A QUALITATIVE PHENOMENOLOGICAL STUDY:

ENHANCED, RISK-BASED FAA OVERSIGHT ON

PART 145 MAINTENANCE PRACTICES

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
May, 2016

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ACKNOWLEDGEMENTS

With God, all things (this dissertation) are possible. First and foremost is my loving wife, the hero of my life, Melissa Sheehan. She is truly my inspiration to fulfill so many of my lifelong dreams, especially this dissertation which would not have been possible without her assistance and sacrifices. To our children and grandchildren, thank you for having the patience to endure my busy schedule while I neglected birthdays and other family events. To Grandpa Thomas Sheehan and Aunt Marty, who passed away before I completed this project, you've been an enormous inspiration in my life.

I am appreciative for the participants of this study, expert panel members, peer reviewer, and triangulation analysts whose identities must be protected. Thank you Dr. Timm Bliss for being my Chair and Advisor, and the committee members to include Vallory Vencill who was a first-rate Education Outreach Manager and Whitney McAllister for being an outstanding IRB Coordinator.

Thank you Daniel McCabe, Jeffery Santiago, and Joel Williamson for my employment opportunities that facilitated this study. I am also grateful for James McCubbins enduring mentorship. To Dr. Gina Pierce who helped me regain the "tenacity" to complete a doctorate with Dr. Shelly deZevallos's seven qualitative books. Thank you Linda McSwain for working diligently to edit and improve my writing.

To Orville Wright who was the first person to fly a motor-powered flight on December 17, 1903, and President John F. Kennedy's legacy that invigorated the United States to win the space race to the moon on July 20, 1969.

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Date of Degree: MAY 2016

Title of Study: A QUALITATIVE PHENOMENOLOGICAL STUDY: ENHANCED, RISK-BASED FAA OVERSIGHT ON PART 145 MAINTENANCE PRACTICES

Major Field: APPLIED EDUCATIONAL STUDIES

Abstract: The purpose of this qualitative phenomenological study was to examine the phenomenon of enhanced, risk-based Federal Aviation Administration (FAA) oversight of Part 145 repair stations that performed aircraft maintenance for Part 121 air carriers between 2007 and 2014 in Oklahoma. Specifically, this research was utilized to explore what operational changes have occurred in the domestic Part 145 repair station industry such as variations in management or hiring practices, training, recordkeeping and technical data, inventory and aircraft parts supply-chain logistics, equipment, and facilities. After interviewing 12 managers from Part 145 repair stations in Oklahoma, six major theme codes emerged from the data: *quality of oversight before 2007, quality of oversight after 2007, advantages of oversight, disadvantages of oversight, status quo of oversight,* and *process improvement.* Of those six major theme codes, 17 subthemes appeared from the data that were used to explain the phenomenon of enhanced oversight in the Part 145 repair station industry. Forty-two percent of the participants indicated a weak FAA oversight system that has hindered the continuous process improvement program in their repair stations. Some of them were financially burdened after hiring additional full-time quality assurance inspectors to specifically manage enhanced FAA oversight. Notwithstanding, the participants of the study indicated that the FAA must apply its surveillance on a more standardized and consistent basis. They want to see this standardization in how FAA inspectors interpret regulations and practice the same quality of oversight for all repair stations, particularly those that are repeat violators and fail to comply with federal aviation regulations. They believed that when the FAA enforces standardization on a consistent basis, repair stations can become more efficient and safer in the performance of their scope of work for the U.S. commercial air transportation industry.

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CHAPTER I.

INTRODUCTION

A safe and trustworthy air transportation system is important for America's national security and economic success. Since the 9/11 terrorist attacks, the U.S. air transportation industry has experienced significant hardships from high jet fuel expenses and maintenance costs to operate air carrier jetliners. Over 70% of U.S. air carrier maintenance has been outsourced to less regulated Part 145 repair stations, also known as Maintenance, Repair and Overhaul (MRO) facilities, to perform airline maintenance at a lower cost (Williams, 2012). Part 145 repair stations are aviation maintenance facilities that have been certified by the Federal Aviation Administration (FAA) under Title 14, Aeronautics and Space, Code of Federal Regulation (CFR) Part 145 (GPO, 2015).

The theory behind the benefits of a certificated Part 145 repair station is the perception that it will perform superior maintenance in comparison to non-FAA certificated facilities. However, it has been mostly Part 145 repair stations—not uncertificated facilities—that have been responsible for several airline mishaps due to outsourced maintenance errors (McFadden, 2012). These mishaps have created national debate about the FAA and its ability to provide adequate oversight on those repair stations that pose the greatest safety risks. Does outsourcing commercialized aircraft maintenance to less regulated repair stations or facilities make a difference in safety?

The FAA is a division of the Department of Transportation (DOT) that manages the safe operation of the U.S. air transportation system. FAA Aviation Safety Inspectors (ASIs) are responsible for the oversight of all civil aviation by enforcing regulations. Safety inspectors are required to provide oversight of outsourced maintenance by the U.S. air carrier industry, issue certificates, certify operators, and complete accident investigations. Another federal agency that provides air transportation oversight is the National Transportation Safety Board (NTSB). The NTSB collaborates with the FAA to determine probable cause for serious or fatal accidents involving civil aviation in the United States.

The Governmental Accountability Office (GAO) and the Office of Inspector General (OIG) are governmental watchdogs over the FAA to promote effective regulations by reducing or eliminating waste and abuse in departmental programs. The GAO reports directly to Congress and investigates how U.S. tax dollars are spent on the domestic air transportation industry. The OIG, a division of the DOT, provides oversight of FAA's surveillance of the air transportation system. Between 1997 and 2013, the GAO and the OIG published 12 audit reports that addressed findings and recommendations for the FAA to correct its inadequate oversight of the repair station industry (GAO, 1997; OIG, 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013).

Statement of the Problem

During the late 1990s, significant safety concerns ignited a national debate after a ValuJet DC-9 crashed in the Florida Everglades and accident investigators discovered that repair station contractors were the primary contributors of the mishap. Aviation critics have stressed that additional FAA oversight is needed at Part 145 repair stations that perform outsourced aircraft maintenance for U.S. air carriers (McFadden, 2012). After 9/11, many air

carriers outsourced their in-house maintenance to repair station contractors to reduce operational (labor) costs. Additional mishaps and incidents have occurred. This alarming trend has given rise to concerns about decreased levels of safety in the U.S. commercial aviation industry (GAO, 1997; OIG, 2007; 2013; McCartney, 2004).

This research project was intended to explore, by way of a qualitative phenomenological study, the operational effects of enhanced, FAA oversight on the U.S. Part 145 aircraft repair station industry. Specifically, this study was used to examine what operational changes have occurred in the Part 145 repair station industry in Oklahoma, including changes in management or hiring practices, training, facilities, equipment, recordkeeping and technical data, and inventory and aircraft parts supply-chain logistics. Changes in any of the aforementioned practices or resources could have serious economic consequences for the commerce of repair stations.

This research is expected to supplement the aviation management curriculum at technical-vocational schools, colleges, universities, and apprenticeship programs for U.S. Part 145 repair stations that perform outsourced maintenance for domestic air carriers. The overall intent is to improve the safety oversight of the U.S. air transportation system. This safety improvement could also help Oklahoma to stay competitive in the aerospace industry.

Background and Significance of the Problem

The U.S. air carrier industry has experienced long-term financial hardships since the 9/11 terrorist attacks, ensuing wars in Afghanistan and Iraq, and high jet fuel costs (Richardson, Park, Moore, & Pan, 2014). As a result, Borenstein (2011) said the air carrier industry has lost billions of dollars of revenue between 2000 and 2009. These events have prompted U.S. air carriers to outsource their in-house maintenance to contract maintenance

providers (Part 145 repair stations and non-certificated repair facilities) in the excess of 70% (Williams, 2012). McCartney (2004) and McFadden (2012) contended that even though airlines have become more reliant upon repair stations to perform outsourced maintenance to reduce labor costs by 50%, the FAA has not increased its surveillance across the full spectrum of repair station and non-certificated repair facility operations (GAO, 1997; OIG, 2007; 2008; 2009; 2010; 2013).

Over the last 15 years, outsourced aircraft maintenance by the U.S. air carrier industry has caused aircraft catastrophes and serious safety concerns. The last mishap occurred in 2003 with a fatal crash of a U.S. Airways commuter airplane in Charlotte, North Carolina (NTSB, 2004). The NTSB cited careless repair station maintenance and negligent FAA oversight as contributors to the crash.

During 1997, the GAO (1997) uncovered 86 out of 86 (100%) FAA safety inspectors who admitted that they used outdated regulations to inspect contract maintenance providers at Part 145 repair stations. The following year, the FAA developed and implemented a risk assessment program for the administration to focus inspections on the areas of highest risk (OIG, 2003). An area of high risk could be a repair station that has repeat violations or performs maintenance on flight safety sensitive components such as engines or flight controls that—if repaired, rigged, or overhauled incorrectly—could result in an aircraft mishap. Five years later during 2003, the FAA's inadequate oversight of contract maintenance providers was apparent again after the OIG discovered 18 out of 21 (86%) repair stations that had repeat findings, improper parts, and faulty equipment, partially due to inadequate FAA oversight.

As repair stations have become an integral part of airline maintenance, the FAA's risk-based oversight system has not followed a standardized process and lacks the necessary training for inspectors to identify systemic defects at repair stations (OIG, 2013). Until the FAA modifies its inspection program and follows a standardized process, additional lapses of FAA oversight may occur in the U.S. air transportation system (Hung & Chen, 2013).

Purpose of Study

There was no literature concerning the personal experiences of Part 145 repair station managers who have overseen outsourced U.S. air carrier maintenance in Oklahoma after the FAA changed procedures with its risk-based oversight system in 2007. Therefore, the purpose of this study was to explore the lived (personal) experiences of Part145 repair station managers concerning changes in outsourced Part 121 air carrier maintenance practices between 2007 and 2014 after the FAA enhanced its risk-based oversight system in 2007.

The purpose of the study was not to examine the effectiveness of changes implemented by the FAA nor to conduct an inquiry of non-certificated repair facilities. Instead, it was to explore how the Part 145 repair station industry in Oklahoma has experienced the enhanced changes. According to GPO (2015), the domestic air carrier industry is governed by Title 14, Aeronautics and Space, CFR Part 121 (domestic, flag, and supplemental operations).

