Equipment Technician (AS), the Air Traffic Controller (AC), and the Aviation Boatswain's Mate (AB) to include its subspecialties. Each of these

rates play an important part in a squadron's performance and are excluded here only due to the nature of the AMEX database used in our analysis (M. Pittner, PowerPoint slides, 21 April 2019).

The production ratings we focus our research on include the Aviation Machinist's Mates (AD), Aviation Electrician's Mates (AE), Aviation Structural Mechanics (AM), Aviation Structural Mechanic Safety Equipment (AME), Aviation Ordnancemen (AO), and Aviation Electronics Technicians (AT). A description of the responsibilities associated with the production rates is provided in the Appendix (Department of the Navy [DoN], 2020a).

Additionally, this project focuses on the ranks of E4 through E8 as those are the ranks that AMEX takes into consideration (M. Pittner, PowerPoint slides, 21 April 2019). Further explanation of the AMEX system is in Section D of this chapter. Attaining the rank of E4 marks the end of being an Airman and the entry into the petty officer paygrades (DoN, 2020a, p. 3). Petty officers' rate and rank are commonly used in combination as a shorthand method that enables an individual to be identified quickly from among a group of Sailors. For example, "AD2" denotes a second-class petty officer in the aviation machinist's mate rating. Petty officer ranks are from E4 to E6 and end once the rank of E7 is attained and the Sailor becomes a Chief Petty Officer (DoN, 2020a, p. 3), commonly referred to as "Chief." Likewise, when a Chief attains the rank of E8 and becomes a Senior Chief Petty Officer (DoN, 2020a, p. 3), commonly referred to as "Senior."

While these commonly used rank references use brevity to distinguish who is being spoken to, they also denote the level of experience the individual is assumed to possess. This is due to the average number of years it takes to attain the rank they have achieved. For instance, Figure 1 illustrates a typical career path for an AE or AT (DoN, 2020a, p. AE-4), while Figure 2 describes the time-in-rate (TIR) requirements for eligibility toward the next rank (Office of the Chief of Naval Personnel [CNP], 2018). As illustrated in Figure 1, these two rates culminate in the rank of E9, or Master Chief Petty Officer, and merge both rates into AV, which indicates a Master Chief Avionics Technician (DoN, 2020a)

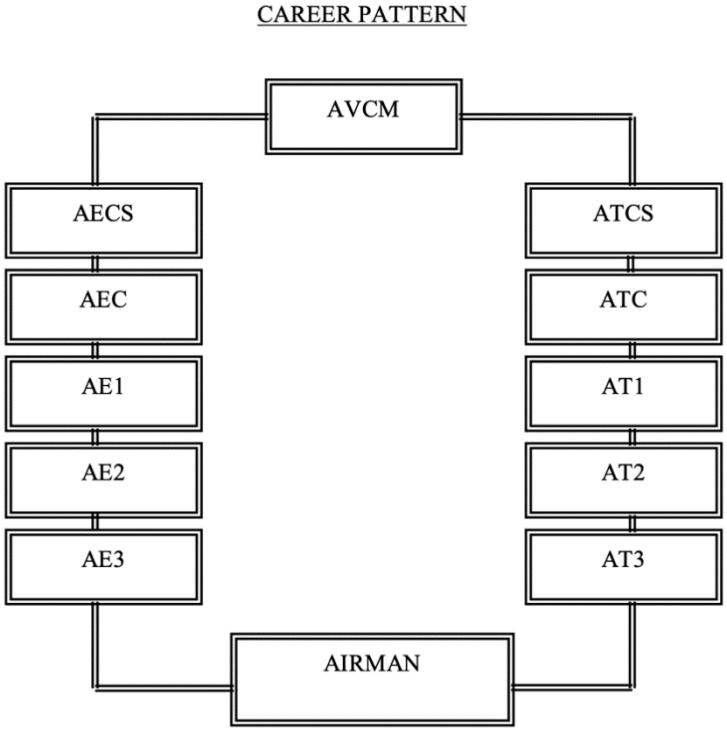


Figure 1. Career Path for an AE and AT. Source: DoN (2020a, p. AE-4).

PAYGRADE	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E7 to E8	E8 to E9
TIR	9 MOS		6 MOS	12 MOS	36MOS* *Refer to 214 (e) for Early Promote (EP) waivers			

Figure 2. Basic Time-In-Rate (TIR) Requirements. Source: CNP (2018, p. 2–1).

In a similar fashion, the rates of AD, AM, and AME are combined into AF at the rank of E9, which indicates a Master Chief Aircraft Maintenanceman (DoN, 2020a). Certain elements of career progression are based on meeting necessary time requirements, as shown in Figure 2 (CNP, 2018, 2–1), while others are subject to a multitude of factors like performance evaluation, individual test scores, current manpower requirements at a given rank of a specific rate, etc. However, in order to help facilitate realistic expectations for career progression Naval Personnel Command has published information on each rate

that allows the individual to monitor their progress in comparison with their peers. Providing Sailors with a method of examining their career progression allows them, and their mentors, to set goals they can attain in their pursuit of achieving milestones every step of the way. While this benefits the growth and success of the individual Sailor, the qualifications and experience they earn along the way will also develop them into a crucial asset that the Navy depends upon to maintain readiness standards.

2. Technical Education

All enlisted Sailors attend indoctrination training at Naval Station Great Lakes. This training is focused on the basic fundamentals of being a Sailor, many of which are unique to the Navy among its fellow services, and provide the essential foundation for their ability to function with their fellow Sailors in the Fleet. All the skills they will need to perform aviation maintenance are provided after indoctrination training at schools specifically designed to toward that end.

> The Center for Naval Aviation Technical Training (CNATT) mission is to develop, deliver, and support aviation technical training necessary to meet validated Fleet requirements through a continuum of professional and personal growth for Sailors and Marines. (Naval Education and Training Command [NETC], 2020)

This is done in either a formal school setting at CNATT training centers or in on-the-job training (OJT) at the squadron. The schools are described below, and locations are detailed in Figure 3.

> The Pensacola-based headquarters is responsible for 28 sites located throughout the continental United States and Japan. CNATT with a staff of nearly 3,000, trains more than 97,000 students annually in the U.S. and abroad. The center is responsible for curriculum and educational tools, as well as developing training solutions and professional development for aviation ratings, airman, related aviation maintenance officer training and training for Marine Corps aviation Military Occupational Specialties requirements. (NETC, 2020)

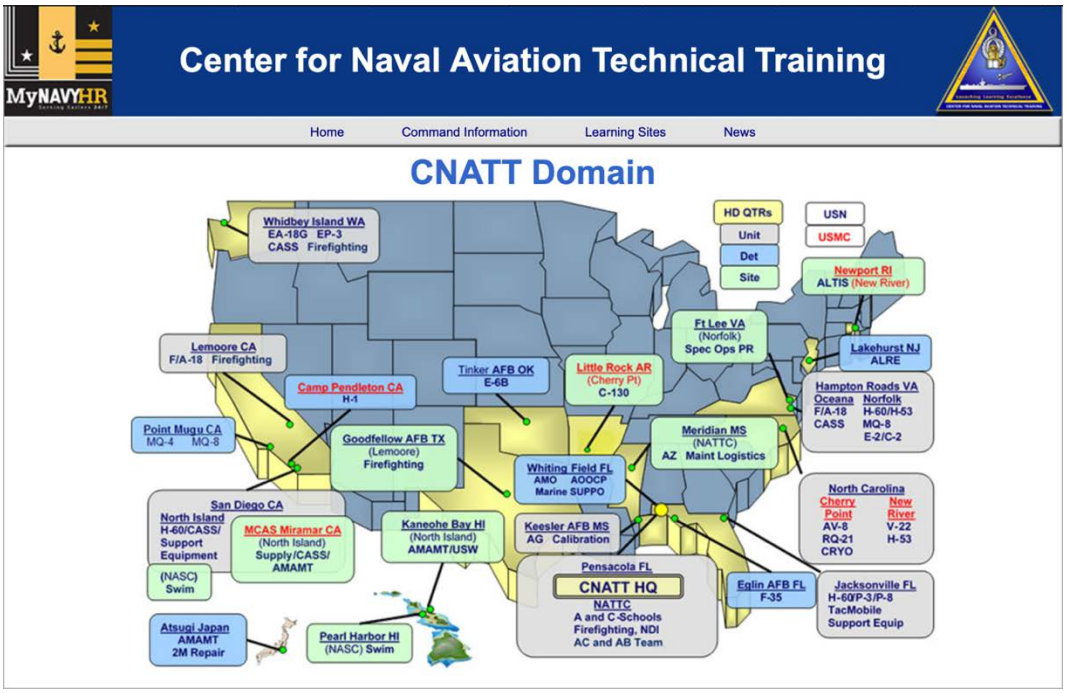


Figure 3. Center for Naval Aviation Technical Training Domain. Source: NETC (2020).

a. Apprentice "A" School

Apprentice school, or "A" school as it is known, builds upon the foundation made at basic training and marks the beginning of the road toward becoming an SME. Sailors who attend this school are typically between the paygrades of E-1 through E-3 (DoN, 2020b). Some "Fleet Returnees," Sailors who opt to change their rate after time spent working in the Fleet, may be in the petty officer paygrades of E-4 or E-5. Undesignated strikers cannot attain the rank of petty officer until they obtain a rating by applying for it and only then can take the required examination for advancement to petty officer (DoN, 2020b).

The skills learned at A-school are put to use at the squadron and built upon while performing OJT, which in addition to completing necessary maintenance tasks serves to reinforce and clarify lessons taught at A-school. This practice of using real maintenance tasks as teaching aids taught outside of the classroom is a proven method of showing new Sailors the practical application of techniques and situations. OJT is a staple in the process

of progression from apprentice to journeyman level personnel qualifications standards (PQS) and a successful method of showing undesignated strikers the skills of a rate in a real world setting prior to applying for that rating.

b. Career "C" School

Career school, or "C" school as it is known, further builds upon the lessons learned while in "A" school and the OJT Sailors receive in the fleet. "C" school facilitates learning information unique to the aircraft at the squadron a Sailor has been assigned.

Rated Sailors can attain a Navy Enlisted Classification (NEC) which are additional codes to ratings that identify personnel and billets in terms of manpower (DoN, 2020b). These codes help Detailers and squadron Assistant Maintenance Officers (AMO) ensure the right personnel are assigned to their unit (DoN, 2020b). For example, NECs will help distinguish an AM3 who graduated with training focused toward maintenance on an F/A-18 Super Hornet from another AM3 whose training focused on a MH-60S Knighthawk. In this example, both of the new third-class petty officers are trained in skills general to all aviation structural mechanics but graduating from a C-school and gaining an NEC identifies them with that particular aircraft. This can occur relatively early on in a Sailor's career and if developed appropriately over the years it can result in a maintenance expert for that aircraft.

3. Advanced Skills Management

Advanced Skills Management (ASM) is an online repository system that allows Navy leaders the ability to view and manage personnel data. The data stored in this system includes training, certifications, qualifications, and licenses that are used in the performance of daily maintenance tasks. A squadron's ASM Coordinator serves as the point of contact for personnel who need access and will assist them in establishing an account.

This system includes the ability to run various types of reports which give maintenance managers insight into the status of their department, division, or work center. One such report allows qualifications currently being pursued to be measured in terms of

percentage toward completion and progression made since the last report. This allows managers to keep Sailors accountable for required qualifications per their rating and current rank as well as help the squadron maintain a healthy maintenance department. It also allows managers to have control and oversight of the qualification process and ensure that once a Sailor receives a new qualification in ASM it is also added to NALCOMIS (OOMA). This allows the Sailor to sign for having completed maintenance actions logged in OOMA where the qualification is a prerequisite for signing. A cumulative list of qualified personnel is published in the Monthly Maintenance Plan (MMP) which is reviewed and routed through the Chain of Command monthly for accuracy and cohesion between the ASM and OOMA as they do not currently integrate with one another. Pen and ink changes are made between revisions to ensure the qualifications in ASM, OOMA, and the MMP are constantly in alignment. These changes are due to qualifications being continually achieved by personnel on a continual basis and the unit's desire to employ a Sailor's new qualification as soon as possible. Putting a qualification to use as soon as it is achieved has a dual benefit of maximizing opportunities to gain further proficiency and immediately increasing the number of available Sailors with that qualification. If this qualification was the current bottleneck in the Maintenance Department, the benefit of putting it to use right away versus waiting until the next month's review is self-evident. ASM as a method for electronically managing qualifications is a vast improvement over the paper-training jackets previously used to manage a Sailor's record of qualifications. This system of tracking qualifications allows each Sailor's record to easily be updated and follow them throughout their career.

4. High Year Tenure

High year tenure is a term that describes a condition in which a Sailor has failed to advance to the next paygrade above their current one during a specified allotted timeline. Details of the policy are listed in the Military Personnel Manual (MILPERSMAN) 1160–120 (Department of the Navy [DoN], 2018b).

> The high year tenure (HYT) policy is a vital and effective force management tool utilized to properly size and shape the Active Component (AC) and the Reserve Component (RC). HYT management is regulated by

> establishing standardized length- of-service (LOS) gates by pay grade balanced with a waiver process to enable the Navy to retain the right number of members. As one of the Navy's key enlisted force management tools, the HYT policy facilitates viable career paths and advancement opportunities across all pay grades and LOS spectrums. The standardized HYT gates allow members greater flexibility to stay Navy within a stabilized force. Through this measured process, the Navy enhances quality throughout the continuum of service. (DoN, 2018b)

Updates and revisions occur as necessary to align this management method to the realities of current manning levels. The most recent change to the HYT thresholds associated with each paygrade was May 18, 2018 (Military Personnel Message 1160–120, 2018). The current policy for maximum years of service for active component (AC) and full-time support (FTS) personnel is as follows in Table 1.

Table 1. Maximum Years of Service for AC and FTS. Source: DoN (2018b).

AC and FTS		
Grade	**Years**	**Remarks**
E-1 to E-2	4	May not reenlist or extend unless HYT is granted by BUPERS-32.
E-3	6	E-3 who "Passed Not Advanced" a Navy-wide advancement exam prior to March 2012 (cycle 215) retain HYT gate of 8 years.
E-4	10	
E-5	16	
E-6	22	Nuclear trained Sailors at the E-6 pay grade desiring to extend their active service past 20 years must have their request approved by OPNAV (N133).
E-7	24	
E-8	26	
E-9	30	
CMDCM	32	CMDCM/FORCM (8CMC/8CSC) selected for a 1- or 2-star flag/general officer support assignment to complete a 3-year tour of duty.
CMDCM	35	CMDCM/FORCM/FLTCM (8CMC/8CSC) selected for a 3- or 4-star flag/general officer support assignment to complete a 3-year tour of duty.
MCPON	38	CMDCM/FORCM/FLTCM (8CMC/8CSC) selected to serve as the master chief petty officer of the Navy (MCPON) to complete a 4-year tour of duty.

There are many reasons high year tenure is important which this project will not fully address. We address it here to describe one way in which the Navy loses experienced

Sailors. Unless a waiver is approved personnel can only re-enlist or extend their current tour up to their HYT date for their current paygrade, and this has additional stipulations based on rate. Various force shaping methods have been tried in recent decades and are often counter balanced by a selective re-enlistment bonus (SRB) or other means of retaining Sailors once the force shaping has cut too deep into specific rates.

B. AVIATION MAINTAINER EXPERIENCE

1. Background

Naval Air Forces has struggled to measure manning in a manner able to quantify the experience and qualifications. In 2014 the NAE Total Force Cross Functional Team (CFT) implemented the Aviation Maintainer Experience (AMEX) metric as an answer to this dilemma (M. Pittner, PowerPoint Slides, 21 April 2019). In 2016, after an initial run and early support from leadership, the NAE pushed to invest more in the system and improve its summary of experience levels in a squadron in the hopes of becoming a predictor of readiness (M. Pittner, PowerPoint Slides, 21 April 2019). This tool allowed TYCOMs to quickly identify and act upon manning and experience shortfalls across the flight line. Today's AMEX gives squadrons quantitative data that reflect the qualifications and experience of an enlisted maintainer. This data is summarized in the squadron's overall AMEX score. This score has helped TYCOMs and Air Wings better manage their squadrons by giving them a tool that reflects the readiness of their manning. It has also allowed leadership to identify weaker squadrons on the flight line and move qualified maintainers from other squadrons to the ones in need in order to better balance overall manning (M. Pittner, PowerPoint Slides, 21 April 2019).