The participants in this study served as top management executives, specifically "accountable managers" and "quality directors" at Part 145 repair stations in Oklahoma. Overall, they were responsible for their organization and had the most familiarity with repair station employees and the FAA. Due to the invasive nature of audits, one could assume that the repair station industry will experience change after audits by the FAA. Accordingly, the

researcher examined the challenges associated with FAA surveillance and U.S. air carrier maintenance that has been outsourced to Part 145 repair stations in Oklahoma.

Qualitative data from this study is needed to prevent or reduce additional U.S. aircraft mishaps or incidents related to outsourced maintenance errors. Obtaining valid facts regarding the lived experiences of those in the domestic Part 145 repair station industry will add an essential balance to the debate of FAA surveillance. This research data may provide the groundwork to reform the practice of outsourced aircraft maintenance to meet some of the most pressing challenges facing today's aviation industry.

Williams (2012) and Wyman (2015) said the U.S. air carrier industry has outsourced over 70% of its in-house maintenance to repair stations at a cost of $2.7 billion to reduce operational expenses (especially labor expenses). This outsourcing may be contributing to additional safety problems in the industry. Since 1996, the NTSB has investigated four major mishaps that were linked to outsourced maintenance errors committed by contractors at Part 145 repair stations and non-certificated repair facilities.

In particular, a NTSB (1997) report of a ValuJet DC-9 crash in the Florida Everglades during May 1996 sparked a change in the FAA surveillance effort (GAO, 1997). The FAA spent over $30 million to develop the Air Transportation Oversight System (ATOS) as its new surveillance program to improve the oversight of repair stations (GAO, 1997; McFadden & Towell, 1999; OIG, 2002). However, even after these efforts, additional mishaps occurred due to outsourced maintenance errors.

The FAA is responsible for the safety oversight of 4,062 Part 145 repair stations in the United States (OIG, 2013). Of those 4,062 repair stations, 127 are located in Oklahoma

where approximately 42 (33%) provide MRO services for the U.S. airline industry (FAA, 2015b).

The GAO and the OIG provide civil aviation oversight of the United States by auditing the FAA. During 1997, the GAO (1997) discovered that FAA inspectors used outdated regulations to evaluate repair stations and concepts that were developed during the infancy of the aviation industry. After 1997, the GAO and the OIG uncovered systematic and repeat findings concerning unsafe maintenance practices (inadequate training and maintenance, and improper equipment and parts) by maintenance contractors due to inadequate FAA oversight (GAO, 1997; OIG, 2013). Ghobrial (2005) said effective oversight of outsourced aircraft maintenance is a fundamental safety component of the U.S. air transportation system.

While air carriers continue to contract out more of their in-house maintenance to contract maintenance providers, the FAA has not adequately increased its oversight of those providers based on risk assessments (OIG, 2013). Notwithstanding, airlines are legally responsible by federal regulations for their aircraft deemed not airworthy, even if the maintenance was performed by contractors (GPO, 2015). Even though the FAA upgraded its safety oversight with an enhanced, risk-based system in 2007 (Table 1), the agency has placed more emphasis at in-house airline maintenance facilities where less than 30% of the maintenance has been accomplished in comparison to the 70% that was outsourced.

Table 1

Overview of FAA's Risk-Based Oversight System

Initiative	Narrative	Initiated

Risk-Based Oversight System	An FAA risk-based system arranged by data analysis (U.S. air carrier operations and maintenance data) to focus on oversight areas that pose the greatest safety risks to effectively maximize the agency's use of limited inspection resources.	1998
Enhanced, Risk-Based Oversight System	The FAA enhanced its risk-based system with a risk assessment tool to aid in the surveillance of U.S. repair stations that perform outsourced aircraft maintenance for the U.S. air carrier industry.	2007*

* Since 2007, the FAA has incorporated a risk assessment tool known as the Repair Station Assessment Tool (RSAT) to enhance the risk-based oversight process.

Notes: Prior to 1998, the FAA inspection program was compliance-based and did not focus on risks. Adapted from "Advancing FAA's Risk-Based Oversight Systems," by the Office of Inspector General, 2002, *FAA Oversight of Passenger Aircraft Maintenance,* Report Number: CC-2002-146, p. 7, and "FAA Developed Risk-Based Inspection Tools, but the Tools Are Ineffective and Inspectors Do Not Use Them," by the Office of Inspector General, 2013, *FAA Continues to Face Challenges in Implementing a Risk-Based Approach for Repair Station Oversight*, OIG Report Number: AV-2013-073, p. 6.

Significance of Study

The significance of this study hinged upon the phenomenon of enhanced, risk based FAA oversight of Oklahoma Part 145 repair stations that performed outsourced maintenance for U.S. air carriers. There have been several outsourced maintenance errors that led to catastrophic airline accidents (McFadden, 2012). These tragic events have compelled the GAO and the OIG to frequently audit the FAA because it is responsible for the safety oversight of the U.S. air transportation system (GAO, 1997; OIG, 2003; 2004; 2005a; 2005b; 2008; 2013).

Research Question

The central research question of this study consisted of the following: What are the lived experiences of Part 145 repair station managers in Oklahoma concerning changes in outsourced Part 121 air carrier maintenance practices between 2007 and 2014 after the FAA

enhanced its risk-based oversight system in 2007? A list of the research questions are located at Appendix D.

Theoretical Perspective

With the approval of the University's Institutional Review Board (IRB), the researcher studied the lived experiences of Part 145 repair station managers throughout Oklahoma to achieve personal, formative knowledge. This research project consisted of a qualitative phenomenological study to explore the phenomenon of enhanced, risk based FAA oversight at Oklahoma repair stations that performed outsourced maintenance for the U.S. air carrier industry. This study specifically explored changes in aircraft maintenance practices between 2007 and 2014 at Part 145 repair stations in Oklahoma.

Phenomenology does not provide information in the usual sense. Instead, the significance of phenomenological knowledge is formative in nature. It heightens our insight; it contributes to our sense of diplomacy in human relations (Patton, 2015).

Assumptions

Regarding this research study, there were three assumptions:

1. It was presumed that the participants would provide honest feedback.
2. It was assumed that Part 145 repair station top management executives (accountable managers and quality directors) would have the most familiarity with the FAA and repair station employees.
3. Due to the researcher's 31 years of professional experience in the U.S. aviation industry, some bias was possible with the research material.

Limitations

There were four limitations associated with this study:

1. The study was limited to Part 145 repair stations in Oklahoma that performed outsourced maintenance for domestic air carriers.
2. The primary focus of the study was limited to the phenomenon inquiry of the enhanced, risk-based FAA oversight system between 2007 and 2014 in Oklahoma.
3. Research was limited to the personal interviews of repair station managers (accountable managers and quality directors) who had at least five years of experience.
4. Time constraints created accessibility limitations with a couple of the participants who had to reschedule due to their busy work schedules.

Definition of Key Terminology

Airframe and Powerplant (A&P) Certificate – The FAA oversees the training and certification of Aviation Maintenance Technicians (AMTs) based on two ratings: airframe and powerplant. An airframe rating allows a mechanic to maintain and repair all systems associated with the airframe of an aircraft while a powerplant rating includes the engine and all associated equipment. A certified aircraft technician with both ratings is known as an A&P mechanic (FAA, 2008).

Airworthiness Directive (AD) – Kinnison and Siddiqui (2013) said an AD is a mandatory FAA compliance document concerning an unsafe condition of an aviation product (aircraft engine, aircraft, propeller, or appliance).

Accountable Manager – A required and designated Part 145 repair station, top management executive who normally serves as the liaison between a repair station and the FAA (GPO, 2015).

Aviation Management Curriculum – At selected universities, the Aviation Management option prepares undergraduate students with the necessary curriculum for management positions in the aerospace industry. The Aviation Management option is accredited by the Aviation Accreditation Board International (AABI).

Aviation Safety Inspector (ASI) – The core mission of the FAA is to regulate and oversee all aspects of the U.S. civil aviation industry with approximately 4,000 aviation safety inspectors who are located at some 90 Flight Standards District Offices (FSDOs) throughout the United States (GAO, 2014). The FAA employs a safety oversight system that is rule-based because the administration believes, if followed, it will lead to an acceptable or high level of safety. Safety inspectors conduct surveillance audits and impose civil penalties to Part 121 air carrier and Part 145 repair station violators (FAA, 2008).

Aviation Safety Reporting System (ASRS) – The National Aeronautics and Space Administration (NASA) implemented ASRS as a voluntary, confidential, and non-punitive reporting program for aviation maintenance technicians, pilots, controllers, and others to report safety issues and concerns to the FAA (NASA, 2015).

Certified AMT – An aviation maintenance technician who was issued an FAA mechanic certificate with either an airframe or powerplant rating, or both, and certified to practice maintenance at a Part 121 air carrier, Part 145 repair station, or non-certificated repair facility. A repairman rating is only valid at a Part 145 repair station or Part 121 air carrier.

Delphi Method – A research technique that Linstone and Turoff (1975) said can be used to explore the perspectives of a homogeneous panel of experts through several rounds of questioning with controlled feedback to refine a process (Patton, 2015).

Federal Aviation Administration (FAA) – The FAA is the national civil regulatory authority of aviation and provides oversight of Part 121 air carriers and Part 145 repair stations (FAA, 2008).

Federal Aviation Regulation (FAR) – Aviation regulations are categorized under Title 14 Code of Federal Regulations (CFR). For example, FAA certified repair stations are governed by 14 CFR Part 145 (GPO, 2015).

Flight Standard District Office (FSDO) – A FSDO is an FAA field office at approximately 90 locations in the United States that serves the civil aviation industry and the general public on all matters pertaining to America's civil aviation (Sheehan, 2013).

Government Accounting Office (GAO) – An independent agency that works directly for Congress and investigates how the federal government spends taxpayer dollars. This agency provides oversight of the U.S. air transportation industry (GAO, 2014).

In-House Maintenance – U.S. air carrier in-house maintenance that was performed by internal employees and not outsourced to an external contract maintenance provider.

Joint Service Aviation Maintenance Technician Certification Council (JSAMTCC) – Members of the five branches of the U.S. military, the Department of Defense (DOD), and the Department of Homeland Security (DHS) may qualify under a special Joint Service Aviation Maintenance Technical Certification Counsel (JSAMTCC) program to obtain an A&P from the FAA at a reduced cost. Members are encouraged to pursue A&P certification according to 14 CFR 65 based on 18

months of practical aircraft maintenance experience in airframe or powerplant systems, or 30 months for both (FAA, 2012; GPO, 2015). The JSAMTCC standardized the U.S. military, DOD, and DHS A&P eligibility process to identify and fill training gaps to ensure members meet FAA eligibility requirements (Goldsby & Watson, 2000).