Why is there a need for AMEX when the Navy has the FIT/FILL system to identify manning shortages? While the FIT/FILL system does identify manning shortages, the system does not consider type model series (TMS) experience and qualifications (FIT/ FILL, PowerPoint slides, n.d.). FILL measures a unit's personnel currently onboard to its funded billets and FIT measures the specific "FIT" of Sailors in a unit considering pay band, NEC, and rating match (FIT/FILL, PowerPoint slides, n.d.). While FIT/FILL is a good metric of a squadron's number of personnel onboard that it is funded too, it does not

consider experience or qualifications which can be a good indicator to a units' readiness overall. Also, the numbers of FIT/Fill are reliant on billets being funded, which is usually lower than the Navy Manpower Analysis Centers (NAVMAC) manpower requirement documents for a squadron (FIT/FILL, PowerPoint slides, n.d.).

AMEX has become the answer for the NAE to better manage manning and consider the information FIT/FILL does not provide. AMEX is not meant to be a replacement for FIT/FILL methods, but instead is being used as a supplement by detailers, squadron AMOs, and leadership.

2. Definitions

a. DEMOT

DEMOT is the acronym used to encompass all the rates measured in AMEX (M. Pittner, PowerPoint Slides, 21 April 2019). Each letter in DEMOT represents the last letter in the maintainers rate; for example, the D in DEMOT refers to the D in AD of the abbreviation for an aviation machinist's mate. As previously mentioned in this chapter there are more jobs or rates in a typical squadron then the DEMOT rates, but AMEX only takes into consideration these rates because they are product rates considered critical to maintenance in a squadron and can be measured through qualifications (M. Pittner, PowerPoint Slides, 21 April 2019). See the Appendix for a full description of the rates that comprise DEMOT.

b. *Deployment and Hard Deck*

Deployment and hard deck are terms used to describe the lower and higher thresholds that have been determined by SMEs and TYCOM Maintenance Officers (M. Pittner, PowerPoint Slides, 21 April 2019).

> The **Deployment** threshold is applicable in the Basic through Sustainment phases (does not apply to Maintenance phase, as illustrated by the dashed segment of the Deployment line). An AMEX score above the Deployment threshold implies a unit can accomplish all assigned tasking/missions without external maintenance assistance (e.g., TAD assist, sister squadron assistance). (M. Pittner, PowerPoint Slides, 21 April 2019)

Hard Deck—An AMEX score below the Hard Deck implies a unit is no longer capable of safely conducting two-shift maintenance and is designed to trigger immediate Wing/CNAP/CNAL N13 manning actions (e.g., divert, TAD assist) to ensure aircrew Air Combat Training Continuum (ACTC) readiness development is not interrupted. (M. Pittner, PowerPoint Slides, 21 April 2019)

These readiness thresholds give AMEX users an easy-to-use chart when comparing fleet squadrons to each other and it allows for an easy identification of a squadron's readiness to deploy or operate. Figure 4 is a snapshot of this chart from the database.

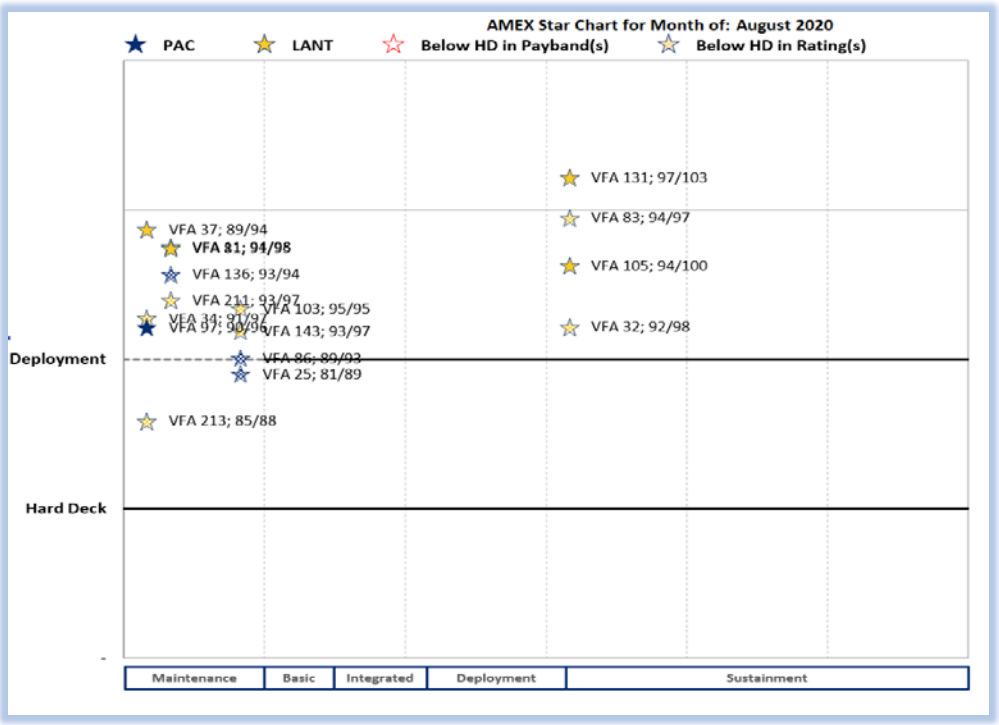


Figure 4. AMEX Star Chart for Month of August 2020. Source: AMEX Database (2020).

3. Source Data

Naval aviation is rich with data and typically new measurement systems require new ways of collecting data and places another burden on the fleet. However, AMEX is different in that it uses existing data already being collected and combines it to create a picture of manning readiness. AMEX takes the input from ASM and uses this information

in its calculation of an individual Sailor's AMEX score (M. Pittner, PowerPoint Slides, 21 April 2019). AMEX also uses the Navy Enlisted System (NES) as an input for information on a Sailor's past duty stations and is used in the calculation of points for TMS experience (M. Pittner, PowerPoint Slides, 21 April 2019).

4. Method

"AMEX is derived from NAVMAC requirements and SME-determined qual need" (FIT/FILL PowerPoint slides, p. 12), to populate the specific manning requirements for squadrons. AMEX only takes into consideration the paygrades of E4 thru E8 and DEMOT rates in its calculation (M. Pittner, PowerPoint Slides, 21 April 2019).

A squadron's finalized AMEX score is derived from the total sum of individual Sailor AMEX scores (M. Pittner, PowerPoint Slides, 21 April 2019), and each individual Sailor is given an AMEX score based on an architecture of logic trees, as shown in Figure 5. These logic trees are broken down by paygrade and TMS. Combined information about a Sailor's qualifications and their TMS experience produce an individual score. Production qualifications, for example Collateral Duty Inspector (CDI) and Safe for Flight (SFF), give the Sailor points per the logic tree. The logic tree does not take into consideration Sailor NECs. Experience points are derived from NES history for an individual Sailor for any relevant past TMS commands. Those scores from the logic tree are then weighted differently depending on paygrade according to the AMEX outcomes and points matrix. This matrix gives the final points outcome for a maintainer. (For an example of a points matrix, see Figure 9.)

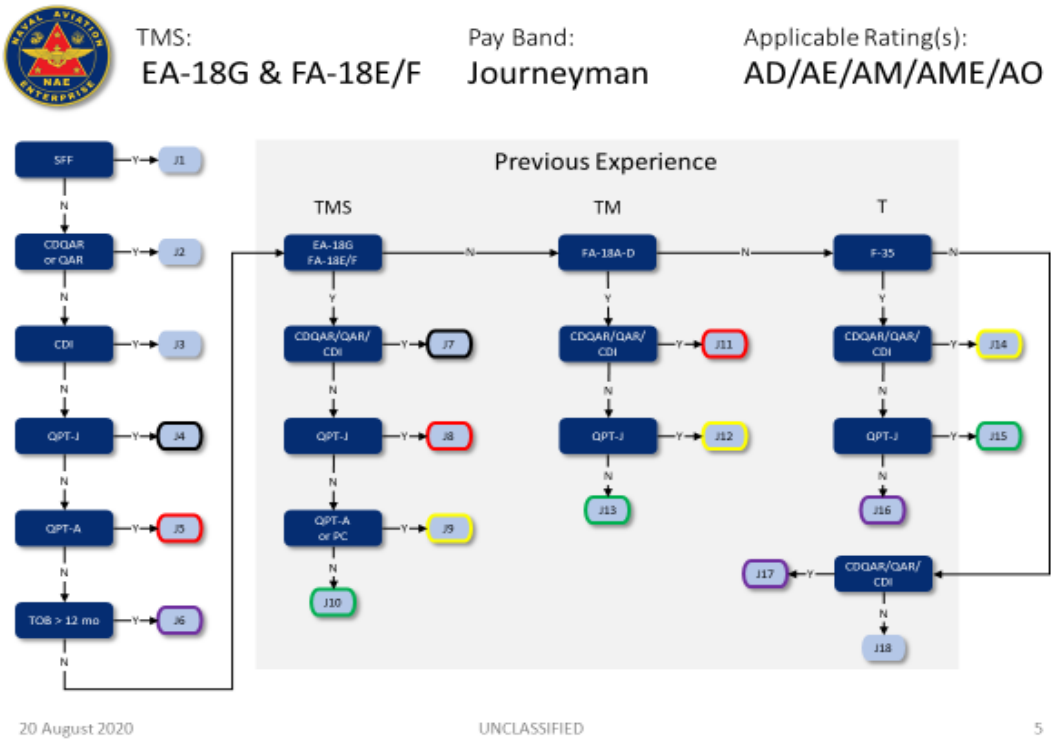


Figure 5. AMEX Score Logic Tree. Source: M. Pittner, PowerPoint Slides (2019).

After individual Sailor's scores are calculated those scores are funneled into their home units; the sum of the individual scores equals the total AMEX points for an entire squadron (M. Pittner, PowerPoint Slides, 21 April 2019). Let us look at a simplified example to explain: If VFA-105 has a total of 100 DEMOT Sailors, each with an individual AMEX score of 5 points, then the unit points total for VFA-105 would be 500. Figure 6 shows an example of unit points total.

SQMD Deployment AMEX Points

	AD	AE	AM	AME	AO	AT	Total
Apprentice	15	8	6	3	14	9	55
Journeyman	60	41	86	46	62	49	344
Supervisor	15	24	18	6	15	21	99
Total	90	73	110	55	91	79	**498**

SQMD Hard Deck AMEX Points

AD	AE	AM	AME	AO	AT	Total
12	4	5	1	8	5	35
54	38	77	40	49	41	299
13	19	16	4	13	16	81
79	61	98	45	70	62	**415**

Figure 6. Unit Points Total Example. Source (NAE, 2018, p. 3)

The AMEX unit point totals are one way to see if squadrons meet the thresholds of Deployment or Hard Deck. However, unit totals are not perfectly suited for comparing Super Hornet squadrons to each other since not every F/A-18 squadron is manned equally due to there being two variants, the F/A-18E and F/A-18F, and the number of jets assigned can vary as well. NAVMAC takes this into account when developing the manning footprint. However, this creates a problem when comparing total Unit Points from squadron to squadron. To solve this issue the program developers, take the unit points total of a squadron and convert them into AMEX scores (M. Pittner, PowerPoint Slides, 21 April 2019). See Figure 7 for the calculation method, Figure 8 for an example of point totals converted to an AMEX score, and Figure 9 for an example of a points matrix. These AMEX scores are what will be used in the regression models for this MBA project. "To conduct an "apples-to-apples" AMEX comparison (chart plots) between dissimilar TMS, and dissimilar units within a TMS (e.g., 10 PMAA FA-18E and 12 PMAA FA-18E), the AMEX points are normalized to calculate an AMEX score" (M. Pittner, PowerPoint Slides, 21 April 2019).

$$AMEX\ Score\ = 1 - \frac{(SQMD\ Deployment\ AMEX\ Points - AMEX\ Points)}{(SQMD\ Deployment\ AMEX\ Points - SQMD\ Hard\ Deck\ AMEX\ Points)}$$

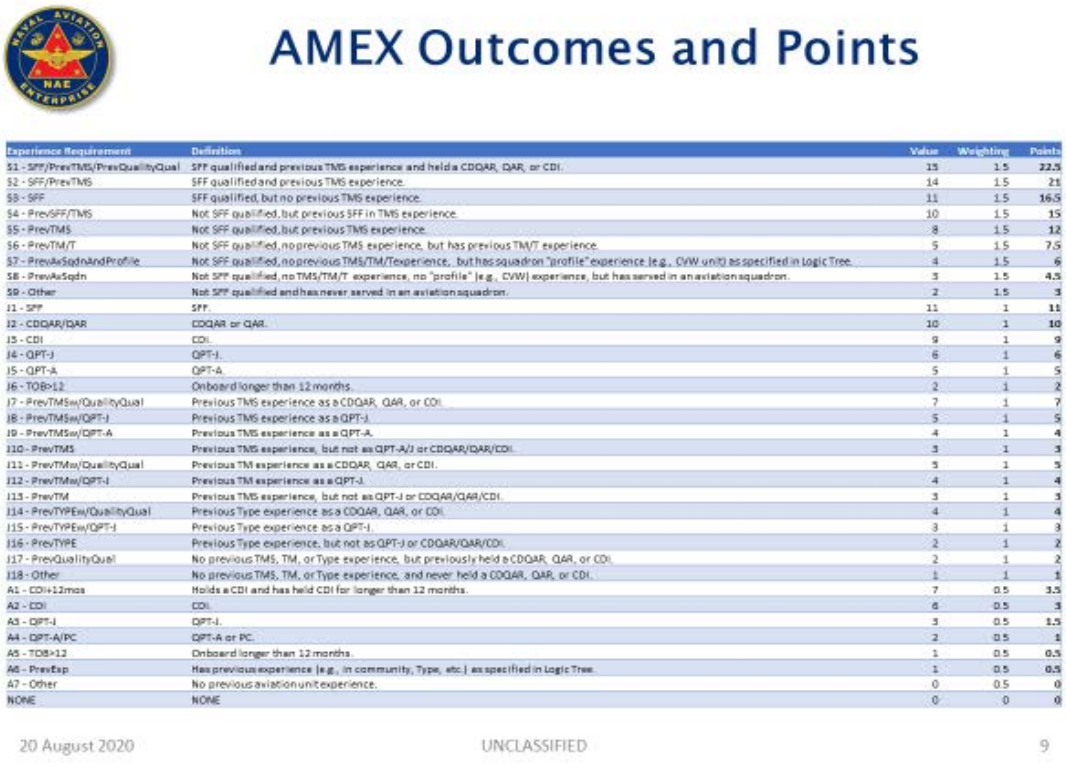
Figure 7. AMEX Score Formula. Source. M. Pittner, PowerPoint Slides (2019).

AMEX Unit Points/Scores Summary for: March 2020

1 Deployment Threshold
0 Hard Deck Threshold

Phase	CVW	Unit	UnitPoints	DeployPoints	HardDeckPoints	AMEX Score
	⊟CVW 11	⊞VFA 31	741	716	564	1.17
		⊞VFA 87	674	652	512	1.16
	CVW 11 Total		**1,415**	**1,367**	**1,075**	**1.16**
Deployment Total			**6,794**	**6,232**	**4,916**	**1.43**
			10,631	**9,713**	**7,665**	**1.45**

Figure 8. AMEX Unit Points/Scores Summary for March 2020. Source: AMEX Data (2020).