Lived Experience – The *lived experience* phrase is frequently used in phenomenological studies to highlight the importance of an individual's personal experience as a conscious human being (Creswell, 2014; Manen, 2014). The lived experience approach is a method that Patton (2015) said is used to conduct in-depth interviews with participants who have directly experienced a specific phenomenon as opposed to secondhand experience.

Major U.S. Air Carrier – A domestic air carrier that yields more than $1 billion in revenue during a fiscal year (DOT, 2015).

National Transportation Safety Board (NTSB) – An independent federal agency charged by Congress to investigate U.S. civil aviation accidents and other modes of transportation. The NTSB determines the probable cause of serious or fatal accidents and issues safety recommendations to prevent future mishaps. At times, the goals of the NTSB and the FAA will conflict after NTSB recommendations implicate the FAA (NTSB 1997; 2002; 2003; 2004).

Noncertified AMT – An aviation maintenance technician who does not hold a valid FAA mechanic certificate with either an aircraft or powerplant rating, or both, and employed at a non-certificated repair facility, Part 145 repair station, or Part 121 air carrier. A repairman rating is only valid at a Part 145 repair station or Part 121 air

carrier. Approximately 50% of the U.S. Part 145 repair station workforce employs noncertified AMTs. The FAA does not require AMTs to have an FAA mechanic certificate unless they inspect or supervise maintenance (FAA, 2003; 2015b).

Office of Inspector General (OIG) – Inspector General (IG) auditors from the OIG, under the auspices of the DOT, provide oversight of the U.S. air transportation system. One of its statutory responsibilities is to audit and investigate the FAA's oversight of the U.S. civil aviation industry. The OIG's mission is committed to achieve a safe, efficient, and effective air transportation system (OIG 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013; 2015).

Oklahoma Aeronautics Commission (OAC) – The OAC is an organization of the state government responsible for stimulating aviation in Oklahoma. The Commission is composed of seven members who are appointed for a six-year term by the Governor of Oklahoma (OAC, 2016).

Part 121 Air Carriers – U.S. air carriers that are certified by the FAA to conduct scheduled services over specific routes in accordance with 14 CFR Part 121 (FAA, 2015a).

Part 145 Repair Stations – FAA-approved repair stations under 14 CFR Part 145 perform various types of aviation maintenance (inspection, repair, overhaul, or modification of an aircraft or aircraft component), as defined by its *rating limitations*, also known as *operation specifications* for U.S. registered aircraft (GPO, 2015). Sheehan (2013) said operation specifications are categorized by six ratings: airframe, powerplant, propeller, radio, instrument, and accessory. Part 145 repair stations operate under an FAA-issued Air Agency certificate, not an A&P. Only maintenance supervisors and

return-to-service inspectors are required by the FAA to have an A&P under 14 CFR Part 65 and 145 (FAA, 2008; GPO, 2015).

Principal Maintenance Inspector (PMI) – An FAA inspector who is responsible for the safety of a designed Part 145 repair station and serves as the primary point of contact between the FAA and repair station (FAA, 2003).

Process Analyst – A business specialist utilized at a particular MRO facility to lean out a process or procedure and reduce errors (Furterer & Elshennawy, 2005; Roth, 2006).

Phenomenological Study – Creswell (2014) and Patton (2015) said a phenomenological study is used to identify the essence of human experiences about a phenomenon as described by participants in a study.

Repairman Certificate – To hold a repairman certificate, one must be employed by a Part 145 repair station or Part 121 air carrier, and hold a job position such as a return-to-service inspector or maintenance supervisor under 14 CFR 145.153 and 145.157, and 14 CFR 65 Subpart E. The certificate is only valid for the repair station or air carrier for which it was issued. Therefore, once the holder leaves the organization, the certificate must be surrendered to the FAA (GPO, 2015).

Safety Assurance System (SAS) – During 2015, the FAA began its implementation of SAS as a new, risked-based, data-supported oversight system for 14 CFR Part 121, 135, and 145 (GPO, 2015). SAS has the capability to share surveillance information as an automated data collection tool to give FAA inspectors a more comprehensive picture of a certificate holder's risk environment. SAS might improve an inspector's ability to prioritize, develop a risk-based oversight program, and aid the FAA with the

necessary capabilities to ensure that risks have been identified, documented, tracked, and effectively managed (OIG, 2013).

Safety-Sensitive Aviation Occupations – Safety-sensitive duties that require periodic drug testing involve the following aviation occupations: aircraft maintenance and preventive maintenance, flight attendant, flight instruction, aircraft dispatcher, air traffic control, ground security coordinator, flight crewmember, and operations control specialist (GPO, 2015).

Touch Labor – Loong (2015) said touch labor is a term used to distinguish between individuals who have a direct, hands-on involvement in aircraft maintenance and those that do not.

Verstehen Process – A procedure to understand the perceptions of others by metaphorically placing yourself in their shoes. Adopting this procedure would require oneself, such as a participant of a study, to be treated as a human being rather than an abstract object to truly understand one's point of view. Denzin and Lincoln (2000) compared the Verstehen Process to an American Indian prayer, "Great Spirit, grant that I may not criticize my neighbor until I have walked a mile in his moccasins" (p. 192).

CHAPTER II.

REVIEW OF LITERATURE

Overview

An extensive literature search for the phenomenon of risk-based oversight by the FAA under the umbrella of ATOS involved the following literature: NTSB aircraft accident reports (NTSB, 1997; 2002; 2003; 2004); GAO and OIG audit reports (GAO, 1997; OIG, 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013); risk-based FAA oversight system (OIG, 2002; 2013); study of Franco (2009); and domestic repair station civil penalties (FAA, 2015d).

U.S. Airline Mishaps due to Outsourced Maintenance Errors

Introduction

Between 1996 and 2003, four highly publicized aircraft mishaps caused serious safety concerns related to inadequate FAA oversight of outsourced air carrier maintenance by repair station contractors who contributed to those mishaps (McFadden, 2012). In response, the first audit report was issued by the GAO and 11 more by the OIG concerning the FAA's deficient oversight of air carriers and maintenance contract providers (GAO, 1997; OIG, 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013).

ValuJet Airlines Flight 592 Accident

On May 11, 1996, the first tragedy occurred after *ValuJet Airlines Flight 592* crashed into the Florida Everglades and killed two pilots, three flight attendants, and 105 passengers. The NTSB determined that the probable cause of the McDonnell Douglas DC-9-32 accident resulted from a fire in a Class D cargo compartment by the inadvertent activation of one or more oxygen generators that were improperly carried as cargo (FAA, 2015c; NTSB, 1997).

The NTSB (1997) identified three serious failures that contributed to the crash. First, SabreTech, a contract maintenance provider for ValuJet, failed to properly prepare, package, and identify unexpended oxygen generators before placing them in a ValuJet cargo compartment. The second failure involved ValuJet's negligent oversight of its contract maintenance program to comply with maintenance procedures, hazardous material requirements, and maintenance training. Third, the FAA failed to require fire suppression systems and smoke detectors in Class D cargo compartments (NTSB, 1997).

Contributing to the accident was the FAA's failure to adequately monitor ValuJet's heavy maintenance programs and ValuJet's poor oversight of its contract maintenance providers. ValuJet neglected to ensure that their employees and subcontractors were aware of the air carrier's *no-carry* hazardous materials policy and provide the required hazardous material training (NTSB, 1997).

Alaska Airlines Flight 261 Accident

The second tragedy occurred on January 31, 2000, with the fatal crash of *Alaska Airlines Flight 261* near Anacapa Island, California. This aircraft was a McDonnell Douglas MD-83 jetliner. Two pilots, three crewmembers, and 83 passengers perished in

the crash. The NTSB (2002) determined that the probable cause of this accident was a loss of airplane pitch control and subsequent, in-flight failure of the horizontal stabilizer trim system jackscrew assembly's Acme nut threads. Thread failure was caused by excessive wear due to inadequate lubrication of the jackscrew assembly (NTSB, 2002).

Contributing to the accident were Alaska Airlines' and repair station contractors' prolonged lubrication interval that was approved by the FAA. This maintenance postponement enabled the likelihood that a missed or inadequate lubrication cycle would result with the excessive wear of Acme nut threads. The NTSB (2002) contended that the lack of routine maintenance permitted the premature wear of the Acme nut threads to fail and go undetected.

Another contributing factor for the accident was the lack of a fail-safe mechanism to prevent the catastrophic effects that led to the complete loss of Acme nut threads. The FAA neglected to fulfill its responsibility to properly oversee the maintenance operations at Alaska Airlines. At the time of the Alaska Airlines Flight 261 accident, the FAA's surveillance of Alaska Airlines and contract maintenance providers had been lacking for several years (NTSB, 2002).

Emery Worldwide Airlines Flight 17 Accident

On February 16, 2000, the third disaster occurred with the fatal crash of *Emery Worldwide Airlines Flight 17* in Rancho Cordova, California. Two pilots and a flight engineer were killed aboard a McDonnell Douglas DC-8. There were no passengers. The NTSB (2003) said the probable cause of the accident was a loss of elevator control that resulted from a loose or defective bolt connecting the right-hand elevator pushrod to the elevator control tab crank fitting. The suspect bolt was attributed to the failure of

Tennessee Technical Services (TTS) repair station mechanics to install the correct bolt and/or cotter pin. Also contributing to the accident was a TTS inspector who failed to identify the incorrect or missing bolt and/or cotter pin after the elevator control tab installation was completed (NTSB, 2003).

Air Midwest Flight 5481 Accident

The fourth and final catastrophe involved *Air Midwest Flight 5481* on January 8, 2003, in Charlotte, North Carolina. Two flight crew members and 19 passengers were killed in the crash. The aircraft was a Raytheon (Beechcraft) 1900D, which was destroyed by impact forces and a post-crash fire.

The NTSB (2004) determined that the probable cause of the accident was the airplane's loss of pitch control during takeoff. The loss of pitch control was due to a Raytheon Aerospace contractor who incorrectly rigged the elevator control system at a non-FAA certificated repair facility. This lapse of oversight severely compromised the airplane's aft center of gravity. Upon further investigation, the elevator control system was incorrectly rigged during routine maintenance and it restricted the aircraft's elevator travel to 7º airplane nose down, or about one-half of the downward travel specified by the airplane manufacturer (NTSB, 2004).

There were six contributors that were linked to the accident (NTSB, 2004). The first contributor occurred after Air Midwest's inadequate oversight of aircraft maintenance performed at a non-certificated repair facility in Huntington, West Virginia. Second, Air Midwest lacked adequate maintenance procedures and documentation. The third contributor consisted of Air Midwest's dysfunctional weight and balance program at the time of the accident. The fourth factor involved Raytheon Aerospace quality

inspectors who failed to detect the improper rigging of the elevator control system. Fifth, weight and balance guidance by the FAA was inadequate to determine the average weight assumptions in its weight and balance program at the time of the accident. The last contributor involved inadequate FAA oversight of Air Midwest's maintenance program (NTSB, 2004).

Risk-Based FAA Oversight System

The safety implications of outsourced maintenance based on risks have been scrutinized in a series of reports prepared by the GAO and the OIG, and testimonies made to the U.S. House of Representatives and Senate subcommittees responsible for aviation safety. Much of that scrutiny involved the FAA's inadequate oversight of Part 121 air carriers, Part 145 repair station industry, and non-certificated repair facilities, which became apparent after the ValuJet air carrier accident in May 1996 (NTSB, 1997). Between 1997 and 2013, the GAO and the OIG published 12 audit reports regarding the FAA's oversight of the repair station industry and critical weaknesses in its surveillance system based on risks (GAO, 1997; OIG, 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013).

Risk-Based FAA Oversight Approach

During 1997, a GAO audit report was cited by Gerald Dillingham, GAO Civil Aviation Director, on the May 1996 ValuJet DC-9 mishap and inadequate FAA oversight, and Part 145 repair stations that performed outsourced maintenance for Part 121 air carriers (GAO, 1997).

In particular, the GAO (1997) identified 19 incidents involving several FAA inspectors who had inspected large Part 145 repair stations that were reviewed by a

special team during the same year. Special inspection teams were employed by the FAA at selected maintenance facilities that need additional attention. The team found a total of 347 deficiencies as opposed to only 15 (4%) by individual inspectors at the same repair stations. Some of those deficiencies that the team identified were chronic and systemic such as inadequate training programs and deficient quality control manuals. Most of the 347 deficiencies were likely to have been present when the repair stations were inspected earlier by individual inspectors (GAO, 1997).

The GAO (1997) said to reduce or eliminate further lapses of oversight, the FAA announced a new initiative to upgrade its oversight of Part 145 repair stations with a $30 million risk-based reporting system known as the ATOS. The intent of this surveillance system was to identify and assign the appropriate inspection resources to target those facilities that posed the greatest risk to aviation safety. The previous FAA system did not have a process in place for its inspectors to document findings, identify and react to inspection trends, and conduct follow up inspections (GAO, 1997).

ATOS was a major change in the FAA's risk-based oversight approach (OIG, 2002). During the previous 30 years, FAA inspectors frequently conducted aircraft inspections that did not rely on data systems as a trend analysis to compliment the review of an air carriers' system. Inspectors were not adequately prepared for ATOS because they were not properly trained. Further complicating the changeover, qualified inspectors were not placed at the weaker repair stations that needed improvements (OIG, 2002).

Enhanced, Risk-Based FAA Oversight Approach

During April 2002, the first of 11 OIG audit reports was cited by Inspector General Alexis M. Stefani on the FAA oversight of passenger aircraft maintenance and ATOS weaknesses that went undetected in the U.S. air carrier oversight system. Although ATOS was a conceptually sound program to monitor air carriers, ATOS failed to reach its full potential at the original 10 major carriers and it was not expanded to the remaining 129 air carriers (OIG, 2002). The January 2000 Alaska Airlines crash and Alaska Airlines maintenance program findings refocused attention on the FAA's risk-based oversight system (NTSB, 2002).

In the second OIG audit report, Inspector General Stefani said the FAA implemented ATOS prematurely, without all the key elements (OIG, 2003). For example, the FAA had only developed procedures for planning, conducting, and reporting inspections, but not for analyzing the results. Over 50% of the FAA inspectors who were interviewed by the OIG did not understand ATOS inspection checklist questions, which they were required to use in evaluating air carrier systems (OIG, 2003).

During 2003, the third OIG audit report was cited by Inspector General Stefani concerning frequent inspections by the FAA at in-house air carrier facilities with no comparable shift toward increased oversight of outsourced maintenance performed at external repair station facilities (OIG, 2003). The OIG described weaknesses in maintenance practices at 15 out of 21 (71%) repair stations. Of those 15 repair stations, seven were foreign and eight were domestic. The findings raised questions about the repair stations' ability to ensure repairs had been completed properly. There were instances where these repair stations used outdated maintenance manuals, neglected to

notify the FAA of change to the repair stations' work capabilities, and failed to segregate scrapped parts from usable parts. Thus, the OIG recommended that the FAA enhance its oversight of the air carriers' use of domestic repair stations that perform aircraft maintenance for U.S. airlines (OIG, 2003).

At the request of Congressman Oberstar, the fourth OIG audit report was cited by the Assistant Inspector General David A. Dobbs on the information notification of an air carriers' use of non-certificated repair facilities, Project No. 04A3007A000 (OIG, 2004). The Congressman expressed concerns about the U.S. airlines' reliance on facilities that were not FAA certified to perform aircraft maintenance. As a result, Assistant Inspector General Dobbs said the OIG would conduct an audit of an air carriers' use of non-certificated repair facilities.

Non-certificated repair facilities normally include one or more aircraft technicians who practice maintenance under the supervision of an FAA-certified mechanic authorized to inspect aircraft repairs (OIG, 2004). Essentially, when an air carrier uses a non-certificated repair facility, that shop becomes an extension of the air carriers' maintenance organization. Accordingly, the FAA depends upon air carriers to ensure that their repair station maintenance providers have adequate facilities, equipment, and staff to perform maintenance. Table 2 contains three audit objectives necessary for the OIG audit.

Table 2

OIG Audit of Air Carriers' use of Non-Certificated Repair Facilities

Objectives of the Audit
(1) How FAA requirements for non-certificated facilities differ from requirements for certificated repair stations.

(2)	How FAA identifies and monitors work performed at non-certificated repair facilities and ensures that air carriers are providing effective oversight of this work.
(3)	The reasons and extent to which air carriers use non-certificated repair facilities to complete their aircraft maintenance work.

Notes: Adapted from "Memorandum," by the Office of Inspector General, 2004, *Audit Initiated of Air Carriers' use of Non-certificated Repair Facilities*, Project No. O4A3007A000, pp. 1-2.

The fourth OIG audit report during June 2005 was cited by Assistant Inspector General David A. Dobbs on the safety oversight of an air carrier industry in transition and stated that the FAA was expected to lose 300 ASIs in 2005 while the administration had limited its budget authority to 97 replacements in 2006 (OIG, 2005a). This same report complimented the FAA on its ongoing progress to fully implement a risk-based oversight system, but lacked the capability to effectively inspect the repair station industry. Once again, the OIG urged the FAA to enhance its oversight of the U.S. repair station industry, particularly those repair stations that perform outsourced aircraft maintenance for U.S. air carriers. In response, the FAA implemented a team-focused, in-depth inspection program designed to enhance the oversight of Part 145 repair stations by increasing the depth and scope of inspections (OIG, 2005a).

The fifth OIG audit report during December 2005 was cited by Inspector General Kenneth M. Mead on an air carriers' use of non-certificated repair facilities at the request of Representative James Oberstar, Ranking Member of the House Committee on Transportation and Infrastructure (OIG, 2005b). The Inspector General said over 50% of air carrier maintenance is performed by external repair facilities. Most of those facilities were certified by the FAA.

For several years, air carriers have used non-certificated facilities, but it was widely accepted that those facilities were principally used to perform minor maintenance

tasks and limited its more significant work to emergency situations. However, the OIG (2005a) determined that this was not the case because they identified six domestic and foreign facilities that performed scheduled maintenance, and 21 that performed maintenance critical to the airworthiness of the aircraft. The FAA permits the use of these facilities as long as the work is approved by an FAA certified mechanic; however, this was not an acceptable substitute for the quality control and additional layers of oversight the FAA requires at Part 145 repair stations.

The OIG (2005a) argued with the FAA that it has oversight responsibly for non-certificated repair facilities because the FAA is responsible for the surveillance of an air carrier's aircraft maintenance programs. Thus, when air carriers' use external maintenance facilities, those facilities become an extension of an air carriers' maintenance program. However, the FAA does not track maintenance at non-certificated repair facilities nor maintain an audit trail on the location of these facilities. Instead, the administration depends upon the domestic air carrier industry to provide oversight of their outsourced maintenance at non-certificated repair facilities (OIG, 2005a). As shown in Table 3, there are key differences between requirements for non-certificated repair facilities and FAA-certificated repair facilities (Part 145 repair stations).

Table 3

Requirements of FAA-Certificated and Non-Certificated Repair Facilities

Requirement	Certificated Repair Station	Non-Certificated Facility
Quality Control System	Annual inspection required	No requirement
Reporting Failures, Malfunctions, and Defects	Must establish and maintain a quality control system that ensures that repairs performed by	No requirement

	the facility or a subcontractor are in compliance with regulations	
Personnel	Must have designated supervisors, inspectors, and return-to-service personnel	No requirement
Training Program	Required starting April 2006	No requirement
Facilities and Housing	If authorized to perform airframe repairs, must have facilities large enough to house the aircraft they are authorized to repair	No requirement

Notes: Adapted from "Table 2. Differences in Requirements for FAA-Certificated Repair Stations and Non-Certificated Facilities," by the Federal Aviation Administration, 2005b, *Air Carriers' use of Non-Certificated Repair Facilities*, Report Number: AV-2006-031, p. 12.

The importance of effective oversight of non-certificated repair facilities by the FAA and air carrier industry became evident in the aftermath of the January 2003 Air Midwest crash in Charlotte, North Carolina (2005b). Independent contract mechanics who were certified by the FAA and working for a non-certificated facility had completed maintenance on the aircraft the day before the mishap. These technicians incorrectly adjusted the flight control system that was determined to be a contributing cause of the accident. This work was also approved by an FAA-certified mechanic who was employed by the non-certificated facility. The NTSB (2004) determined that the contributing causes of the accident included Air Midwest's lack of oversight of the work performed by a contract mechanic who was employed at a non-certificated aircraft facility and the lack of FAA oversight of Air Midwest's maintenance program.

According to the OIG (2005b), non-certificated repair facilities perform the same type of aircraft maintenance that certified repair stations perform, but without the regulatory FAA oversight. The use of non-certificated repair facilities to perform aircraft maintenance presents a dual standard for aircraft maintenance and oversight (OIG, 2005b).