AMEX Outcomes and Points

Experience Requirement	Definition	Value	Weighting	Points
S1 - SFF/PrevTMS/PrevQualityQual	SFF qualified and previous TMS experience and held a CDQAR, QAR, or CDI.	15	1.5	22.5
S2 - SFF/PrevTMS	SFF qualified and previous TMS experience.	14	1.5	21
S3 - SFF	SFF qualified, but no previous TMS experience.	11	1.5	16.5
S4 - PrevSFF/TMS	Not SFF qualified, but previous SFF in TMS experience.	10	1.5	15
S5 - PrevTMS	Not SFF qualified, but previous TMS experience.	8	1.5	12
S6 - PrevTM/T	Not SFF qualified, no previous TMS experience, but has previous TM/T experience.	5	1.5	7.5
S7 - PrevAsSqdnAndProfile	Not SFF qualified, no previous TMS/TM/Texperience, but has squadron "profile" experience (e.g., CVW unit) as specified in Logic Tree.	4	1.5	6
S8 - PrevAsSqdn	Not SFF qualified, no TMS/TM/T experience, no "profile" (e.g., CVW) experience, but has served in an aviation squadron.	3	1.5	4.5
S9 - Other	Not SFF qualified and has never served in an aviation squadron.	2	1.5	3
I1 - SFF	SFF.	11	1	11
I2 - CDQAR/QAR	CDQAR or QAR.	10	1	10
I3 - CDI	CDI.	9	1	9
I4 - QPT-I	QPT-I.	6	1	6
I5 - QPT-A	QPT-A.	5	1	5
I6 - TOB>12	Onboard longer than 12 months.	2	1	2
I7 - PrevTMSw/QualityQual	Previous TMS experience as a CDQAR, QAR, or CDI.	7	1	7
I8 - PrevTMSw/QPT-I	Previous TMS experience as a QPT-I.	5	1	5
I9 - PrevTMSw/QPT-A	Previous TMS experience as a QPT-A.	4	1	4
I10 - PrevTMS	Previous TMS experience, but not as QPT-A/I or CDQAR/QAR/CDI.	3	1	3
I11 - PrevTMw/QualityQual	Previous TM experience as a CDQAR, QAR, or CDI.	5	1	5
I12 - PrevTMw/QPT-I	Previous TM experience as a QPT-I.	4	1	4
I13 - PrevTM	Previous TMS experience, but not as QPT-I or CDQAR/QAR/CDI.	3	1	3
I14 - PrevTYPEw/QualityQual	Previous Type experience as a CDQAR, QAR, or CDI.	4	1	4
I15 - PrevTYPEw/QPT-I	Previous Type experience as a QPT-I.	3	1	3
I16 - PrevTYPE	Previous Type experience, but not as QPT-I or CDQAR/QAR/CDI.	2	1	2
I17 - PrevQualityQual	No previous TMS, TM, or Type experience, but previously held a CDQAR, QAR, or CDI.	2	1	2
I18 - Other	No previous TMS, TM, or Type experience, and never held a CDQAR, QAR, or CDI.	1	1	1
A1 - CDI+12mos	Holds a CDI and has held CDI for longer than 12 months.	7	0.5	3.5
A2 - CDI	CDI.	6	0.5	3
A3 - QPT-I	QPT-I.	3	0.5	1.5
A4 - QPT-A/PC	QPT-A or PC.	2	0.5	1
A5 - TOB>12	Onboard longer than 12 months.	1	0.5	0.5
A6 - PrevExp	Has previous experience (e.g., in community, Type, etc.) as specified in Logic Tree.	1	0.5	0.5
A7 - Other	No previous aviation unit experience.	0	0.5	0
NONE	NONE	0	0	0

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Figure 9. AMEX Outcomes and Points. Source: M. Pittner, PowerPoint Slides (2019).

C. EXPERIENCE

1. Mishaps

One way in which the effect of experience has been measured and studied is in terms of how it relates to mishaps. In November of 2018, the Center for Naval Analyses (CNA) published a study that investigated the impact that experience levels of E5 supervisors, in terms of years of service (YOS), would have on the likelihood of a mishap occurring (Nguyen, 2018). The study was done at the request of CNAF and focused exclusively on data from Strike Fighter Squadrons (VFA) since in addition to having the largest number of aircraft in the NAE, they also account for over 40 percent of the mishaps in their data (Nguyen, 2018). The data they analyzed in Figure 10 was from 2011 to 2016 and, "found a correlation (with a 95 percent confidence level) between mishap probability and supervisor fit percentage and E5 years of service by using a logistic regression model." (Nguyen, 2018)

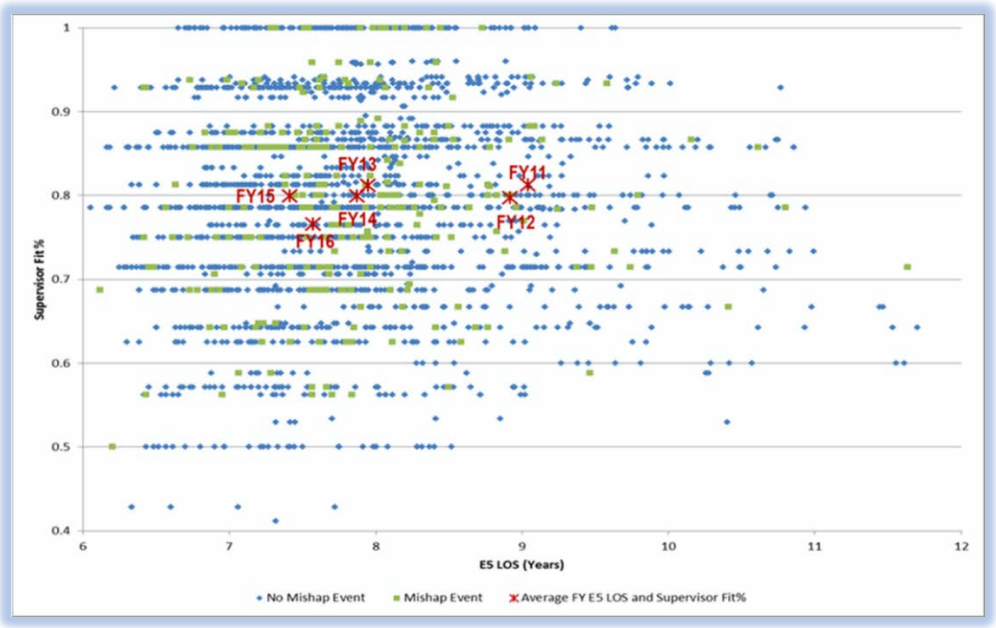


Figure 10. Scatter Plot of Raw FY11- FY16 Mishap Data.
Source: Nguyen (2018).

The data show that from FY 2011 to FY 2016 the average YOS of an E5 supervisor had decreased by 1.5 percent and that the supervisor FIT percentage had decreased by 4 percent, as shown in Figure 11 (Nguyen, 2018). They determined that these covariates were non-linear and used a multivariable logistic regression model to better fit the information available (Nguyen, 2018).

FY	Average E5 LOS (Years)	Average Supervisor Fit %
FY11	9.04	81%
FY12	8.91	80%
FY13	7.94	81%
FY14	7.87	80%
FY15	7.41	80%
FY16	7.57	77%

Figure 11. FY11–FY16 Averages: E5 LOS and Supervisor Fit %.
Source: Nguyen (2018).

Figure 12 illustrates two mishap probability curves. The red curve shows supervisor fit at 75 percent while the green curve shows supervisor fit at 86 percent (Nguyen, 2018). In both curves the supervisor fit is shown against the E5 LOS and all the information is taken directly from the data depicted in the Figure 10 scatter plot (Nguyen, 2018). These two levels reflect the CNAF goal of 86 percent and the year-to-date average of 75 percent for FY 2017 (Nguyen, 2018).

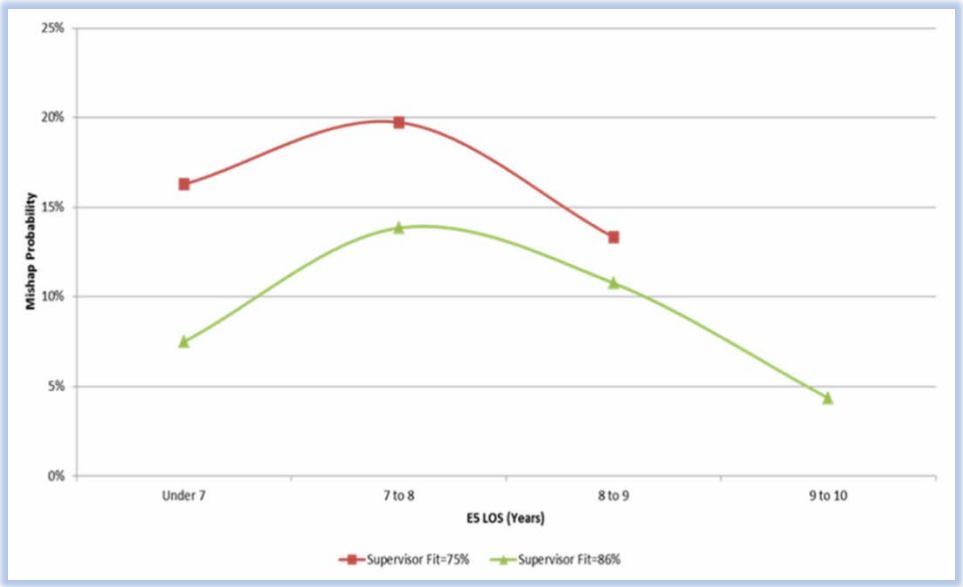


Figure 12. Mishap Probability of Supervisor Fit at 75% and 86%. Source: Nguyen (2018).

The CNA study was unable to conclusively determine mishap probability on the basis of the experience and FIT of an E5 supervisor, however, they did find sufficient statistical correlations for them to make recommendations toward an average YOS and supervisor fit that CNAF could use to decrease mishap rates (Nguyen, 2018).

> Due to the complexity of the problem, we can neither understand fully nor derive the impact on mishap probability of the changes in the covariates. However, because of the statistically significant correlations between mishap probability and the covariates mentioned above, we can rely on historical data and recommend that CNAF strive for around 9 YOS for E5s and 80 percent of supervisor fit to reduce the mishap rate to 10 mishaps per 100,000 flight hours, matching the lower FY 2012 mishap rate. (Nguyen, 2018)

The CNA study concluded by making a series of recommendations, which included looking at the number of executed flight hours in future studies since they found that low flying activity impacts mishap probability (Nguyen, 2018). This study was concluded in November of 2018 and aligns with a statement made in June of the same year regarding mishaps. Rear Admiral Roy Kelly, commander of Naval Air Forces Atlantic, said in his opening statement before the House Armed Services readiness subcommittee, "We have determined from the Naval Safety Center and the Center for Naval Analyses damage sustained during maintenance is the leading cause of these mishaps, with the analysis pointing towards maintainers that are less experienced" (Eckstein, 2018b).

At that time in question concerns over the Navy's Class C mishap rate were due to an unexplained increase see Figure 13. Class C mishaps involve $50,000 to $500,000 in damages to aircraft or a nonfatal injury and had doubled from 2012 to 2018 (Eckstein, 2018b).

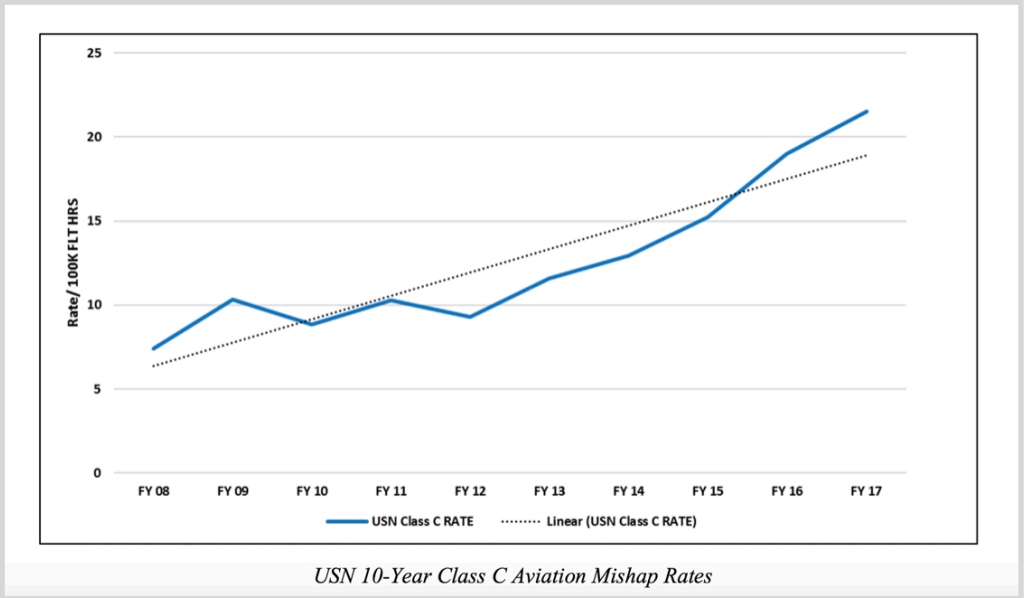


Figure 13. USN 10-Year Class C Mishap Rates.
Source: Eckstein (2018a).

Rear Admiral Mark Leavitt told USNI News that the largest number of mishaps are occurring in naval aviation's largest communities in terms of density of squadrons and aircraft (Eckstein, 2018a).

> The bulk of these mishaps occur during maintenance evolutions and involve aircraft striking or being struck by other objects. Multiple discrete studies from numerous sources point to inexperience in the E-5 and E-6 maintainer rates as a significant contributing factor. (Eckstein, 2018a)

Despite his comment on the linkage between inexperienced maintainers and ground mishaps Rear Admiral Leavitt stated before the House Armed Services tactical air and land forces subcommittee that there is no correlation between flight hours and the rate of mishaps (Eckstein, 2018a); however, his statement was made in June of 2018 prior to the release of the CNA study in November of 2018. We find the discussion of flight hours intriguing since increased flying results in increased maintenance actions, which in turn result in more opportunities for maintainers to put their skills to work and gain experience.

In his 2018 comments to USNI News Rear Admiral Kelly mentioned the AMEX program, which was still relatively new at the time, and plays a key role in our research.

> The difference in the enlisted experience that we have in E-5s, E-6s, is about a year and a half short of what it used to be 10 years ago. So, to give you an example, if you had an E-6 that 10 years ago in the same timeframe in their career had 11-and-a-half years of experience, today they would have 10 years. So that difference. Also, the fact that we have people that are being assigned, they have helicopter backgrounds and they're going to F-18 squadrons or vice versa. We're now clarifying specific qualifications at the Bureau of Naval Personnel through this AMEX program. (Eckstein, 2018b)

As alluded to by Rear Admiral Kelly in the quote above, maintenance actions require the individual performing them to hold specific qualifications prior to executing those tasks.

In order to attain a new maintenance qualification a Sailor will perform a series of specific tasks associated with the qualification they are pursing in repetition under the guidance of a supervisor who is already qualified to perform that same task. A signature by a qualified individual is required to prove that each of the assigned tasks were properly carried out. It should be noted here that a Sailor pursing a new qualification will have

practiced the tasks under the guidance of a qualified mentor to gain proficiency before requesting the required signature that asserts their competence in the task. ASM provides an electronic record that tracks the progress toward attaining the qualification and uses that record to prove that the Sailor pursuing the qualification has attained the degree of knowledge and proficiency required to perform the task on their own. Once they have performed all the required tasks and received the associated signatures, the Maintenance Officer (MO) will signed off on the approval of their qualification. This new qualification will stay on record in ASM and be added to NALCOMIS (OOMA) as required.

This short description of how a Sailor attains maintenance qualifications is meant to further explain the link between flight hours and qualifications. A squadron that is steadily executing flight hours will have more opportunities for maintenance qualifications to be both attained and utilized. Routinely performing maintenance actions ensures a Sailor's qualifications are being exercised. Long periods of not utilizing a qualification can lead to atrophy in both knowledge and acumen in the performance of the associated task to varying degrees for each individual Sailor. The Navy acknowledges this fact by requiring periodic assessments of all qualifications to ensure proficiency standards for retaining the qualification. Sailors who underperform risk losing their qualification until they can prove their ability to a qualified evaluator.

2. Learning Curve

Although learning curves are not the focus of the research in this project, the authors want to briefly address them since they affect the analysis of methods that leverage experience as a resource. Therefore, the rate at which individuals gain proficiency at performing any given task must be included in this discussion of how experience of a maintenance rated Sailor impacts readiness. The words *learning* and *experience* are occasionally used interchangeably and shift when the description changes from a micro to a macro concept with learning describing the micro and experience describing the macro (Martin, n.d.). "The term experience curve relates to the total production, or the total output of any function such as manufacturing, marketing, or distribution" (Martin, n.d.) Regardless of which concept is being described, the fundamental concept of the learning

or experience curve is that the required amount of time to complete a task will decrease as a worker's experience increases (Martin, n.d.).

> The basic concept is that the time, or cost, of performing a task (e.g., producing a unit of output) decreases at a constant rate as cumulative output doubles. Learning curves are useful for preparing cost estimates, bidding on special orders, setting labor standards, scheduling labor requirements, evaluating labor performance, and setting incentive wage rates. (Martin, n.d.)

There are two models for measuring learning curves. The first was developed by T. P. Wright in 1936 and the second was developed by a team of researchers at Stanford University and is known as the Crawford Model (Martin, n.d.). Wright's cumulative average model function is described as $Y = aX^b$, shown in Figure 14, where Y is the cumulative average time (or cost) per unit, X is the cumulative number of units produced, a is the time (or cost) required to produce the first unit, and b is the slope of the function (Martin, n.d.).

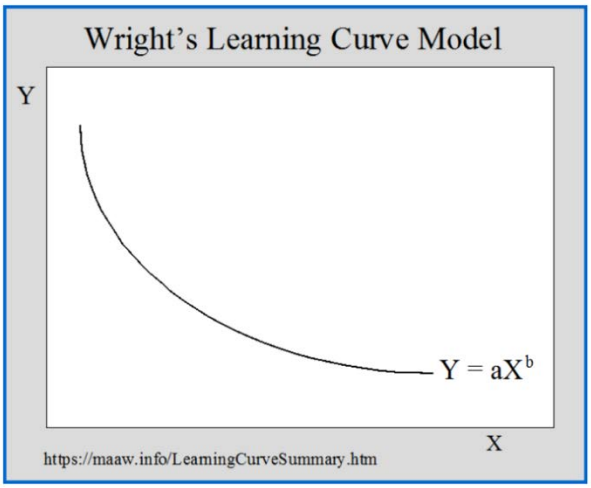
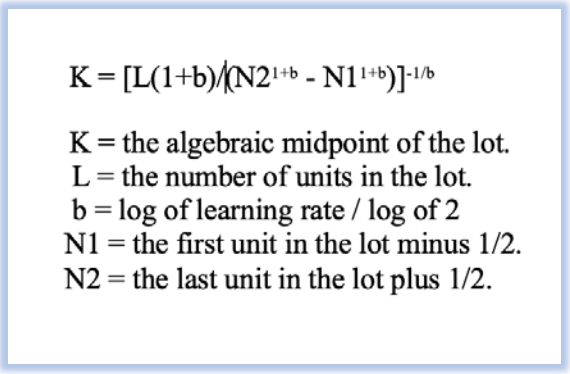


Figure 14. Wright's Learning Curve Model.
Source: Martin (n.d.)

Crawford's incremental unit time (or cost) model is described as $Y = aK^b$ where Y is the incremental unit time (or cost) of the lot midpoint and K is the algebraic midpoint of a specific production batch or lot (Martin, n.d.). However, since the relationships are non-

linear the following equation in Figure 15 must be solved to find the algebraic midpoint (Martin, n.d.).



Once Y_c is determined for the algebraic midpoint of a lot, then the cost of the entire lot is found by multiplying Y_c by the number of units in the lot as indicated above.

Figure 15. Algebraic Midpoint Equation in Crawford's Model. Source: Martin (n.d.)

In short, the main difference between the two models is the use of incremental unit time in Crawford's model and cumulative average time in Wright's model, although Crawford's model is more commonly used (Martin, n.d.).

Learning curve impact will be further explored in Chapter IV, but as a segue into the next topic consider that learning curve models assume a specific task or series of tasks are being performed by the same worker or type of worker with a similar skillset. In order to optimize the benefit of the learning curve it follows that the task being performed is associated with the job description of the worker performing it. To do otherwise and inject a worker that is unfamiliar with the task being performed would reset the learning curve at its beginning state. So, in a broad sense we are describing the rating system the Navy uses to specialize its Sailors in order to maximize the return on investment it has placed in each one through various levels of training and years of performing job-specific tasks on a particular aircraft.

D. 5G

Research in this project is not about the newest technology coming to market; it is about experience and how best to leverage that experience. However, the speed of technology change is an important factor as to why experience of a maintainer may be so critical when looking for ways to stay ahead of this technology curve. The Navy must set up its talent to best embrace and deploy the newest technology. Tech has been changing at a rapid pace, and a mere two decades ago many could not imagine a world where unlimited information would be available in an affordable device carried in a pocket. The Navy is keenly aware of the buzz words of artificial intelligence, machine learning, and autonomous vehicles, and it is hungry to adopt and embrace these technologies. However, there are many questions as to how best to go about it, and they are the same ones many businesses and industries are facing. The trapped value or return on investment (ROI) of investing in technology is very difficult to realize and therefore makes it difficult to know how to properly invest in it (Abbosh & Downes, 2019).

One emerging technology stands out from the rest, one that is destined to be an enabler of all other technologies coming online. Fifth generation technology for mobile networks, better known as 5G, is poised to change the way the world does business. Banking, manufacturing, healthcare, military, and many more are expected to be so transformed by 5G that it is hard to predict what that transformation will look like; and s for the military this includes how war will look two decades from now. 5G will not make the world is live in virtual reality, but will instead change the way people are able to exchange data, speeding up the process significantly (Brown, 2020).

The predecessors of 5G can be linked to much of the technology taken for granted today. There have been several innovations to include mobile phone web browsing, multimedia, and navigation since 3G was widely available in the early 2000s (White House, 2019). Phones today have the capability of computers and information moves at a breakneck pace. Innovations are changing the way Americans conduct life every day from asking “Alexa” for a morning news up-date to having all the answers to the world at one’s fingertips with a simple Google search. There has also been a financial effect; in 2016 4G added $100 billion to U.S. GDP according to the White House (White House, 2019, p ii).

5G is expected to accelerate technology even further than its predecessors with the expectation that the network will be 100 times faster than current 4G networks (Brown, 2020). The higher speeds and lower latency are expected to significantly reduce the lag time between when a device asks for information and when it receives it, which creates a higher connectivity between people and means more people can be working on the most pressing and complicated issues (Brown, 2020). This increased speed is expected to change things in artificial intelligence, virtual reality, drone technology, autonomous vehicles, or what is becoming known as the "internet of things" (Brown, 2020).

The National Security Strategy (NSS) stresses the importance of technology being adapted within the military calling for agencies to, "work with industry to experiment, prototype, and rapidly field new capabilities that can be easily upgraded as new technologies come online" (White House, 2017, p. 29). Considered critical by President Trump, he laid out the importance of being world leaders in emerging technology such as artificial intelligence and autonomous vehicles by making it a national priority to build 5G infrastructure to increase national competitiveness (White House, 2017, pp. 19, 20).

In a Naval Postgraduate School interview of two Cyber Command leaders, General Keith Alexander and Vice Admiral Jan Tighe discussed the effects 5G will have on the military and advised students on actions that should be taken by the services. Both stressed the impact 5G will have on the speed of new capabilities coming to market and emphasized the importance of a strong partnership between industry and military in addressing emerging technologies, to embrace the benefits they can have on capabilities to outpace competition (Alexander & Tighe, 2020).

> While disruptive technologies can always lead to company collapse for those not agile enough to recognize and act upon the disruptive effects, I view these advances as all upside. As far as military applications go, we must position ourselves to take advantage of 5G in all the applications that commercial industries forge, but also in ways that we are uniquely equipped to implement, such as greater precision and lethality in warfighting. (Alexander & Tighe, 2020, paragraph 2)

Embracing the newest technology is important to the military, but rarely taught in the naval education system. This may be due to what is considered by some as an old and

inadequate education system that rarely changes at the pace of technology. The Education for Seapower (E4S) final report observed that the need to have an education system that is more adaptive to emerging technologies (Department of the Navy [DoN], 2018a).

> Necessary teachings of advanced technology in strategic education curricula are haphazard and randomly pursued, made more difficult by the Department's decentralized approach to education, as well as the lack of adequate time and means provided in naval careers (both enlisted and officer) to attain such education. (DoN, 2018a, p. 6)

The E4S points out the importance of training our best and brightest officers and enlisted with the latest innovations and addresses emerging technology as a national security threat (DoN, 2018a). Furthermore, it emphasizes how ill prepared the Navy and Marine Core are in getting ready to adapt the newest technology, see Figure 16 for an example of what a future squadron may look like.

> Changes in society, technology, and our security environment are occurring at a rapid pace. Failure to adapt all aspects of how we prepare our naval leaders for the future creates unacceptable risk for American citizens, who have long relied on the Naval Services to be at the intellectual forefront of national security concerns. The Naval Services must learn from the history of war, as it teaches that when the equilibrium between the character (technology and tactics) and nature (human role) of war is upset, strategic surprise is often the result. (DoN, 2018a, p. 11)

Figure 16. Boeing's Loyal Wingman Prototype UAV.
Source: Reim (2020).

Relating this back to the research of this project, the question is what will these technology changes bring to the NAE? The answer is nobody knows entirely, but some of those changes are already here and others are swiftly approaching. At the end of 2019, Boeing demonstrated the capability of an EA-18G Growler to fly while autonomously controlling two other Growlers in mid-air, demonstrating what the future may look like for a squadron. A future where a pilot in one jet can be in control of several drones at the same time completely changes the definition of air superiority (Reim, 2020). This technology is not far off from being an everyday reality and opens the door to several other advances the Navy will need to adopt to outpace competition.

> All of the warfare communities of both the Navy and Marine Corps face the technological challenges of integrating unmanned and autonomous systems into their daily operations. The requirement to understand and employ cybernetics, artificial intelligence, unmanned systems, and robotics will only accelerate. (DoN, 2018a, p. 32)

Knowing that emerging technologies sped up by 5G will create a disruptive environment, the president is addressing it as a national security concern, and military leaders are emphasizing the importance of adapting and learning this new technology; the question becomes not just how but who should focus their attention toward answering the inevitable problems the NAE will have in merging new technology into our current capabilities?

E. SUMMARY

In summary, the Navy puts enlisted Sailors through extensive training to prepare them in the specific field required by their rating. Multiple levels of formal schools exist to provide training appropriate to the level and aptitude needed by squadrons from individual Sailors at different points in their careers. This training is an investment that is expected to return higher performance from the Sailors who go through it. Initial formal training serves as the cornerstone on which they build experience gained by OJT in the fleet while subsequent schools expand on key areas necessary for the Sailor's development within their rating. The rates that currently serve in Naval Aviation are not static but exist as a reflection of the necessary specializations that are currently employed with today's

technology. Changes to ratings are made as deliberate responses to needs of the Navy and often take years to fully implement. This concept will be further discussed in Chapter IV.

AMEX is the current database in the NAE that best measures the experience and qualifications of an aviation maintainer. This system allows leadership to see how prepared for operations a squadron may be through measuring the experience and qualifications of Sailors, unlike FIT/FILL which shows manning numbers in relation to funded billets.

Experience matters. Naval aviation has had its fair share of issues with mishaps, and experience of supervisors may be a contributing factor to this according to the CNA. Also, proven through the learning curve model we see that to be proficient at something an individual must repeat a process over and over (experience); when they reach the peak of the model only then can they be considered experienced and proficient.

Lastly, emerging technologies are here and are already changing how war is fought. 5G will accelerate this technology change significantly over the years to come due to the lower latency times and the ease of transferring large amounts of data. To better prepare for this inevitable technology change the NAE must educate its personnel in order to keep pace with the changes or risk falling behind in the great power competition.

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III. ANALYSIS

A. AMEX SCORE AND RBA COMPARISON

1. Data Collection and Preparation

Thanks to support from CNAF and NATEC, we were able to get data from August 2018 through August 2020 on monthly AMEX scores and daily AMSRR reports. We chose to analyze this data using linear regression models since it would allow us to determine the statistical relationship that exists between our variables (Balakrishnan et al., 2013).

Our primary research question is, to what degree does the experience level of an aviation maintainer affect the readiness of an F/A-18 Super Hornet squadron? This question inherently makes squadron readiness the dependent variable and aviation maintenance experience the independent variable. We took squadron readiness from the AMSRR data and aviation maintenance experience from the AMEX data. We decided to start with a univariate regression model of the two variables to determine the basic level of their relationship and move forward with multiple regression models afterward.

In order to perform analysis, we first had to prepare the data so that the end of month summary for AMEX would align with the material condition of all aircraft reported daily in AMSRR. For the purposes of our analysis we are using the term Ready Basic Aircraft (RBA) to also include the condition Full Mission Capable (FMC). This was done so we could make the conditions binary, up, or down, and since the term Ready for Tasking (RFT) was not used in the CNAF data set. We then took the daily AMSRR reports and used them to make an average RBA for each month. Additionally, the AMEX score is reported on the first of the month as a summary of the previous month's numbers. As such we shifted the AMEX data back by one month in order to use it as a reflection of the month it was summarizing. For example, September 1st AMEX scores were compared to the entire month of August's readiness numbers. This gave us two variables that described the monthly behavior of the squadron, the first in terms of average monthly experience of the maintainers in each squadron, and the second in terms of an average monthly readiness at each squadron.

2. Single Regression

We use Microsoft Excel's data analysis add-in to perform a univariate regression on the two columns of data. This applies the formula $\hat{Y}_{it} = b_0 + b_1 X_{it}$, where $\hat{Y}_{it}$ is the expected value of RBA rate for squadron *i* during month *t*. The Y-intercept is b_0, and b_1 is the slope of the line (Balakrishnan et al., 2013). The dependent variable was the monthly RBA average of every VFA squadron from August 2018 to August 2020, and the independent variable is the monthly AMEX score of those same squadrons. The result of this is Model 1, seen in Table 2 below.

3. Multiple Regression

In our first version of our multiple regression model, referred to as Model 2 in Table 2, we added the average number of aircraft per squadron as a second independent variable, or covariate. The average number of aircraft, termed "number_aircraft" in the tables below, took into account when aircraft are in an Out of Reporting (OOR) status or are being swapped between squadrons, both of which make the number of aircraft reported that month fluctuate. This number helped us account for when an aircraft goes through a planned maintenance interval (PMI) or other occasion when the maintenance personnel assigned to the squadron do not work on that aircraft for a temporary amount of time (Commander, Naval Air Forces, 2017). By including a second independent variable we were able to determine how much of the correlation between RBA and AMEX from the single regression model could be attributed to the new variable. The process of using Excel's data analysis add-in was the same with the exception of adding the additional variable. The formula inside the function changed to $\hat{Y}_{it} = b_0 + b_1 X_{1it} + b_2 X_{2it}$, where X_{1it} is the AMEX score for squadron *i* during month *t*, and X_{2it} is the number of aircraft for squadron *i* during month *t*.

To briefly recap, we first started with the entire prepared dataset of AMEX and RBA data of all geographic areas and operational phases. We fit a univariate model, Model 1, and then add the number of aircraft as a covariate, Model 2, as shown in Table 2 and displayed in Figure 17.