The FAA requires Part 145 repair stations to have quality controls systems and designated supervisions and inspectors. Nonetheless, at non-certificated repair facilities performing the same kind of work as Part 145 repair stations, the FAA has placed most of the reliance on individual mechanics to perform a broad range of repairs on various aircraft and to verify that the maintenance has been properly performed. As demonstrated in the circumstances surrounding the Air Midwest accident, this system is not adequate. The FAA-certificated mechanics completed and approved the repairs that are believed to have been a contributing cause of the January 2003 crash. The NTSB concluded that air carrier and FAA oversight was needed (OIG, 2005b).

During September 2006, the fifth OIG audit report was cited by the Acting Inspector General Todd J. Zinser who testified before the House Transportation Aviation Subcommittee on observations about FAA's oversight of aviation safety (OIG, 2006). Inspector General Zinser reported that FAA inspectors did not complete 26% of their planned inspections when air carriers were at the height of streamlining operations and reducing costs.

Specifically, over 50% of those inspections were not completed in areas where inspectors had identified risks. This occurred because the FAA did not have a system to prioritize the planned inspections, so some of the areas that posed a safety risk were not inspected. For example, FAA inspectors had identified an air carrier at risk since it had filed for bankruptcy protection and laid off a number of its mechanics, but the administration failed to review the qualifications of remaining maintenance personnel.

Despite this determination, inspectors did not finish the inspections that had been planned to assess these risks. Ten months later, they found out that mechanics at two of

the air carriers' maintenance facilities had been making repairs on parts that they were not qualified to perform. Inspector General Zinser said the FAA had a substantial amount of work remaining to implement its enhanced, risk-based oversight system to carry out its safety oversight mission (OIG, 2006).

Six months later, a seventh OIG audit report was cited by Inspector General Calvin L. Scovel who testified before the House Transportation and Infrastructure Aviation Subcommittee on aviation safety and the FAA's oversight of outsourced maintenance facilities. Inspector General Scovel reported that the FAA cannot effectively implement an enhanced, risk-based system for oversight of aircraft maintenance if it does not know where the maintenance has been performed. For instance, the FAA developed a voluntary process for air carriers to report the top 10 critical maintenance providers used each quarter. However, as long as the process is voluntary, the FAA cannot be assured that it is getting the accurate and timely information needed to determine where it should focus its inspections.

Inspector General Scovel said air carriers have reduced operating costs by decreasing their in-house staff and negotiated labor agreements while increasing the outsourcing of air carrier maintenance to the repair station industry. Personnel and aircraft maintenance are significant cost areas of an air carrier's operation. Thus, outsourced maintenance has been a popular financial alternative for the air carrier industry (OIG, 2007).

During September 2008, the eighth OIG report was cited by Assistant Inspector General David A. Dobbs on an air carriers' outsourcing of aircraft maintenance and said that the FAA's enhanced, risk-based oversight system failed to monitor and track high

risk repair stations. Inspector General Dobbs identified occurrences when the FAA could not effectively target its inspection resources to those repair stations providing the largest volume of high risk repairs. This shortfall caused deficiencies at repair stations to go undetected or reoccur. It also prevented inspectors from obtaining sufficient data to perform comprehensive risk assessments based on trend analysis (OIG, 2008).

Inspector General Dobbs uncovered incidences when several air carriers did not provide clear guidance between in-house and outsourced maintenance processes, and a method to perform outsourced maintenance and inspections at repair stations. This oversight lapse hindered FAA inspectors from conducting initial and follow-up inspections, detailed assessments of repair station and air carrier audits, and inputting inspection findings in a national database to be reviewed by other inspectors (OIG, 2008).

The ninth OIG audit report during November 2009 was cited by Inspector General Calvin L. Scovel on actions needed to improve safety oversight and security at aircraft repair stations. According to Inspector General Scovel, the OIG has reported since 2003 that FAA's oversight of aircraft repair stations has not been robust enough to ensure that outsourced maintenance was in compliance with FAA standards (OIG, 2009).

Specifically, the FAA did not know where all critical outsourced repairs were performed in the repair station industry. Instead, the organization has relied heavily on an air carriers' oversight of repair stations to include those air carriers that have known quality assurance problems. An air carrier is primarily responsible for its maintenance program to include outsourced maintenance. Accordingly, an air carrier is required by FAA regulations to audit a repair station before it can perform outsourced airline maintenance (OIG, 2009).

Inspector General Scovel also said the FAA has relied heavily on air carriers to inspect and determine if repair stations are suitable to perform outsourced maintenance—even air carriers with known quality assurance problems. These quality assurance flaws have hampered the FAA's ability to identify high risk facilities and determine if outsourced maintenance complied with FAA regulations (OIG, 2009).

During December 2010, the tenth OIG audit report was cited by Assistant Inspector General Jeffrey B. Guzzetti on the follow-up review initiated on the FAA's oversight of foreign and domestic repair stations at the request of Representative Jerry F. Costello, Chairman of the House Subcommittee on Aviation. Inspector General Guzzetti said domestic airlines have steadily increased with the outsourcing of their aircraft maintenance at repair stations. Thus, the OIG audit objectives were to examine the effectiveness of repair station changes as a result of FAA oversight and recognize any additional challenges (OIG, 2010).

During May 2013, the eleventh and final OIG audit report was cited by Inspector General Jeffrey B. Guzzetti on how FAA continues to face challenges in implementing a risk-based approach for repair station oversight. This report highlighted inadequacies of the FAA's enhanced, risk-based oversight system of U.S. repair stations that performed outsourced aircraft maintenance for domestic air carriers. The FAA has been responsible for the oversight of 4,062 domestic repair stations and 726 additional facilities overseas (OIG, 2013). Even though the FAA developed an enhanced, risk-based oversight system for safety inspectors to identify high-risk areas, it has placed more emphasis on completing mandatory inspections instead of targeting high-risk repair stations (OIG, 2013).

Inspector General Guzzetti said the FAA has failed to effectively employ its enhanced, risk-based oversight system to identify repair station deficiencies based on risk and verify that all findings have been corrected. The OIG reviewed 27 repair stations that perform outsourced aircraft maintenance for U.S. Part 121 airlines and uncovered numerous discrepancies. For instance, an FAA inspector determined that a repair station failed to maintain a current list of required mechanic training for three consecutive years; however, the inspector improperly accepted the repair station's corrective actions each time (OIG, 2013).

Several other deficiencies consisted of 57 out of 119 (48%) work orders that contained errors such as unserviceable tools that had expired calibration due dates, inadequate maintenance procedure training, and inaccurate work order documentation (OIG, 2013). Incorrected maintenance deficiencies such as these could lead to the use of improperly repaired aircraft parts on U.S. air carriers. As a result of the FAA's insufficient oversight, some repair stations may not be operating in full compliance with federal aviation regulations (OIG, 2013).

Additionally, FAA inspectors did not complete repair station inspections with the required enhanced, risk-based elements within appropriate time intervals. The FAA is required to complete these inspections at least once every three years so it can determine whether repair station operations have changed, such as a repair station that has contracted out maintenance to another facility. Conversely, the FAA's inspection database between 2009 and 2012 indicated that inspectors did not complete timely inspections at 20 out of 27 (74%) repair stations, which left inspectors unaware of any changes in operations that could impact risk levels (OIG, 2013).

The OIG (2013) also found that inspectors constantly performed inspections in areas of repair station operations where little or no risk was previously detected. Between 2009 and 2012, the FAA completed inspections at 24 out of 27 (89%) repair stations where little or no risk was previously identified.

To improve the FAA's enhanced, risk-based oversight system, the OIG provided nine recommendations to the administration (OIG, 2013), shown in Table 4. Upon receipt of those recommendations, the FAA concurred with all nine of the recommendations.

Table 4

Office of Inspector General Recommendations

	Nine Recommendations for the FAA
Recommendation 1:	Modify its oversight system so that all inspection elements are considered in inspector risk assessments of repair stations.
Recommendation 2:	Implement a risk-based system suitable for oversight of foreign repair stations.
Recommendation 3:	Modify the risk assessment tool so that inspectors can document changes to their surveillance plans as soon as they are made.
Recommendation 4:	Develop a control that will ensure inspectors prioritize inspections to those repair stations determined to have increased risk.
Recommendation 5:	Enhance training to inspectors so that they understand the importance of using the available tools for assessing and trending risk.
Recommendation 6:	Develop the Repair Station Data Package and provide training to all inspectors on how to use it.
Recommendation 7:	Develop a standardized checklist that all inspectors can use to improve the consistency in the way they perform and report their inspection findings.
Recommendation 8:	Provide training for inspectors to improve their review and acceptance of repair station corrective plans.
Recommendation 9:	Develop guidance and training to inspectors on how to conduct comprehensive briefings to repair station officials on inspection findings.

Notes: Adapted from "Recommendations," by the Office of Inspector General, 2013, *FAA Continues to Face Challengers in Implementing a Risk-Based Approach for Repair Station Oversight,* Report number: AV-2013-073, p. 16.

Repair Station Assessment Tool

Once the FAA implemented its enhanced, risk-based oversight system in 2007, the administration assimilated the Repair Station Assessment Tool (RSAT) as an enhanced supplement to this process. However, the RSAT's limitations in tool versatility and data availability precluded inspectors from using it and hindered the FAA's ability to effectively conduct enhanced, risk-based oversight. According to the OIG (2013), less than half of the FAA's audits at repair stations are based on RSAT risk-based assessments to identify and reinspect repeat violators who posed the greatest risks. Overall, there has been an apparent lack of training and standardization of repair station surveillance data to share with other FAA inspectors. Thus, the OIG (2013) concluded that the FAA failed to incorporate RSAT inspection elements and prioritize audits based on risk as part of its enhanced, risk-based oversight system.

The OIG (2013) reported that policies and procedures were incorporated in RSAT along with an automation tool necessary for the FAA to review findings. RSAT also provides inspectors with the ability to perform annual reviews with programmed inspection elements, shown in Table 5. Less than half of those inspection elements are based on risk.

Table 5

Inspection Elements and Frequency of Inspections

Required Annually	Based on Risk**
Maintenance Process	Certificate Requirements
Quality Control	Housing and Facilities
Technical Data	Manuals

Training	Parts and Materials
Air Carrier Requirements*	Personnel Records
Contract Maintenance (certificated repair facility)*	Records Systems
Contract Maintenance (non-certificated repair facility)*	Tools and Equipment
Domestic EASA Oversight Audit*	
Work Away from Station*	

* Only inspected if the element applies to the repair station.
** If no risk is detected, these elements are required to be inspected once every 3 years.

Notes: EASA = European Aviation Safety Agency. Adapted from "FAA Inspectors Use a Limited Risk-Based Approach to Repair Station Oversight," by the Office of Inspector General, 2013, *FAA Continues to Face Challenges in Implementing a Risk-Based Approach for Repair Station Oversight*, Report Number: AV-2013-073, p. 5.

According to the OIG (2013), the FAA does not have a functional system to perform accurate risk assessments of the domestic repair station industry because of critical weaknesses in its repair station oversight process. In reiteration, less than half of the inspection elements—7 out of 16 (43%) are evaluated based on risk. Also, inspectors do not have the proper tools to evaluate risks and lack the necessary training, which has led to inconsistencies in oversight and hindered the FAA's ability to prioritize surveillance based on risks (OIG, 2013).

During 2015, the FAA began implementing SAS as its next generation of surveillance for domestic air carriers and Part 145 repair stations. The information sharing features of SAS included an automated data collection tool that will give FAA safety inspectors a more comprehensive picture of a repair stations risk environment. Accordingly, SAS was designed to improve an inspector's ability to prioritize and develop a risk-based oversight surveillance program. SAS is expected to augment the

FAA's ability to evaluate the health of repair station systems and ensure that risks have been identified, documented, tracked, and effectively managed.

Air Carrier In-House Facility Comparison

Since 9/11, Videtich (2012) said most U.S. airlines have outsourced most or all of their in-house maintenance to Part 145 repair stations and non-certificated facilities, primarily due to financial reasons. Aircraft maintenance is a critical, safety-related function. However, Part 145 repair stations and non-certificated repair facilities that perform outsourced airline maintenance are not held to the same safety, quality, training, and security standards as the in-house maintenance facilities operated by the air carrier industry. Thus, the FAA has placed less emphasis on outsourced aircraft maintenance (Videtich, 2012).

Videtich (2012) also said the primary Part 145 repair stations that perform major airframe maintenance for the domestic airline industry consisted of the following outsourcers: AAR Aircraft Services, ATS, TIMCO Aviation Services, and PEMCO World Air Services. None of these operators were required to conduct background checks on their overhaul mechanics, unlike the requirements for mechanics who perform in-house maintenance for a U.S. air carrier. For example, TIMCO Aviation Services is an aircraft maintenance contractor for Delta, United, and US Airways. In 2005, Videtich (2012) said the OIG discovered multiple employees who were working on critical aviation maintenance structures with falsified immigration documents.

Certificated and Non-Certificated Repair Organizations

The FAA has minimal to no oversight of non-certificated repair facilities because certification is not required by the administration. Part 145 certification of repair facilities is not a federal requirement, but considered a quality improvement. Non-certificated repair facilities normally perform critical maintenance without the knowledge of the FAA (OIG, 2009).

Federal regulations allow air carriers to use non-certificated repair facilities as long as the mechanics approving the repairs are FAA certified and the air carrier provides oversight of the maintenance. However, the use of non-certificated repair facilities can create safety vulnerabilities. Because these facilities do not operate under FAA repair station certificates, they are not required to comply with regulatory and quality control standards. For example, non-certificated facilities are not bound by FAA operating requirements such as maintaining a quality control system (OIG, 2009).

Unlike U.S. Part 145 repair stations, there is no requirement for non-certificated repair facilities to employ supervisors and inspectors to monitor maintenance work as it is being performed. Non-certificated repair facilities are not required to have an aircraft hangar to perform maintenance. In fact, of the ten non-certificated repair facilities the OIG audited, two were operated by only one aviation technician with a truck and basic tools (OIG, 2009).

In addition to not being bound by FAA operational requirements, non-certificated facilities can perform a vast array of scheduled and critical repair work and engine replacements. When the OIG reported this finding in 2005, the FAA was unaware that domestic and foreign non-certificated repair facilities performed the same type of work as

Part 145 repair stations—not just minor aircraft work on an as-needed basis. The OIG reviewed records at three air carriers and identified 21 non-certificated repair facilities that performed outsourced maintenance critical to the airworthiness of aircraft (OIG, 2009).

Despite these vulnerabilities, neither the FAA nor air carriers regularly conduct on-site reviews of non-certificated repair facilities. In fact, the FAA had not inspected 6 of the 10 (60%) domestic and foreign non-certificated repair facilities the OIG reviewed. According to the FAA, the quality of repair work at non-certificated repair facilities was ensured because the mechanics at these facilities hold FAA certificates. However, as the OIG had reported in 2005, some mechanics at these facilities are temporary personnel and neither the FAA nor air carrier ensures that their work meets FAA standards. Moreover, Part 145 repair station certification involved additional controls to ensure repairs are performed properly. Specifically, Part 145 repair stations have approved quality control systems, undergo multiple levels of oversight, and have recurring training programs. It is incumbent upon the FAA to determine which non-certificated repair facilities perform critical and scheduled maintenance so that it can target inspections accordingly or limit the type of work these facilities can perform (OIG, 2009).

Outsourcing of Air Carrier In-House Maintenance

During the late 1990s and especially after 9/11, most of the U.S. airline industry could no longer afford to perform in-house aircraft maintenance. The outsourcing of airline maintenance to independent Part 145 repair stations or non-certificated repair facilities saved the industry as much as 67% in operating (labor) costs (GPO, 2012; OIG, 2005b; McFadden, 2012). This monumental change has allowed air carriers to reduce a

significant part of their operating costs by reducing or eliminating their in-house workforce of highly trained and compensated AMT employees to underpaid and non-certificated technicians at Part 145 repair stations or non-certificated repair facilities (Sheehan, 2013).

Most contractors at non-certified aircraft maintenance facilities are paid considerably less than AMT employees at a major airline. Outsourcing has decreased the need for expensive tools, specialized equipment, and maintenance facilities (GPO, 2012). The average hourly wages between FAA certified and non-certified AMTs is noted in Figure 1.

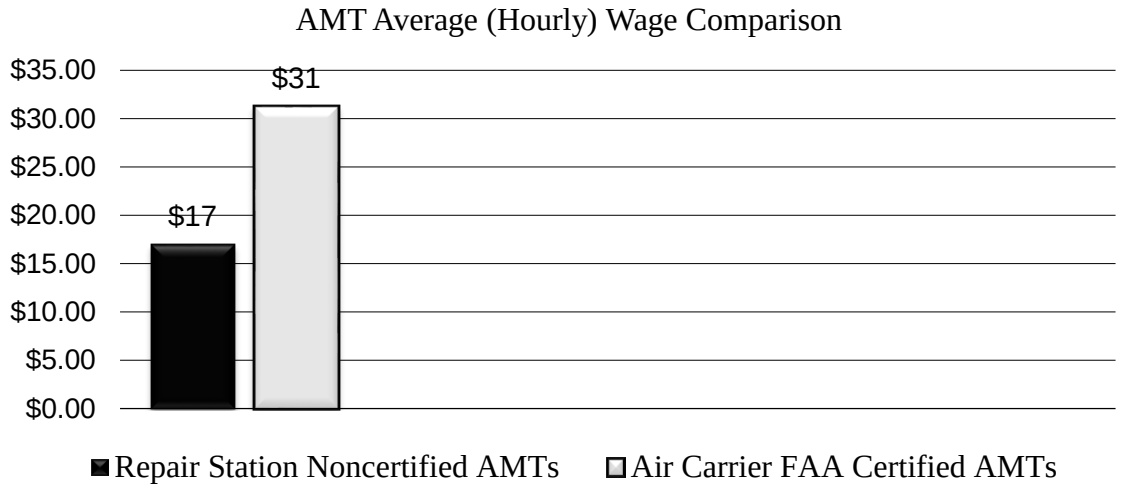

Figure 1. AMT Average Salary. The bar graph illustrates the hourly wage disparity between noncertified AMTs who are employed by U.S. Part 145 repair stations and FAA certified AMTs who are employed at a domestic air carrier. Adapted from "Personal Communication, May 21, 2015," *RSM02* and "Occupational Employment Statistics," by the Department of Labor, 2015, *Occupational Employment and Wages, May 2014: 49-3011 Aircraft Mechanics and Service Technicians.*

U.S. air carriers are primarily responsible for the airworthiness of its aircraft in accordance with 14 CFR Part 121.363 and 121.367(a), even when the maintenance is contracted to a Part 145 repair station or non-certificated facility provider (GPO, 2015).

When those providers perform maintenance for an air carrier, they must follow procedures in the respective air carrier maintenance manuals. Specifically, GPO (2015) said air carriers are required by 14 CFR Part 121.369(a) to maintain a listing of contractor maintenance providers and a general description of the outsourced maintenance.

The OIG (2008) said a typical air carrier general maintenance manual is predominantly geared toward in-house maintenance. Those manuals often fail to provide the necessary instructions for contractor maintenance providers to follow an air carriers' maintenance program. This problem is exacerbated when an air carrier's manual contains proprietary data. Air carriers are often reluctant to share proprietary information with contracted mechanics when they perform maintenance on a competitor's aircraft (GPO, 2012). As a result, the FAA identified numerous air carriers that have failed to list their maintenance providers with an adequate explanation of work procedures in air carrier maintenance manuals (GPO, 2012; OIG, 2008).

FAA regulations require the listing of contract maintenance providers to be comprehensive and readily accessible. Accurate data is necessary for the FAA to properly plan its surveillance of an air carrier maintenance program. This data will determine the manner that maintenance providers accomplish their work according to the air carriers' maintenance manuals. The lack of reliable information has hindered the FAA's ability to employ its inspection resources to inspect Part 145 repair stations and non-certificated facilities (GPO, 2012; OIG, 2013). GPO (2012) and OIG (2008) said most of the contractor listings are not in a current format that is readily available during audits by the FAA.

FAA Oversight Concerns

McFadden (2012) said high profile airline mishaps were attributed to outsourced maintenance errors and loss of life between 1996 and 2003 with the following aircraft: ValuJet Flight 592 (in-flight fire) in the Florida Everglades (NTSB, 1997), Alaska Airlines Flight 261 (inadequate lubrication of flight control jackscrew) off the coast of California (NTSB, 2002), Emory Worldwide Airlines DC-8 crash (improper installation of flight control system) in Rancho Cordova, California (NTSB, 2003), and the loss of Air Midwest Flight 5481 (improper rigging of the elevator control system) in Charlotte, North Carolina (NTSB, 2004). These events promoted the GAO and the OIG to audit the FAA and its oversight of the repair station industry, particularly domestic repair stations that performed outsourced aircraft maintenance for the U.S. air carrier industry (GAO, 1997; OIG, 2002; 2003; 2004; 2005a; 2005b; 2006; 2007; 2008; 2009; 2010; 2013).