Table 2. Models 1 and 2

Model	1	2
R Square	0.138	0.173
Observations	852	852
Parameter estimates		
Intercept	0.631***	0.662***
AMEX	0.090***	0.091***
number_aircraft		-0.003***

Pr (>|t|) Significance Codes:

*** = 0 to 0.001 / ** = 0.001 to 0.01 / * = 0.01 to 0.05 / . = 0.05 to 0.1 / blank = 0.1 to 1

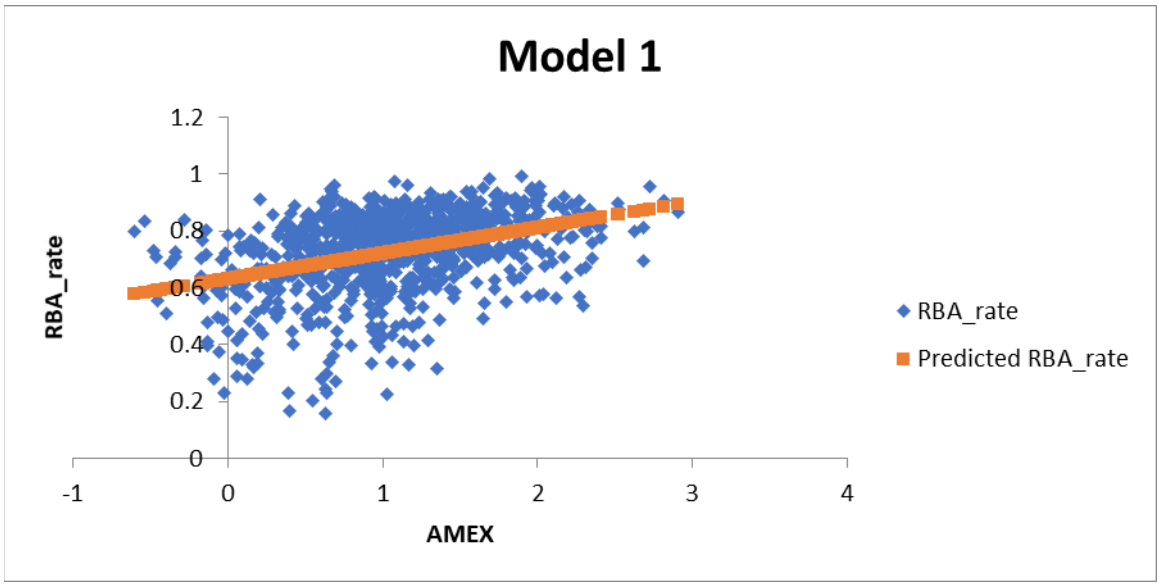

Figure 17. Model 1 Scatterplot. Source: Director, Force Readiness Analytics Group, email to author, June, 26, 2020.

Our initial take-away was that commonality existed among the models. We then fit modes with squadron fixed effects and random effects to test the validity of our models and found that the results were not qualitatively different. The models consistently showed

a correlation. Every unit increase in AMEX score was associated with an increase in RBA rate of 8 or 9 percentage points. We display the results for the pooled models for simplicity.

Further scrutiny of the data led us to reconsider which squadrons to include. We had been supplied AMEX and AMSRR for every VFA squadron, which meant that data included Fleet Replacement Squadrons (FRS) and squadrons based in Japan.

An FRS is vastly larger in size than a typical fleet squadron, both in assigned aircraft and manpower, and its mission is different as well. Unlike a fleet squadron, which focuses on planning and executing tactical-level missions in support of theater-specific operations, an FRS focuses on training newly qualified pilots in how to fly the specific aircraft they've been selected to fly in the fleet. Additionally, an FRS can be called upon as necessary to replace an aircraft in a fleet squadron due to unforeseen complications that cannot be repaired at the operational level of maintenance, for example, if an aircraft severely catches on fire. The FRS swaps one of their RBA aircraft for the fleet aircraft with the problem in order to facilitate the fleet squadron's operations. Lastly, unlike a fleet squadron, the manpower at an FRS is not solely made up of Sailors but also includes civilian contractors. All these factors convolute the analysis, so we removed the FRS squadrons from the data set.

Fleet squadrons based in Japan do not go through a typical five-stage cycle that includes Basic, Deployment, Sustainment, Maintenance, and Integration. They do a truncated version that only includes a repeated cycle of Deployment and Sustainment. Additionally, since they are Forward Deployed Naval Forces (FDNF) they have a higher Force Activity Designator (FAD) than squadrons in the continental United States (CONUS), which means it has a higher priority for personnel manning levels and logistics support. As with the FRS, we decided that these factors made squadrons outside the continental United States (OCONUS) different enough from the majority that we also removed their information from the data set.

As a result, we created Models 3 and 4, seen below in Table 3, which are essentially the same as Models 1 and 2, respectively, with the exception of having the FRS and OCONUS squadrons removed. When we ran Models 3 and 4, the coefficient on AMEX

was consistently around 9 to 10 percentage points, which is similar to where it was previously but with a slight increase.

In our second version of the multiple regression model, referred to as Model 5 in Table 3 and displayed in Figure 18, we built upon the first version by adding operational phases as additional covariates and once again tested them with fixed effects and random effects. The goal for running this model was to test the coefficient of AMEX on the RBA rate by seeing how much could be attributed to covariates that dictate much of the way a squadron operates. A squadron will go through all the operational phases given enough time, but the variance is such that the impact is somewhere between a time varying factor and a fixed factor. The deployment phase was associated with the highest (positive) effects on RBA and maintenance phase the lowest. This finding aligns with general expectations and assumptions about how the different operational phases are prioritized in terms of manning and supply, every unit increase in a squadron's AMEX score results in an increase in RBA rate by roughly 5 percentage points which is statistically relevant.

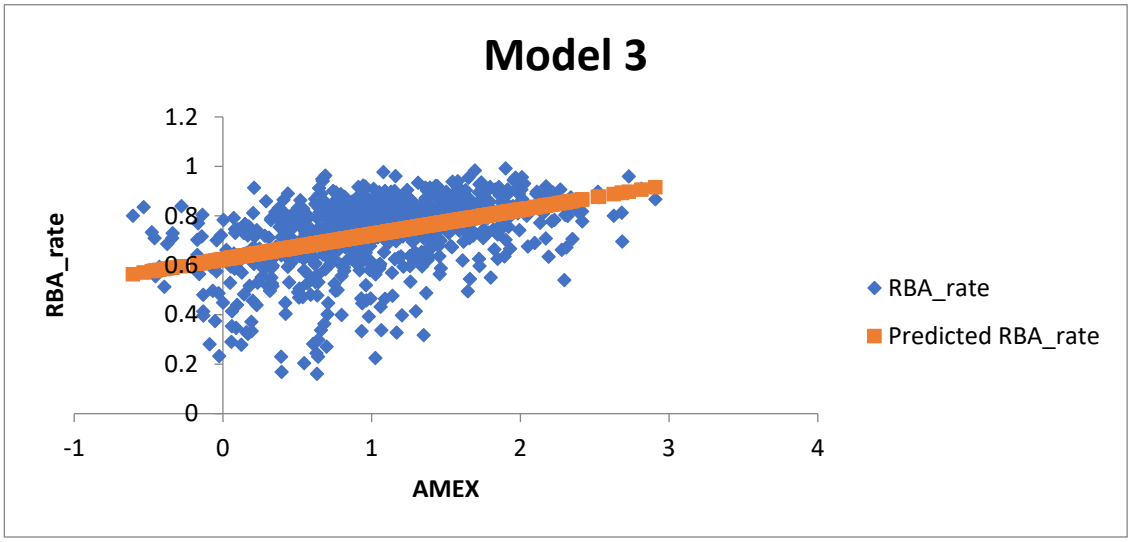

Figure 18. Model 3 Scatterplot Source: Director, Force Readiness Analytics Group, email to author, June, 26, 2020.

Table 3. Models 3, 4, and 5

Model	3	4	5
R Square	0.178	0.193	0.268
Observations	708	708	708
Parameter estimates			
Intercept	0.624***	0.530***	
AMEX	0.100***	0.099***	0.059***
number_aircraft		0.009***	-0.002
Basic			0.673***
Deployed			0.7515***
Integrated			0.706***
Maintenance			0.628***
Sustain			0.733***

Pr (>|t|) Significance Codes:

*** = 0 to 0.001 / ** = 0.001 to 0.01 / * = 0.01 to 0.05 / . = 0.05 to 0.1 / blank = 0.1 to 1

B. CONCLUSION

We were able to use causal forecasting models to quantitatively show that there is a highly significant correlation between the experience of aviation maintainers and squadron readiness rates and the results answer our primary research question. Yes, the experience of aviation maintainers is relevant to Super Hornet readiness; an increase in experience corelates to an increase in readiness. Our findings were tested for fixed and random effects and the answers were not quantitatively different.

IV. LEVERAGING EXPERIENCE

A. SUBJECT MATTER EXPERTS

What follows is a description of methods that leverage the experience and knowledge of aviation personnel from different angles. The first is the Navy's use of civilian subject matter experts. The second is a series of historical examples that highlight the impact of changing technology to aviation, and examples of specialization from the Navy and other branches of the DoD. The third is a review of practices taken from industry, which includes both the airlines and leaders in technology. This chapter culminates in a recommendation for the NAE.

1. Naval Air Technical Data and Engineering Service Command

Naval Air Technical Data and Engineering Service Command (NATEC) can trace its origin back to 1942, shortly after Pearl Harbor, to the Airborne Coordinating Group (ACG) (Commander, Navy Region Southwest, n.d.). The increase in production of electronic equipment caused a gap in available skilled workforce, and the ACG was designed to respond to that need. The name has changed several times throughout the years and ultimately became NATEC in 1998 when the Naval Aviation Engineering Service Unit (NAESU) merged with Naval Air Technical Services Facility (NATSAF) and relocated to San Diego, California (Commander, Navy Region Southwest, n.d.). The mission has expanded from the original intent during the days of the ACG.

> In addition to providing naval engineering and technical assistance, its mission now includes providing technical support services in preparation, publication, and distribution to activities operating, maintaining, or manufacturing aircraft, guided missile target drones, and related equipment. (Commander, Navy Region Southwest, n.d.).

To achieve this mission NATEC employs Naval Engineering Technical Support (NETS) from U.S. civil service and military personnel, and contractor engineering technical services (CETS) from non-DoD personnel. These experienced individuals work in teams to respond to requirements and requests from the fleet for assistance and training (Commander, Navy Region Southwest, n.d.). NATEC support is available for units at both

the organizational and intermediate levels to assist in the areas of avionics, airframes, electrical, power plants, and support equipment (J. Risser, PowerPoint Slides, April 21, 2020). They provide training in the following ways:

- On-the-job skill exchange
- Just-in-time training
- On-station troubleshooting
- Distance support
- Integrated weapons system reviews
- Formal courses: corrosion, paint/final finish, battery safety, aircraft confined space (ACSP)
- Support equipment and engine test cell qualifiers

This training is not intended to be a substitute for formal training as described in Chapter II., but as a method for ensuring personnel are trained to the point of self-sufficiency as described in the learning curve (J. Risser, PowerPoint Slides, April 21 2020).

a. Engineering and Technical Services (ETS)

Requests for NATEC support are via requests for engineering technical services (ETS). NATEC is responsible for managing, controlling, and coordinating these requests, however, priorities for them are determined by the type commander (TYCOM), Fleet Air Forward (COMFAIRFWD), type wing (TYPEWING), U.S. Marine Forces Command/ Pacific/Reserve (COMMARFOR/COMMARFORES), Marine aircraft wing (MAW), and/ or the Commander, Fleet Readiness Center (COMFRC) (Commander, Naval Air Forces, 2018).

> ETS should be requested to help develop self-sufficiency prior to deployment and minimize the use of ETS while deployed or during work-up periods. (Commander Naval Air Forces, [CNAF] 2018)

Among the numerous responsibilities of a squadron's Maintenance Officer (MO) is the job of ensuring the proper utilization of NATEC personnel. As specified in the Naval Aviation Maintenance Program (NAMP), "Use the on-site COMNAVAIRSYSCOM or NATEC field service representatives (as required) to effect liaison and support for the NAMP" (CNAF, 2017).

The method used in requesting a tech assist is dependent on the location of the requested help. If services are available locally then requests must be made via NATEC's website ETS Local Assist Request (ELAR). A request for assistance where local service is not available, or if it is made away from the unit's home base, requests are submitted via Naval Message (CNAF, 2018). The requirements become even more stringent for shipboard assistance requests.

> All training must be completed prior to an extended deployment so ETS support is not required after departure. Squadrons should coordinate ETS requirements with their MAW/air combat element (ACE)/carrier air wing (CVW) MO. MAW/ACE/CVW MOs will consolidate all squadron requests and pass them to the ship's Aircraft Intermediate Maintenance Department (AIMD) officer. AIMD and the detachment MOs must gather ETS requirements as soon as feasible but should be submitted at least 30 days prior to at-sea periods. (CNAF, 2018)

The need for NATEC services has grown over the years for F/A-18 Super Hornets (see Figure 20), and today these experts are more vital than ever to the success of the community. Reasons for the increased NATEC manhours in the super hornet community were not researched in this project; however, it is significant to note and compare Figure 19 which shows NATEC manhours for all type model series (TMS) in the NAE to Figure 20. Figure 19 does not show the same increasing manhour trend as the super hornets in Figure 20. This growth of NATEC support in the hornet community is an indicator of a possible increase in future need for NATEC services within the F/A-18 community.

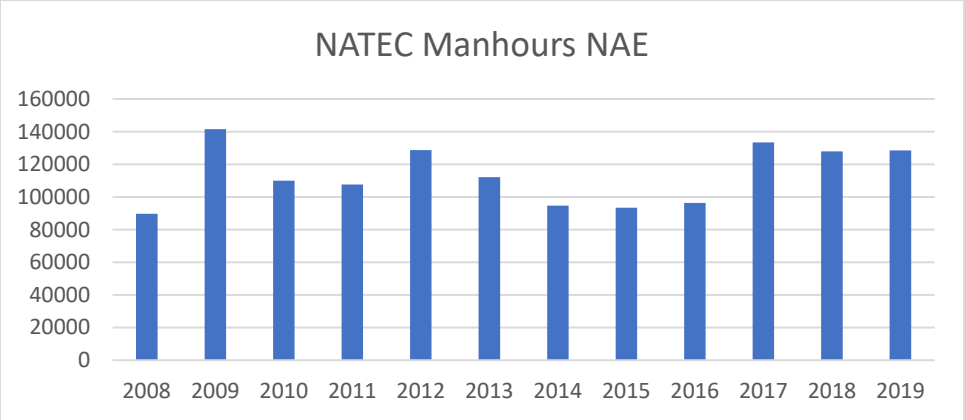

Figure 19. NATEC Manhours for all NAE from 2008 to 2019. Source: Adapted from NATEC (2020).

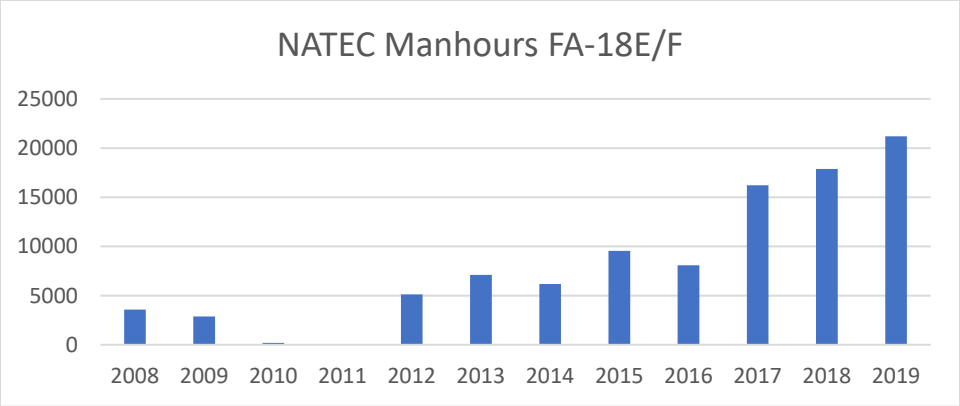

Figure 20. NATEC Manhours for F/A-18E/F from 2008 to 2019. Source: Adapted from NATEC (2020).

2. Specialization in the DoD

The Navy's system of identifying the jobs Sailors perform is tied to the name of their rating. Each rate has its own insignia and descriptive title, which may include a unique subspecialty. For example, an Aviation Boatswain's Mate, Handling (ABH) is a subset of the Aviation Boatswain's Mate rating. The ratings are used to distinguish the various professions among U.S. Navy enlisted personnel and have a long history of changing to adapt to the times. For instance, in the 1920s the Navy used the rating Airship Rigger, shown in Figure 21, since at the time the technology was deemed to have a long future in Naval Aviation. This rating was "responsible for maintaining the infrastructure of the dirigible and repaired any tears in the gas cells or skin." (U.S. Naval Institute Staff, 2014) Dirigibles is a general term for any lighter-than-air craft, such as blimps, zeppelins, and rigid airships, that is steerable and powered, which separates them from the category of balloons.