While the domestic air carrier industry has noticeably contracted most of its in-house maintenance to repair stations, the FAA has struggled to increase its surveillance at Part 145 repair stations and non-certificated facilities. Thus, the FAA has not always ensured that correct maintenance procedures were accomplished (GAO, 1997; OIG, 2003; 2005a; 2005b; 2013).

FAA's Implementation of a Risk-Based Oversight System

A change in FAA surveillance was required after the May 1996 ValuJet DC-9 mishap in the Florida Everglades (GAO, 1997). Prior to 1998, the FAA's inspection program focused primarily on compliance with federal regulations and selected inspections, regardless of the level of risk.

During October 1998, the FAA gradually modified its traditional safety surveillance of air carriers and aircraft repair stations toward a risk-based system under the umbrella of ATOS. This arrangement was based on the data analysis of aircraft maintenance and air carrier operations to identify the most vulnerable areas susceptible to safety risks.

In 2005, the OIG continued scrutinizing the FAA's ability to oversee the U.S. air carrier industry after the September 11 terrorist attacks (OIG, 2005a; Richardson et al., 2014). An earlier OIG report cited FAA inspectors as having collaborative relationships with the air carrier industry, which has inhibited its ability to provide adequate oversight (OIG, 2008).

Non-certificated maintenance facilities that perform outsourced maintenance for U.S. air carriers has become another FAA oversight concern because these facilities are not subject to requirements of the FAA (OIG, 2005b). Instead, the FAA expects an air carrier to provide oversight. An air carrier that outsources its maintenance to a repair station must audit and provide oversight of that contracted facility in accordance with an approved maintenance program. According to the OIG (2005b), non-certificated repair facilities that perform critical maintenance create a double standard since certified repair stations (Part 145 repair stations) are required to have designated supervisors, inspectors, return-to-service personnel, and quality control systems. This requirement does not apply to non-certificated repair facilities (OIG, 2005b).

The OIG (2006) said FAA safety inspectors had completed several hundred inspections of one air carrier, even though no significant problems were discovered. Eight years later during 2013, the OIG (2013) said the FAA has continued to struggle with its

inadequate oversight surveillance system. Thus, the OIG urged the FAA to improve its risk-based oversight system to prevent or reduce additional mishaps related to outsourced maintenance errors.

After the FAA shifted to its enhanced, risk-based system in 2007, the OIG (2013) said the administration's risk-based oversight system lacked the means to accurately identify risks using a standardized inspection process. The risk-based system was poorly utilized by the FAA to collect data based on a set of factors to determine areas of risk and to assign inspectors to problematic repair stations (OIG, 2013).

Despite the FAA's implementation of its enhanced, risk-based system in 2007, the OIG (2009) testified for the third time during 2009 about a flawed FAA oversight system. According to the OIG, the FAA failed to follow a standardized process that would have allowed its safety inspectors to document findings and use that data as trend analysis to aid in detecting potential risks. In particular, the OIG discovered that the FAA's RSAT failed to include risk-assessment data beyond the previous year—rendering it useless to evaluate long-term surveillance trends (OIG, 2013).

FAA inspectors are required to use RSAT as a data collection tool to plan surveillance audits and analyze risks in the repair station industry (OIG, 2013; "Chapter 9," 2014). However, the OIG (2013) uncovered FAA safety inspectors who circumvented the required application of RSAT simply because they were not adequately trained to inspect repair stations. As a result, inspectors would often resort to conventional feedback methods such as hand-written notes because those inspectors lacked the necessary training and tools to effectively audit repair stations. Thus, the OIG (2005b; 2013) said the FAA's risk-based oversight system does not adequately monitor Part 145 repair

stations nor non-certificated repair facilities to identify potential risks using a standardized and consistent process.

Scholar Review

A Franco (2009) study consisted of qualitative phenomenological research in the southeast United States that examined the effects of increased FAA oversight at domestic Part 145 repair stations that performed outsourced maintenance for Part 121 carriers between 2000 and 2007. Those repair stations performed outsourced maintenance for the U.S. airline industry under the FAA's previous umbrella of a risk-based oversight system.

Remarkably, Franco (2009) explored operational changes in the domestic Part 145 repair station industry as a result of the FAA's risk-based oversight system. His work examined changes in the number of employees, training, facilities, inventory, part supply-chain logistics, recordkeeping, maintenance data, equipment, and management practices. After Franco interviewed 20 managers of Part 145 repair stations in the southeast United States, five major theme codes appeared from the data: *effects of oversight, quality of oversight, status quo of oversight, suggestions*, and *relationship with the FAA.* Of these five major theme codes, 20 subthemes materialized from the data. The themes and subthemes were used to explain the phenomenon of increased FAA oversight of the Part 145 repair station industry in the southeast United States between 2000 and 2007. The majority of Franco's participants found that the levels of oversight increased during that time period, and the depth and focus of the FAA inspectors had improved. Notwithstanding the increased oversight, Franco (2009) said there has been minimal financial impact on the domestic repair station industry.

The participants of Franco (2009) felt as though the program of increased FAA oversight still needed improvement. Results of the study indicated that the participants wanted FAA inspectors to apply oversight in a more standardized manner. The participants felt that FAA inspectors should become more proficient at interpreting regulations at every repair station to improve the quality of oversight, specifically those facilities that have a poor record of regulation compliance. Overall, the participants believed that when the FAA follows a standardized process to enforce compliance of regulations, repair stations can perform their scope of work more effectively and efficiently to ensure civil aviation safety.

Air Carrier and Repair Station Penalties

The highest proposed and administered fine by the FAA occurred on August 26, 2010, when the administration recommended a $24.2 million civil penalty against American Airlines for the noncompliance of AD 2006-15-15. This error involved the substandard maintenance of approximately 300 McDonnell Douglas MD-80 airplanes by American Airline technicians and contractors (repair station employees). FAA safety inspectors discovered electrical wiring errors that could have led to fuel tank explosions and fires. Therefore, American Airlines was charged with a record penalty of $24.2 million due to incorrect maintenance procedures that enabled the potential chafing of electrical wires in the wheel wells of its MD-80 series jets (Lunsford, 2010).

On July 28, 2014, the FAA proposed its second largest fine of $12 million against Southwest Airlines after their contractor at a Part 145 repair station, Aviation Technical Services (ATS), was in noncompliance with FAA regulations during Boeing 737 repairs. FAA investigators alleged that Southwest Airlines failed to properly supervise ATS

contractors who performed aircraft maintenance (airframe modifications) to eliminate cracks on the aluminum skin of 44 jetliners. FAA investigators also determined that ATS failed to follow maintenance procedures for replacing the fuselage skins on these aircraft (Lunsford, 2014).

Although there has not been a catastrophic U.S. air carrier mishap since 2003 as a result of outsourced maintenance errors from a domestic repair station, the FAA has struggled to adequately detect outsourced maintenance errors that could lead to additional mishaps. Between 2010 and 2015, the FAA has proposed and administered $16,855,400 in civil penalties to 14 out of 4,062 (3%) repair stations (Table 6), which is a mere fraction of the domestic Part 145 repair station industry (FAA, 2015d: OIG, 2013).

Table 6

Repair Station Civil Penalties

Date	Repair Station	Penalty Summary	Penalty Fine
7/31/2015	TAD PGS, Inc.	Failed to include nine safety-sensitive repair station employees in its random drug and alcohol testing program.	$177,800
7/22/2015	Eaton Corp - Aerospace Ops	Failed to include six safety-sensitive repair station employees in random drug and alcohol testing pools.	$173,100
11/21/2014	AAR Aircraft Services, Inc.	Used an unqualified repair station employee to perform 18 tasks on a major air carrier's aircraft.	$150,000
9/18/2014	Tecom Industries, Inc.	Failed to include 14 safety-sensitive repair station employees in its random drug or alcohol testing pools.	$417,000
9/12/2014	Worldwide Flight Services	Five unqualified repair station employees performed de-icing procedures on 12 American Eagle aircraft.	$60,000
7/28/2014	Aviation Technical Services, Inc.	Failed to follow proper procedures for replacing the fuselage skins on 44 jetliners.	$12,000,000

10/23/2012	Circor Aerospace, Inc.	Failed to conduct pre-employment and negative drug verifications for 29 safety-sensitive repair station employees.	$205,250
10/23/2012	Woodward, Inc.	Failed to conduct required pre-employment and negative drug verifications for 12 safety-sensitive repair station employees.	$246,450
10/23/2012	GKN Aero Chem-Tronics, Inc.	Failed to conduct pre-employment and negative drug verifications for 17 safety-sensitive repair station employees.	$359,350
10/21/2011	Streamline Aviation, Inc.	Failed to complete the proper repairs and inspections on at least 62 landing gear parts.	$241,200
9/21/2011	Aviation Technical Services, Inc.	Failed to properly inspect and replace the fuselage skins on 44 Southwest Airlines B-737-300s.	$1,100,000
1/21/2011	Pemco World Air Services	Failed to carry out required follow-up drug or alcohol testing of 24 repair station employees.	$170,000
1/20/2011	San Antonio Aero LP	Failed to conduct pre-employment and negative drug verification before hiring 90 safety-sensitive repair station employees.	$1,025,000
11/19/2010	Aviation Technical Services, Inc.	Failed to follow approved procedures to detect fuselage skin cracks on 14 Southwest Airlines Boeing 737s.	$530,250
			TOTAL $16,855,400

Notes: According to 14 CFR 120.105, employees who are employed in safety-sensitive occupations such as an airframe and powerplant technician must be subjected to drug testing under a drug testing program. An air carrier is subject to a penalty up to $11,000 for a single violation of a federal aviation regulation or aviation law while other entities are subject to a penalty up to $1,100. For a single violation of federal aviation regulations or aviation law, large business concerns are subject to a penalty up to $25,000 while small business concerns are subject to a penalty up to $10,000. A small business is one that earns less than $7.5 million per year. Adapted from "News Search," by the Federal Aviation Administration, 2015e, *News Type: Press Release,* and "NAICS Search Results," by the NAICS Association, 2015, *Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance* (NAICS Code 811310).

Summary

During 2007, the FAA began upgrading its risk-based oversight system with an enhanced, risk-based oversight system. Thus, there has not been any study to examine the phenomenon of enhanced, FAA oversight of the domestic repair station industry. Notwithstanding, the Franco (2009) study between 2000 and 2007 found that most of his participants rejected the FAA's strategy for increased safety surveillance of the Part 145 repair station industry. The participants (repair station maintenance directors) contended that FAA inspectors should focus most of their oversight at repair stations that have a history of FAA violations (Franco, 2009).