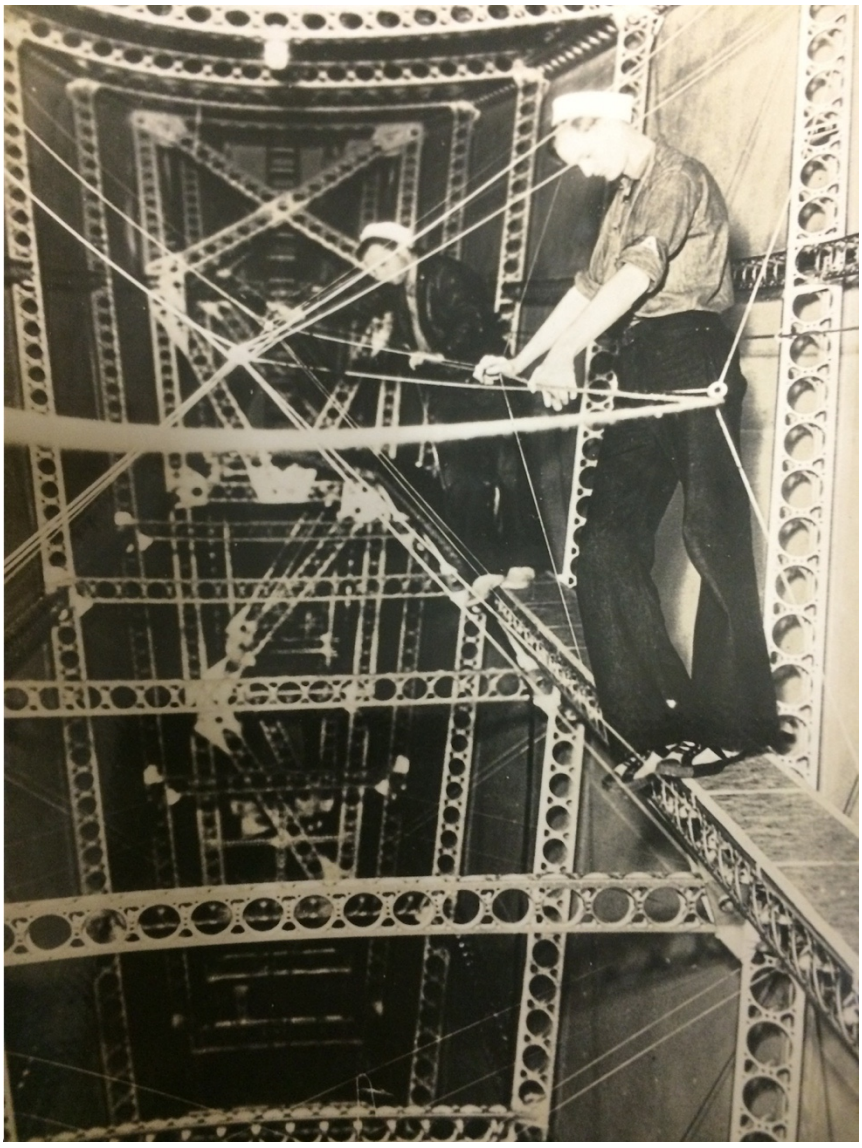

Figure 21. Airship Riggers aboard USS *Macon* in 1933. Source: U.S. Naval Institute Staff (2014).

However, in 1948, once the Navy decided the future of dirigibles was not in alignment with where naval aviation was heading, this rating was disestablished, and the airship program was abandoned entirely in 1961. This is merely one example of a change made to a rating that was in response to a technology shift; there are many others such as the Aviation Carpenter's Mate, whose importance is illustrated in Figure 22, was a predecessor of the modern AM rate, and the International Business Machine (IBM)

Operator, a forerunner of the Information Systems Technician (IT) (U.S. Naval Institute Staff, 2014).

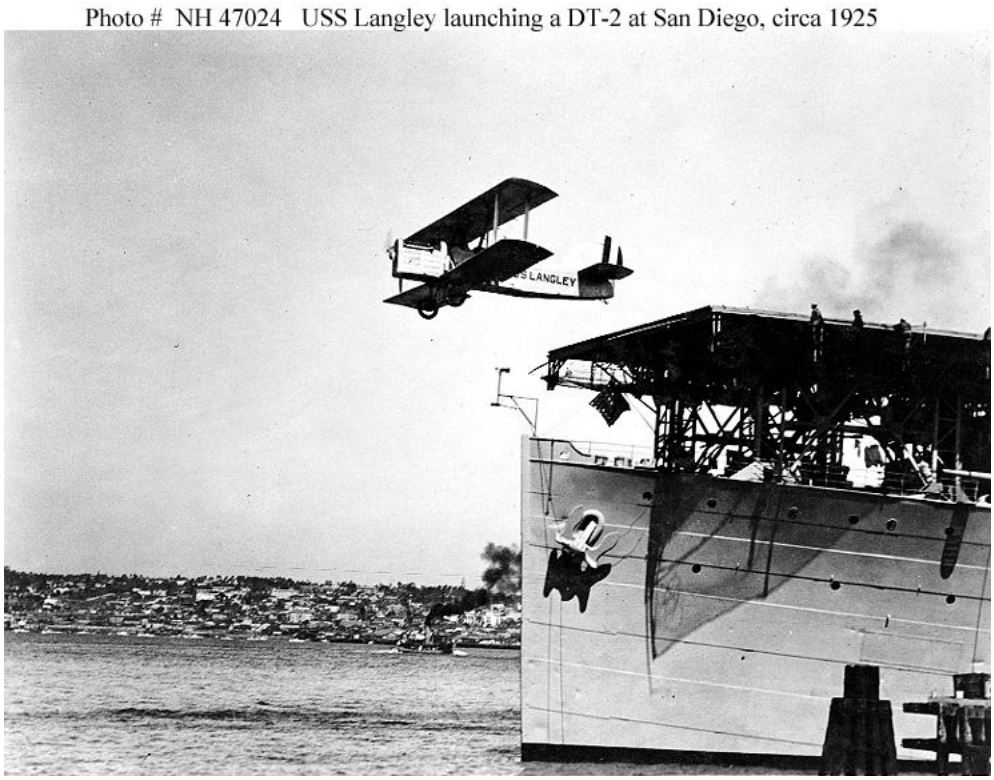

Figure 22. USS *Langley* Launching a Mostly Wooden DT-2.
Source: U.S. Naval Institute Staff (2014).

Changes to Navy ratings are not only made in response to major changes in technology. They can also occur due to manpower restructuring, which can necessitate consolidation from many rates into one, as was the case with Storekeepers (SK), Aviation Storekeepers (AK), and Postal Clerks (PC) merging into a singular Logistics Specialist (LS) rating in 2003 (NAVADMIN 023/00). Restructuring may also occur as a combination of consolidation and specialization as it did in 2005 in the enlisted Aircrew (AW) community. NAVADMIN 092/05 changed and consolidated what had previously been a community divided into two categories. Prior to this change the term Aircrew, when referencing enlisted Sailors, could be for the Aviation Warfare Systems Operators who were primarily concerned with operations and tactics during flights as well as maintenance

rated Sailors who primarily serviced and repaired the aircraft but also served as aircrew during flights as well.

> THE CONSOLIDATION OF ALL ENLISTED HELICOPTER AIRCREW INTO THE AVIATION WARFARE SYSTEMS OPERATOR RATING HAS BEEN APPROVED. AS AN ELEMENT OF NAVY'S HUMAN CAPITAL STRATEGY, THIS CONSOLIDATION MARKS A MAJOR MILESTONE IN THE EVOLUTION OF NAVAL ROTARY AVIATION AND HELICOPTER AIRCREW CULTURE. IT PREPARES THE INVENTORY AND BILLET BASE FOR THE CONVERSION TO THE MH-60R AND MH-60S MULTI-MISSION PLATFORMS AND IMPROVES THE EFFICIENCY OF THE AIRCREW ACCESSION AND TRAINING PIPELINE. (NAVADMIN 092/05)

The NAVADMIN's acknowledgement of both training efficiency and new helicopters replacing older models is particularly interesting as we find ourselves in the beginning stages of transitioning from F/A-18s to F-35s. It is also interesting that the phased approach which began in 2005 was completed in 2008 with the release of NAVADMIN 152/08.

> THIS CONSOLIDATION MARKS A MAJOR MILESTONE IN THE EVOLUTION OF NAVAL AVIATION AND AIRCREW CULTURE. ESTABLISHING A SINGLE AIRCREW GENERAL RATING WILL ELIMINATE INEFFICIENCIES IN THE TRAINING PIPELINE, IMPROVE ADVANCEMENT QUALITY, PROVIDE MORE CONTROL OF THE NAC ENLISTED FORCE AND IMPROVE PROFESSIONAL DEVELOPMENT AND CAREER MANAGEMENT. (NAVADMIN 152/08)

The description of changes to rates was done in order to establish a baseline of historical precedence within the Navy. However, changes to military jobs to leverage or consolidate knowledge and experience through specialization is not unique to the Navy. The other branches have successfully leveraged the knowledge and experience of their workforce in a similar manner.

The Army goes as far as having a rank called "specialist" which has undergone many changes over the years. In 1920, the consolidation of 128 different rank insignias and titles into seven sparked the need to identify support soldiers with expertise in each field (Milzarski, 2018). The result was the "private/specialist." Although the nature of the role

continued to be that of an expert within a particular field, the rank expanded until between 1959 and 1968 a soldier could rise to the rank of E-9 as a specialist. However, just as previously described with the Navy, nothing is permanent with manpower. These years represent the apex of a specialist within the Army, and its rank structure began to decrease until 1985 when only one rank, the Spec/4, has remained since (Milzarski, 2018).

The Army, Navy, and Air Force have experimented with specialization of pilots to varying degrees. The Navy briefly included warrant officers as pilots (NAVADMIN 031/06; NAVADMIN 192/13) in a manner similar to the Army's use of flying warrants. The Army makes a clear distinction between its aviator groups, and warrant officers continue to be specialists in flying aircraft (Figure 23) while traditional line officers focus on administrative and leadership skills in addition to flying and are thereby more generalists at flying (Marshburn & Rollin, 2005).

Figure 23. Mississippi National Guard's First AH-64 Apache Pilot, WO1 Jessi McCormick. Source: Clarion Ledger (2016).

However, despite this known difference between the two groups, a 2005 study by Marshburn and Rollin concluded that "commissioned officer and warrant officer aviators

do not significantly differ in their overall motivational orientations, their preferences for future flight experience, or their expectations of future flight experience" (Marshburn and Rollin, 2005, paragraph 1). The study utilized a multivariate analysis of variance (MANOVA) and hierarchical linear regression models on a dataset of responses from 116 Army commissioned officers and warrant officers participating in the Initial Entry Rotary Wing (IERW) aviator course at Fort Rucker, AL.

> Based on their dual motivational orientations, both commissioned officer and warrant officer aviators will thrive in work settings where both intrinsic and extrinsic motivators are available. Specifically, they will likely seek opportunities for competence, challenge, and enjoyment while focusing on income goals, promotion goals, and the potential for recognition for their efforts. (Marshburn and Rollin, 2005, paragraph 18)

The findings of this study conflict with the Air Force's results of an attempt at specialization for their pilots. Air Mobility Command briefly experimented with a flying-only program they called the Aviator Technical Track from 2018 to 2020 before canceling the program after only getting two applicants. The goal of the program was to help alleviate pilot shortages within the Air Force and is summarized in this quote from an Air Mobility Command spokeswoman, "The bottom line is, there just wasn't the appetite there for the program" (Losey, 2020, paragraph 3).

3. Industry

The methods of leveraging experience vary across different business sectors and the details of most industry career paths are closed source and not available for public consumption. However, we were able to find many successful business practices and philosophies that differ in approach to application of manpower from the NAE.

In answering the question of how to leverage the experience of manpower, one management expert stood out as the leader on this subject. Peter Drucker is considered by many to have written some of the most influential management philosophy followed by today's industry. Looking through the lens of leveraging experts, Mr. Drucker in his 1967 book, *The Effective Executive* wrote about a concept of the knowledge worker.

> Knowledge workers do not produce a "thing." They produce ideas, information, concepts. The knowledge worker, moreover, is usually a

> specialist. In fact, he can, as a rule, be effective only if he has learned to do one thing very well; that is, if he has specialized. (Drucker, 1967, p. 61)

This idea behind a knowledge worker is having someone who holds the capital, or the knowledge, of how to perform a task extremely well. It is important to note the difference between a knowledge worker and manual laborer. Manual labor is a task performed by a person at one specific location, for example a factory floor; this person is not mobile, and their results require the capital, or tools, of the factory to produce those results. On the other hand, the knowledge worker has the know-how in their mind; this knowledge is considered their capital they can apply physically with their hands. The key difference of the knowledge worker from the manual laborer is they are mobile and can move to any location to produce results (Drucker, 1999, p. 87). Drucker further refers to these individuals as technologists. Technologists can be many different occupations; some examples include surgeons, plumbers, and aviation maintainers. Technologists own their means of production; this means of production is the knowledge in their head. Drucker further explains that these technologists should be treated as assets (Drucker, 1999, pp. 87–89). He uses "asset "as meaning something that produces an outcome, for example an aviation maintainer uses their maintenance knowledge through their hands to produce the outcome of a fixed aircraft. While referring to a person as an asset may seem derogatory, Mr. Drucker was making the point that the companies should be investing in these individuals since they are the company's capital producers. Management should be placing value on their knowledge workers by investing in them through higher education or financial incentives (Drucker, 1999, pp. 84, 87–88, 94).

> an organization is effective only if it concentrates on one task. Diversification destroys the performance capacity of an organization. (Drucker, 1992, paragraph 35)

Commercial enterprises understand the importance of the knowledge worker; however, how to leverage this talent is not as clear-cut as the concept. A typical career path in industry may work something like this: an employee becomes good in their job to a point of specialization and performs above her peers. When this employee performs well her boss will want to reward her with more money or a promotion. If she keeps performing well at her job and becomes a superstar, she will eventually be promoted into the

management office. Management positions are the typical incentive companies use for their best employees (Benson et al., 2019). However, becoming a manager does not always leverage the knowledge worker and in some cases may take the worker out of the very specialization that made them successful in the first place.

The “Peter Principle” is a theory that addresses this typical career progression to management. This principle suggests that the skills that made a worker successful at one level do not dictate the success they will have at the next level. Bluntly stated, people are promoted to their highest level of incompetence (Peter, 1969, p. 173). This theory comes from Dr. Laurence Peter in his 1969 book *The Peter Principle*, and although there was no statistical data to validate his theory at the time it was published, it was believed by many to hold true. Not all people are meant to be managers, some are very good at performing specialized tasks and may benefit from staying in those specialized roles.

In 2019, professors Benson, Li, and Shue provide an empirical test of the Peter Principle. Their research demonstrates that people who worked in sales were either promoted to management based on their sales numbers or on being a good salesperson, and that specialization of being a good salesperson did not always translate into being a good manger (Benson et al., 2019).

Figure 24 Graph A shows a positive correlation between sales and the probability of being promoted to manager. Graph B shows a negative correlation between sales and manger value added (Benson et al., 2019, Figure II). The researchers concluded, “We estimate that the costs of promoting workers with lower managerial potential are high” (Benson et al., 2019, Abstract). Their research also identified that incentives, pay, and status to advance to a management position were high. Therefore, the best salespeople were incentivized to be a manager and were not as equally incentivized to stay and improve in their specializations as salespeople (Benson et al., 2019).

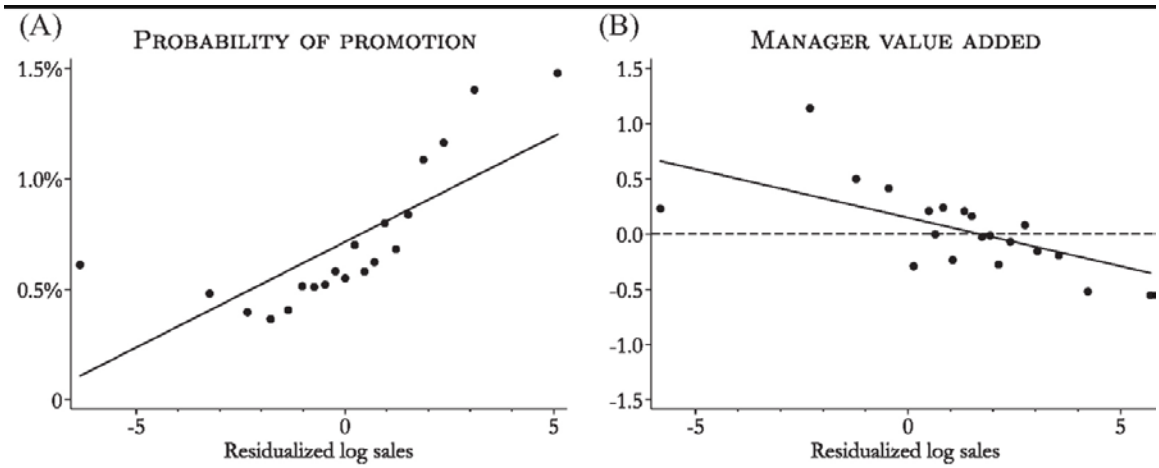

Figure 24. Probability of Promotion and Manager Value Added.
Source: Benson et al. (2019, Figure II).

We agree that it can reasonably be assumed if aviation maintainers were used in place of salespeople in Benson, Li, and Shue's research that the NAE would have similar results. The outcome would show that promoting the best technicians in squadrons does not always translate to a successful First-Class Petty Officer or Chief. Further dissecting this assumption, one could also say, that by promoting the best technician on the floor to management can further degrade a squadron by removing that superior technician from the maintenance floor.

In this project a specialist is defined as a worker that is judged on results from their own personal efforts whereas a manager is judged on their ability to move a team to complete a task. These are two inherently different functions. Industry, especially the technology sector, has acknowledged that specialists can produce some amazing end-results when they are allowed to work in their passions and are incentivized correctly. Further, industry has recognized the need for two career paths for individuals, a management track and a specialist's track see Figure 25 (Tiffan, 2009).

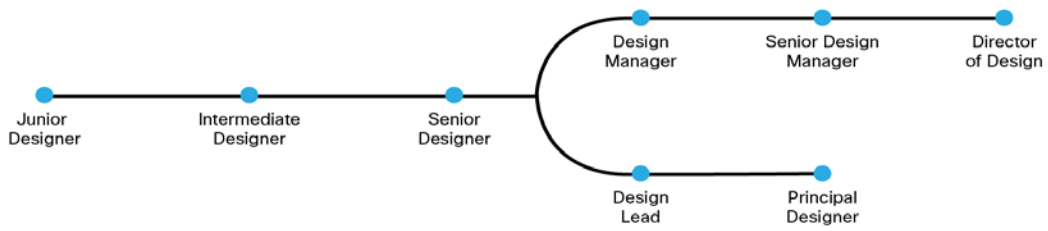

Figure 25. Example of a Two-Career Track. Source: Love (2018).

The difficulty in a two-career path model is that there is not one "right" way to map out the career of a specialists because the needs are so different from company to company. Figure 26 and Table 4 show some of this difference between two technology companies' approach on the subject. In addition, industry does not typically release career track information for public consumption for various reasons, the most obvious of which is wanting to have an edge over their competition. Therefore, it was difficult to find a concrete career road map for the NAE to follow; however, the concepts from this section can be used to justify looking at a change in the approach of an aviation maintainer's career path. Recognizing the importance of a specialist, or knowledge worker, and that not everyone needs to be a manger are important considerations when moving forward.

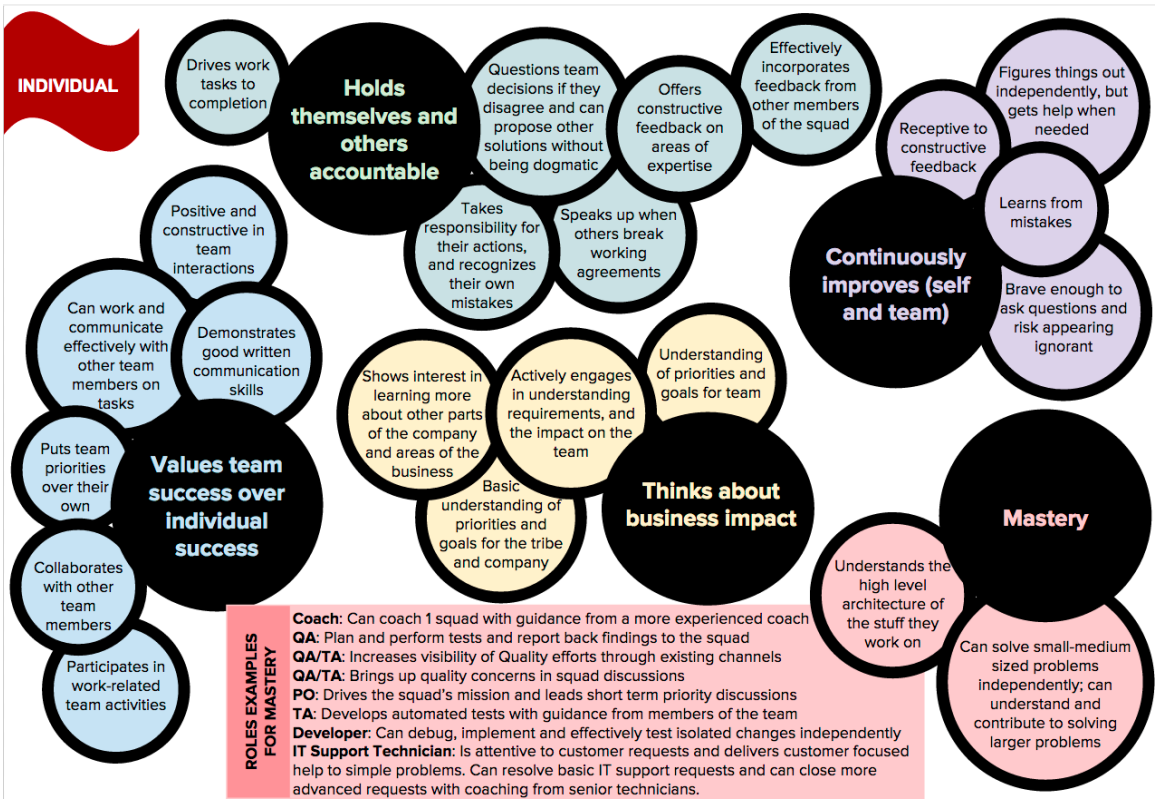

Figure 26. Spotify Career Steps Individual. Source: Goldsmith (2016).

Table 4. Buffer Careers for Makers. Source: Griffis (2019).

Level	Step 1	Step 2	Step 3	Step 4
Level 1 Entry	Ownership: No ownership, receives instructions on nearly all tasks Initiative: None expected, does work as directed	Ownership: Little ownership, receives instructions on most tasks Initiative: Little, expected, does work as directed	Ownership: Some ownership, receives instructions on some tasks Initiative: Beginning to take initiative through asking questions and learning	Ownership: Increasing ownership, can work independently on many tasks. Initiative: Increasing initiative through asking targeted questions
Level 2 Developing	Ownership: Works on individual tasks mostly independently Initiative: Begins deeper questioning of processes in order to improve them	Ownership: Works on individual tasks completely independently Initiative: Deep questioning of processes; begins to suggest improvements and tweaks	Ownership: Mastering ability to break down projects into tasks; co-owns projects with strong guidance Initiative: Takes initiative through iterating on existing processes	Ownership: Co-owns projects and owns pieces of larger projects with decreasing guidance Initiative: Takes initiative through iterating on existing processes
Level 3 Career	Ownership: Co-owns projects and owns pieces of larger projects in their area completely Initiative: Makes good decisions within their scope without seeking consensus	Ownership: Fully owns projects in their area with guidance Initiative: Makes good decisions within their scope without seeking consensus	Ownership: Fully owns projects in their area with decreasing guidance Initiative: Takes initiative through identifying gaps and opportunities	Ownership: Fully owns projects in their area completely Initiative: Takes initiative through identifying gaps and opportunities
Level 4 Advanced	Ownership: Works independently and owns projects entirely, both in their area and cross-functionally Initiative: Gives guidance and unblocks others; finds opportunities to mentor and grow teammates	Ownership: Sought out as a mentor and known as the "teammate of record" in their subject area Initiative: Gives guidance and unblocks others; finds opportunities to mentor and grow teammates	Ownership: Identifies and proactively tackles major challenges and problems in their area Initiative: Shows discretion in delegating tasks and focusing on higher level	Ownership: Leads adoption of new systems/tools/methodologies in their area Initiative: Shows discretion in delegating tasks and focusing on higher level
Level 5 Expert	Ownership: Conceives and own projects entirely, both in their area and cross-functionally. Regularly scopes and stages work into well-defined milestones Initiative: Reduces the complexity of projects/services/processes in order to get more done with less work	Ownership: Demonstrates knowledge of industry trends; researches and leads adoption of new approaches in their area Initiative: Reduces the complexity of projects/services/processes in order to get more done with less work	Ownership: Involved in setting direction at area level Initiative: Takes initiative to identify and solve important problems, often coordinating cross-functionally	Ownership: Involved in setting direction at area level Initiative: Takes initiative to identify and solve important problems, often coordinating cross-functionally
Level 6 Principal	Ownership: Drives projects on which multiple teams depend Initiative: Routinely and consistently pushes multiple teams within the company forward.	Ownership: As subject matter expert, plays a key role in developing overall company strategy Initiative: Drives the conversation about their area's direction, drives team-wide consensus to adopt direction	Ownership: Decisions have a direct impact on the long-term success of Buffer Initiative: Identifies major strategic opportunities to allow Buffer to grow as a business	Ownership: Leads the company in developing direction in major areas Initiative: Identifies and acts on major strategic opportunities to allow Buffer to grow as a business

a. Google: The Individual Contributor

A specialist is identified by different names depending on the business sector. The technology industry uses the terms individual contributors and makers; manufacturing-based businesses uses principle engineers; and the medical and financial industries refer to them as practitioners. However, a business may refer to a specialist the philosophy is the same; it is the idea of the knowledge worker as someone who uses their experience and knowledge via their hands to produce results.

Google is well known for facilitating a culture of innovation and is an excellent example of a company that celebrates their specialist or as they call them, individual contributors. Two legendary employees who have stamped their names on the company

are Jeff Dean and Sanjay Ghemawat. They are both Google Senior Fellows, the top tier engineer within the organization, and are responsible for some of the most innovative creations at the company, both are considered individual contributors (Somers, 2018). It is no secret that Google facilitates a unique work environment for its employees to leverage their creative ideas to drive results. The specifics of the individual contributor career track are somewhat secretive, but the company has figured out a way to capture and invigorate what an individual mind can bring to the table by allowing employees to work within their passion in a creative work environment that emphasizes collaboration. (Stewart, 2013) Mr. Dean and Mr. Ghemawat are examples of success stories that occur when trying to emulate the idea of specialization. Both men have been at Google for around 20 years running small teams that work on some of the company's most pressing issues, like artificial intelligence and software systems (Dean, n.d.; Ghemawat, n.d.).

These excellent examples show that Google has figured out how to leverage specialization in their employees and make the utmost of creative minds. The company's culture has created one of the most profitable companies in the U.S. Google's parent company, Alphabet, reported a little over 46 billion in revenue for the fourth quarter in 2019 (Elias, 2020). The results prove that Google is doing something right in how they leverage their employees' skills, and it gives the NAE an example of how they may consider using individual contribution when solving Naval Aviation's most pressing issues.

While tech companies provide great examples of how to leverage talent, they also have an abundance of resources to pay for that talent and have different goals than the NAE, therefore it may not be 100 percent practical to incorporate their concepts when it comes to aviation maintenance. Fortunately creating specialist roles to leverage experience in companies is not a new phenomenon left only to Silicon Valley.

b. American Airlines: Technical Crew Chief

One interest area that was sought out for replication purposes was the airline industry, which share the same goal with the NAE of flying safe aircraft efficiently. Different airline representatives were contacted during research of this project, and all

mentioned having specialists to support operations. One that stood out from the rest was American Airlines, who for the most part uses aviation technicians in the same way as the NAE. One example is American Airlines' Crew Chiefs, who perform very similar roles as Navy Chief Petty Officers, they assign work and are expected to have a superior level of maintenance knowledge (American Airlines, 2020, p. 21). Another example is their Aviation Maintenance Technicians (AMTs), who perform a similar role to our E6 and below maintainers but have a more generalized role then the specificity of naval aviation rates (American Airlines, 2020, p. 24). However, American Airlines differs from the NAE in the way they employ a specialist or resident expert. They refer to this specialist as a Technical Crew Chief.

> The Technical Crew Chief will provide technical assistance, guidance, and training support to the Technical Operations department. In those cases where management determines that the work to be performed requires a level of responsibility equivalent to that of a Technical Crew Chief, an employee in the classification may be assigned to that function even though he has no other employees assigned directly to him. (American Airlines, 2020, p. 23)

This individual's experience is leveraged with the expectation that they assist with maintenance up and down the flight line at airports all around the world. Their job is not to supervise a team, but instead to be a technical expert and assist AMTs and Crew Chiefs with some of the more difficult jobs. This person in theory should have superior knowledge of the aircraft to assist other maintainers on the flight line, without the added burden of supervising a crew. The technical crew chiefs experience and knowledge is leverage by the company to provide safe reliable aircraft to its customers. American Airlines seems to have recognized the importance of expertise and pays to have employees in that specific role giving the NAE an example and road map to a career track the Navy can duplicate (American Airlines, 2020).

B. CONCLUSION

In answer to our secondary research question—How can we best leverage the connection between maintainer experience and readiness in terms of manpower in the

aviation maintenance community?—our research concluded that utilizing a specialist career track is the best answer.

NATEC is the current go-to source for technical experts in the NAE. However, their available pool of expertise is limited by the need for requests for support that come from the fleet via ETS in lieu of their continual involvement. When requested, their experts come to the aid of squadrons in a similar fashion as the Technical Crew Chiefs used by American Airlines, but with notable differences. NATEC emphasizes developing self-sufficiency prior to extended deployment whereas Technical Crew Chiefs have no such stipulations and go wherever the most complicated and pressing maintenance issues are located. NATEC also provides supplemental training with relevant OJT if requested while Technical Crew Chiefs are solely focused on resolving the problem with the aircraft.

Bearing this in mind, the role of a Technical Crew Chief is similar to the description of a specialist in the Army. Leveraging a specialist for their knowledge recognizes their experience comes from years of invested training and focus on their specific skill set. Naval aviation does not currently have a specialist in this same capacity; however, if we employ the Peter Principle and the concepts of Peter Drucker the ability to create a specialist from our current manpower becomes apparent. Successfully developing and retaining a specialist would require utilizing a two-career track that supports both the aptitude and desire of an individual for their career to lead into becoming either management or a specialist.

A specialist within the NAE would need the same flexibility as NATEC personnel have by not being assigned to a squadron, while also providing continual support availability like a Technical Crew Chief with American Airlines. We further explore our recommendations for implementing this dual career track in Chapter V.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

This chapter recapitulates key points from our research, provides conclusions, makes recommendations, and identifies areas for further study.

Our research was driven by close personal experience and missed opportunities we have witnessed first-hand. We addressed our research questions, explained the methodology for approaching those questions, and culminated with the research layout.

A detailed review was conducted on the DEMOT rates, which included their rank structure, education, and methods currently in place that grow their occupational experience. The AMEX system is introduced and explained to provide knowledge on the primary database used in our research. The literature identified how experience can be measured, which included a brief explanation of learning curve models. We finished Chapter II with information on emerging technology and how it might relate to the military.

Chapter III analyzed two years of VFA squadron data from AMSRR and AMEX databases. We used linear regression models to quantitatively show a highly significant correlation between the experience of aviation maintainers and squadron readiness rates. The result answered our primary research question, and concluded that the experience of aviation maintainers is relevant to Super Hornet readiness; an increase in experience corelates to an increase in readiness. Our findings were tested for fixed and random effects and the answers were not quantitatively different.

Several examples of how to leverage experience were taken from naval history, other branches of the DoD, and industry that could be incorporated into the NAE. It also contained research on NATEC which, in our opinion, is the NAE's current way of leveraging experience since it provides squadrons access to civilians with many years of aviation maintenance experience. Of note, Figure 20 in Chapter IV shows an upward trend in usage of NATEC civilians by the super hornet community, which indicates an increased need for experts with specialization. A significant highlight from industry was their emphasis that not everyone is meant to be manager, and a talented person with critical skills

should be treated as an asset best kept in their specialization. Industry uses various names, like individual contributor in the technology sector or practitioners in the medical field, but the philosophy remains the same in keeping talent where they are best utilized. One of the most important takeaways from this section was the American Airlines Technical Crew Chief, which is commercial aviation's version of a specialist. The technical crew chief is an experienced aviation technician with a role of fixing aircraft without the burdens of management, and provides the NAE with a road map for creating a specialist in the Naval Aviation Maintenance community.

B. CONCLUSIONS AND RECOMMENDATIONS

1. Primary Research Question

a. Conclusion

Our primary research question asked: To what degree does the experience level of an aviation maintainer affect the readiness of an F/A-18 Super Hornet Squadron? There is a highly significant correlation between the experience of aviation maintainers and squadron readiness rates. Every unit increase in a squadron's AMEX score results in an increase in RBA rate by roughly 5 percentage points. We derived this by using multiple regression models on a combined data set that contained monthly averages of AMEX scores and RBA rates from all non-FRS CONUS based VFA squadrons. We tested our results against fixed and random effects and found that the answers were not quantitatively different.

b. Recommendation

We recommend the NAE increase utilization of the AMEX system across all aircraft platforms and it becomes the standard database TYCOMs use to balance out manning among squadrons. We further recommend Navy Personnel Command aviation detailers utilize AMEX with squadron AMO's when working the detailing process to promote a balance of talent across the NAE.

2. Secondary Research Question

a. Conclusion

Our secondary research question asked: How can we best leverage the connection between maintainer experience and readiness in terms of manpower in the aviation maintenance community?" Our research concluded that establishing a specialist career track would have a positive effect on NAE readiness.

b. Recommendation

We recommend CNAF works in conjunction with CNATRA, NATEC, and CNATT to create a specialist career track for aviation maintainers that takes the best methods from current and historical specialization in the military along with successful practices from industry to create a unique role that is suited to the dynamic needs of the NAE. In the following paragraphs we have described how this specialist career path could be employed and implemented in the fleet.

We suggest offering a two-career track option to E-6 Sailors in the AD, AE, AM and AT rates. We excluded AOs on the basis that squadrons already have a Gunner who in many cases already takes the role of a specialist. The first track would be the continuation of the traditional career, which inevitably leads into management; and the second track, would lead to becoming a specialist. Targeting this critical time of around 10 years of service in a Sailors career is key because they are typically proficient technicians with plenty of time left to serve in their military career. The selection process should be a stringent review that includes both a review of their qualification record and an on-site evaluation of their work performance. Imagine the precision associated with the Blue Angels flight demonstrations, then associate that with welding, wire harness repair, and other tasks our specialists will perform. Simply stated, the overall standard of a specialist needs to be very high; and flexibility to remove Sailors who do not uphold those standards, and return them to the traditional career track, should be incorporated into the process.

Part of aviation maintenance culture is the pride that Sailors associate with their rate and the importance that comes with identifying a Sailor with that rate. As such, we recommend rebranding specialists with ratings already recognized within the existing

construct. For example, a first-class petty officer selected for the specialist career track that was previously either an AE1 or AT1 would become an AV1. Similarly, an AM1, AME1, or AD1 would become an AF1. This nod to the rate change that normally occurs at E-9 would be more than ceremonious in that it would carry the prestige associated with being on an elite team whose members are chosen through a highly competitive selection process and recognized for their top talent throughout the fleet.

Once selected, these Sailors are identified as specialists within their specific TMS. The addition of a closed loop NEC, which would include a HYT waiver, would be added to their record. This waiver would alleviate concerns over HYT regulations and potentially retain talented Zone B Sailors who tend to leave the Navy to pursue a career in industry at potentially higher salaries and job security. Advancement will not be critical to the development of a specialist, instead they would remain at the rank of E6 and be incentivized with bonuses yearly for performance and results. If the Sailor is performing well as a specialist then they should be paid well and could continue to serve and complete a 30-year career at this rank.

NATEC, as talked about previously in this project, is the Navy's current source for experts. Leveraging that expertise should be a priority with any specialist's career track. Having a specialist in every squadron is not meant to replace NATEC; it is leverage them more then we currently do. As we have shown in the trends there is growing need for their expertise, we would want our specialists to further integrate with NATEC civilians. Therefore, we would propose that the specialist work for and are managed by NATEC. We envision specialists distributed through TAD assignments to a squadron for four to five-year tours, but would report to, and be evaluated by, the local NATEC OIC.

This command structure of working for a squadron but reporting to NATEC would be done for three main reason:

- First, creating a line of communication between the squadrons and NATEC civilian experts more robust then we currently have is ideal. A specialist that reports to and is evaluated by the NATEC OIC would

enforce this line of communication, therefore leveraging the expertise that already exists within the NAE.

- Second, being evaluated by the NATEC OIC would allow the specialist to focus on being a technician and not getting bogged down with squadron politics of the evaluation cycle.

- Third, this would allow an additional flow of information from squadrons to the NAE through NATEC of the fleet's most pressing maintenance issues and solutions.

Each squadron would be billeted one specialist, assigned to a position equivalent of their rank. For example, an AV1 would fill the slot of any DEMOT E6 billet on the squadron manning document, therefore not adding any additional cost to the manpower footprint. The specialist will be the squadron's knowledge worker, and can therefore extend that knowledge to each of the different shops. This one person will be the go-to source for perplexing maintenance issues, and would have the full network support of other specialists and NATEC without the barrier that deployment presents currently. A requirement for more than one specialist within a squadron should not be needed since their focus is not on routine maintenance, and having more than one risks diluting the intent of their position.

When we researched companies about specialists and how they leveraged expertise it was emphasized that having clear-cut expectations was key. It is absolutely necessary that leadership from the highest level in the NAE have clear expectations of what this Sailor's role and responsibilities would, and would not, include. Below are some of our ideas on what the expectations of the specialists would be:

- Upon selection, a specialist must complete a one-year probationary tour at an FRC, under the close supervision of NATEC, would ensure the selectee met the standard and expectations of becoming a specialist.

- Continually improve their maintenance knowledge of existing technology installed on the aircraft, technology soon to be incorporated via technical

directive, and emerging technology with potential impact on their specific TMS specialty.

- Maintain a clear and current understanding of the readiness goals and concerns of their TMS within the NAE.
- Focus on improving readiness and NAE maintenance concerns of their TMS and work diligently to develop solutions.
- Must actively utilize the civilian experts from NATEC and learn from them daily. The idea here is one day those experts are going to retire and we must siphon as much knowledge from them as possible. Todays enlisted specialists are the future and will be tomorrows NATEC civilian experts.

If we are going to have an elite group of technicians, we are going to have to pay or incentivize these experts. While it is typical to brush off an idea when increased cost becomes a factor, we would argue in this case we are paying for increased readiness. If the ability to pay out bonuses and leverage incentives was left in NAE leadership hands, they could reward specialists for meeting and exceeding the expectations set forth by them. Below is a list of incentives we believe would create enough of a splash to attract and retain the right talent:

- Once a Sailor has been selected as a specialist and completes their probationary period at an FRC they would be awarded a $30,000 initial bonus, and an increase of $10,000 in addition to their current pay for each following year of service as a specialist.
- Additional bonuses attainable for finding solutions to fleetwide problems, outstanding improvement to squadron readiness numbers, or developing patents.
- All expenses paid for relevant education. For example, A&P licensing or aviation welding schools. This would incentivize specialty trades

education and certifications, not traditional education programs like BA or master's programs.

- Flexibility in location preference, and if flexibility is not available at the time, bonuses and incentive pay for less than desirable locations.

- Specialists would be exempt from being assigned collateral duties and any other task unassociated with maintenance since it would distract from their unique role, would not factor into their performance, and would impair the ability of traditional career track Sailors to gain the benefit of having them.

We realize this may be seen as excessive by some in the NAE, but the courses we have taken at NPS have shown that individuals are motivated by different factors. Combining monetary incentives with job flexibility and non-traditional educational opportunities would provide a sufficient incentive for the Sailors to risk pursing a new rating and career track. We were given the opportunity to attend NPS and believe it is our responsibility to give the NAE a different way a thinking about a problem. In developing these specialist rates, we believe our future technology and readiness issues can be solved by approaching the problem in a different manner and leveraging the talent that already exists within the NAE. Far too often the Navy funds projects that aim to do more with less; what we propose is doing more with what we already have available.

C. FURTHER RESEARCH

Due to the nature of completing an MBA project we had to narrow the scope of our research to make it feasible to complete within the timeline available. However, there are many avenues still to be explored and additional questions we would have pursued if they had not gone beyond the scope of our project and time permitted.

Our research focused on the F/A-18 community due to being naval aviation's primary platform with sufficient AMEX data available to put to use, however, once AMEX is more established with-in other communities it would be beneficial to perform similar analyses on them. The F/A-18 community is the largest within the NAE, but the lessons

learned from analyzing their AMEX scores and readiness numbers should not be assumed to be applicable for all platforms.

We recommend performing a cost benefit analysis (CBA) on our recommendations, since performing one in this project would have amounted to an additional MBA project of its own. However, a CBA would be extremely useful to the NAE since moving forward with the creation of a specialist career track would come at an opportunity cost that should be measured against current practices.

Optimization research could be performed to determine which of the recommended versions of a specialist track would be the most beneficial to the NAE. A study may conclude the best way to implement the specialist career track within the enlisted aviation maintenance ranks, or it may counter our conclusion and argue that current policies are the optimal method. Either way, the Navy would reap the benefit of the research.

While writing this we are in the middle of the COVID-19 pandemic, and it affects everyone in different ways, but one of the worst hit sectors is the U.S. airlines industry. In the maintenance departments of commercial aviation many layoffs have occurred while the departments have been expected to perform the same amount of maintenance, especially at the MRO depot-equivalent level. The results and data are inconclusive today, but the airlines maintenance teams so far seem to have performed well and are keeping up with demand with less people. After the pandemic is over there may be area for future research on this subject to see if working with less people helped or hurt the airlines while keeping up with demand. If they do perform well with less manpower, gathering lessons learned as to why could be beneficial to the NAE.

There are major concerns in the civilian aviation maintenance community that many technicians should be retiring soon without equivalent younger replacements. This concern may be an issue within NATEC for the Navy if we are not prepared for it. Research is recommended in how retirement numbers may affect our ability to retain talented aviation technicians.

Lastly, we were unable to turn the NATEC data into a covariate within our regression models since the requests, which come from the Wing, could not be reliably

split into individual squadron without making more assumptions than we deemed suitable. We would have preferred to have tested how much NATEC assistance factored into an increase in readiness numbers but given the time necessary to do so we were unable to pursue it, but we do believe is worth researching.

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APPENDIX. AVIATION PRODUCTION RATINGS.

Aviation Machinist's Mate (AD)

Aviation Machinist's Mates (AD) maintain, inspect, troubleshoot, preserve, and de-preserve aircraft transmission systems, rotor systems, propeller systems, and engines, including fuel, lubrication, intake, compressor, combustion, turbine, exhaust, accessory gearbox, anti-ice, bleed air systems, etc.; conduct special and conditional inspections and oil analysis; perform functional checks and required adjustments on engines and related systems; and supervise and provide training to power plant work centers. (DoN, 2020a, AD-3)

Aviation Electrician's Mate (AE)

Aviation Electrician's Mates (AE) maintain electrical and instrument systems, including power generation, conversion, and distribution systems, aircraft batteries, and interior and exterior lighting; and maintain electrical control of aircraft systems, including hydraulic, landing gear, flight control, utility, and power plant engine, flight and non-instrument-type indicating and warning systems, automatic flight control and stabilization systems, aircraft compass systems, attitude reference systems, inertial navigation systems, and environmental control systems. (DoN, 2020a, AE-3)

Aviation Structural Mechanic (AM)

Aviation Structural Mechanics (AM) maintain aircraft airframe and structural components, flight surfaces and controls, hydraulic and pneumatic control and actuating systems and mechanisms, landing gear systems, air conditioning, pressurization, visual improvement, oxygen and other utility systems, egress systems including seat and canopy ejection systems and components, fabricate and repair metallic and nonmetallic materials; supervise operation of airframe work centers; maintain aircraft metallic and non-metallic structures including fuselages, fixed and moveable flight surfaces, tail booms, doors, panels, decks, empennages, and seats (except ejection seats); maintain flight controls and related mechanisms; maintain hydraulic power storage and distribution systems including main (primary and secondary), auxiliary (utility), and emergency systems; maintain hydraulic actuating subsystems; maintain landing gear systems including wheels and tires, brakes, and emergency systems; maintain pneumatic power, storage and distribution systems; maintain

hoists and winches, wing and tail fold systems; maintain launch and arresting gear systems; perform hydraulic component repair and testing; and perform aircraft daily, special, hourly, non-destructive, and conditional inspections. (DoN, 2020a, AM-3)

Aviation Structural Mechanic (Safety Equipment) (AME)

Aviation Structural Mechanics (Safety Equipment) (AME) maintain ejection seats, canopy jettison components, environmental control, fire extinguishing, and associated life support systems; maintain gaseous and liquid oxygen, cockpit pressurization, heating and cooling, ventilation systems, avionics cooling, and anti-gravity and control components; maintain utility systems and associated lines, fittings, rigging, valves, control mechanisms, oxygen gauges, converters, and regulators; inspect, remove, and install ejection seats, shoulder harnesses, and lap belts; inspect, remove, and install explosive devices; adjust canopy and ejection seat firing mechanisms; operate and maintain liquid oxygen, gaseous oxygen and nitrogen support equipment; and perform daily, pre-flight, post-flight, and other periodic aircraft inspections. (DoN, 2020a, AME-3)

Aviation Ordnanceman (AO)

Aviation Ordnancemen (AO) receive, inspect, package, store, handle, and process for shipment: airborne weapons, air launched torpedoes, aerial mines, sonobuoy, pyrotechnics and ammunition; maintain, test, assemble, load, download, arm, and de-arm all airborne weapons, aircraft gun systems, targets, sonobuoys, and pyrotechnics for aircraft carriage; receive, inspect, inventory, configure, test, and maintain Armament Weapons Support Equipment (AWSE), Ordnance Handling Equipment (OHE), Aircraft Armament Systems (AAS) and Materials Handling Equipment (MHE); test and maintain aircraft armament release and control systems; inspect and maintain conventional ordnance magazines and Ready Service Lockers (RSL); maintain and operate magazine sprinkler systems; maintain and operate cargo/weapons elevators; perform preventative maintenance and inventory small arms weapons; manage accounting systems, rework of airborne weapons/systems/equipment, and conventional weapons qualification/certification programs, afloat and ashore; and prepare, review, maintain, and inspect compliance with directives and reports applicable to Notice of Ammunition Reclassification (NAR), Hazards of Electromagnetic Radiation to Ordnance (HERO), weapons certification program, and explosive handling certification program. (DoN, 2020a, AO-4)

Aviation Electronics Technician (AT)

Aviation Electronics Technicians (AT) perform intermediate level maintenance on aviation electronic components with conventional and automatic test equipment; repair Weapons Replaceable Assemblies (WRA) and Shop Replaceable Assemblies (SRA); and perform test equipment calibration/repair and associated test bench maintenance. They also perform organizational level maintenance on aircraft electronics systems to include: computers, communications, Radio Detection and Ranging (RADAR), navigation, Anti-Submarine Warfare (ASW) sensors, fiber optics, Forward Looking Infrared (FLIR), wiring, weapons systems, Light Amplification by Stimulated Emission of Radiation (LASER), electronic warfare, data link, fire control, and tactical displays with associated equipment. (DoN, 2020a, AT-3)

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