Franco (2009) interviewed 20 maintenance directors in the southeast United States. Franco's results indicated that most of his participants did not believe that increased FAA oversight would improve the safety of air transportation. Instead, they felt that the administrator of the FAA should revise policies of standardization, which would increase safety throughout the U.S. air carrier industry.

Since 2003, the OIG has emphasized weaknesses in the FAA's oversight along with catastrophic airline mishaps that resulted from repair station maintenance errors (NTSB, 1997; 2002; 2003; 2004). The FAA has repeatedly failed to target facilities with the greatest risks.

Specifically, the OIG discovered repair station lapses to otherwise ensure air carrier manuals were followed when contracted maintenance was performed by repair station employees (OIG, 2010; 2013). Since air carriers have an increased reliance upon repair stations to perform its aircraft maintenance, it is crucial for the FAA to increase its surveillance (OIG, 2011; 2013).

Although there has not been a major mishap of outsourced maintenance since 2003, the FAA has since proposed and administered 14 repair station civil penalties due to faulty aircraft maintenance at a cost of $16.8 million between 2010 and 2015 (FAA, 2015d). As long as there are lapses in FAA oversight, it will continue to appear in the literature.

CHAPTER III.

METHODOLOGY

Purpose

The purpose of this qualitative phenomenological study was to conduct in-depth personal interviews with managers of Part 145 repair stations in Oklahoma. It involved those managers who superintended outsourced maintenance for domestic air carriers in the wake of enhanced, risk-based FAA oversight. Interviews were essential to determine potential gaps in existing aerospace safety curriculum, as well as informing and supporting efforts to keep Oklahoma competitive for outsourced maintenance by the U.S. air carrier industry.

Theoretical Perspective

Epistemology

The epistemology of this study consisted of constructionism, where research was socially and individually constructed with Part 145 repair station managers in Oklahoma. Epistemology, according to Dawson (2009), is a study of knowledge, while Crotty (1998) and Dawson (2009) said epistemology is the theory of knowledge ingrained in a theoretical perspective (Figure 2).

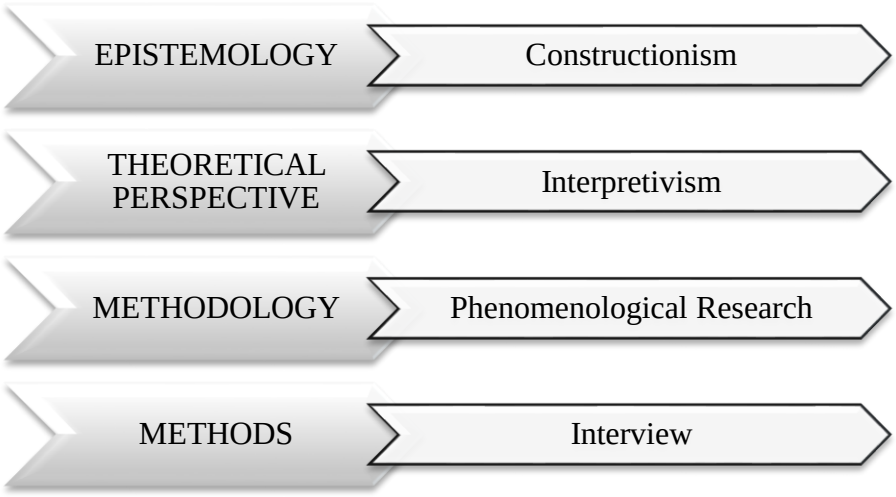

Figure 2. Research Perspective.

The theoretical perspective informed the research project through *interpretivism*. Crotty (1998) defined theoretical perspective as the philosophical stance to inform and provide structure for the research process. Schwandt (1994) described theoretical perspective as everyday conceptions and circumstances to obtain knowledge from the research. With interpretivism, individuals can interpret and measure another person's interpretation of the world by metaphorically placing themselves in their shoes, a process known as Verstehen (Denzin & Lincoln, 2000). In this study, the researcher observed, interpreted, and measured the participants' personal feelings (lived experiences) of the Part 145 repair station industry.

The methodology element of phenomenological research examined the meaning, principle, and experience arrangement of Part 145 repair station managers and effects of enhanced, risk-based FAA surveillance. Crotty (1998) explained the purpose of the methodology element was to achieve a desired outcome. The common methodology used in this study was a qualitative phenomenological study of Oklahoma Part 145 repair station managers who were interviewed and asked a specific set of open-ended questions.

The phenomenological approach was appropriate for this study to identify safety curriculum needs for the aerospace industry, particularly outsourced airline maintenance from the U.S. air carrier industry.

The methods element involved the personal interviews of repair station managers. Interview data from this study had several truths, different voices, and descriptions of what participants believed was the phenomenon of enhanced, risk-based FAA oversight and outcomes of outsourced maintenance practices in Oklahoma's repair station industry. The methods element is also defined as the mode to obtain and examine data related to research questions (Crotty, 1998).

Guest, Bunce, and Johnson (2006), and Dawson (2009) said a homogeneous strategy of purposive sampling with a small group can improve the legitimacy of a study. Homogeneous sampling is appropriate for a small group of participants who have a comparable background and occupation experience (Patton, 2015). In this study, homogeneous sampling was appropriate for Part 145 repair station managers who superintended outsourced maintenance from the U.S. air carrier industry. Findings from the interview process of these managers, when compared to a literature review of FAA's oversight system, provided valuable insight. Results of the findings can be used to improve the management and surveillance of Part 145 repair station maintenance, particularly outsourced maintenance from the U.S. air carrier industry.

The underlining goal of phenomenological research is for the participants voices to be heard (Berg & Lune, 2011; Creswell, 2014). Research data can provide valuable insight using a phenomenological approach by dividing the procedures into statements, transforming them into meanings, and tying the results together to make a general

description of the experience (Patton, 2015). Using this methodology, research questions were a mechanism for the participants' voices to be heard by exploring the meaning of their personal experiences.

Since the methodology of this study consisted of a qualitative field study, a small sample of managers from the Oklahoma Part 145 repair station industry were interviewed with semi-standardized, open-ended questions. One of the crucial expectations of phenomenological research is to understand that the world has coherent arrangements (Rudestam & Newton, 2007; Creswell, 2014). The research questions in this study were used to generate data and comprehend the intricacies of enhanced, risk-based FAA oversight and outsourced maintenance practices at repair stations.

Sample and Population

All types of sampling in qualitative research can be classified under the broad term of purposeful sampling (Patton, 2015). Patton emphasized the term 'homogeneous purposive sampling' as one of the 20 different strategies to purposefully sample participants for information-rich data. Patton said homogenous sampling was essential to sample participants who have a similar perspective, attitude, or knowledge, whereas Miles, Hubberman, and Saldana (2014) emphasized that it can be used to sample people who share similar demographic or social characteristics. In this study, the homogenous sampling strategy was appropriate for Oklahoma Part 145 repair station managers (accountable managers and quality directors) who superintended outsourced aircraft maintenance for domestic air carriers. These managers normally have the highest level of knowledge of the organization and interaction between FAA inspectors and their repair station employees.

Part 145 repair station managers were randomly sampled and interviewed from a pool of 127 repair stations in Oklahoma. In order for every participant of the repair station population to have an equal opportunity of being selected, the researcher utilized the Stat Trek website as an analytical tool to generate a table of 127 random numbers (Stat Trek, 2015). Creswell (2014) described this process as random sampling in which each individual in the population has an equal probability of being selected. Next, the researcher used the snowball sampling method to select Part 145 repair station managers who had at least five years of experience superintending outsourced Part 121 air carrier maintenance.

The sample size of this study reached its saturation point with a small population of 9 out of 127 repair station managers in Oklahoma. Scholars differ with their interpretation of saturation point concepts and the minimum number of participants to use in a qualitative study. Dawson (2009) said a sample size should be limited to a saturation point when no new explanations or ideas have appeared from the study. Creswell (2014) argued that between 2 and 10 participants were adequate for a saturation point, whereas Leedy and Ormrod (2005) said 5 to 25 experienced participants are an appropriate sample size.

Unlike a quantitative design, Patton (2015) said there are no set rules for a sample size in a qualitative study. Collection methods exploited in phenomenological research often involve in-depth interviews and use a relatively small sample size because phenomenological research relates to the lived experiences of individuals.

In qualitative research, which is inductive by nature, the explanation provided by the sample is more important than the sample size (Lofland, Snow, Anderson, & Lofland,

2006). For example, 12 participants was the appropriate sample size for this particular study. After conducting nine interviews, the researcher determined that the saturation point had been accomplished because no new themes had emerged from the data. Notwithstanding, the data-gathering process in this study was concluded after the twelfth interview.

Expert panel members were selected with the snowball sampling method to improve the legitimacy of this study based on the following requirements:

1. Three panelists must have more than five years of aerospace experience in their respective occupations: Part 145 repair station quality director, FAA Flight Standards District Office (FSDO), ASI, and Oklahoma Aeronautics Commissioner.

2. The panelists must have the experience, knowledge, or training related to aircraft maintenance management and human factors.

3. The two panelists (ASI and Part 145 repair station manager) must be knowledgeable of repair stations that perform outsourced U.S. airline maintenance.

4. The Oklahoma Aeronautics Commissioner must have limited knowledge of the Part 121 and Part 145 repair station industry to increase the likelihood of a non-biased view of the FAA and repair stations under FAA scrutiny.

One peer reviewer was identified with the snowball sampling method to enrich the legitimacy of this study. The sampling methodology was based on the following requirements:

1. The peer reviewer must not have any link to the study or researcher.

2. The peer reviewer must have more than ten years of aerospace experience as a MRO manager with a doctorate degree.

The snowball method was used to select two triangulating analysts to help the researcher increase the legitimacy of this study based on the following requirements:

1. One triangulating analyst must have at least five years of aerospace experience as a DOT OIG auditor with no link to the researcher.

2. The second triangulating analyst must have more than five years of aerospace experience as a general aviation corporate officer with a doctorate degree, and limited knowledge about the Part 145 repair station and U.S. air carrier industry to promote an unbiased response.

Instrumentation for Data Collection

The primary instrument used to gather data for this phenomenological study consisted of semi-structured, open-ended questions. A questionnaire was developed and implemented to address objectives of this study (Appendix D). These interview questions were created to specifically probe the participants for their lived experiences of enhanced, risk-based FAA oversight. Phenomenology is centered on recovering the understanding of a living moment and how words, theories, and concepts have shaped lived experiences (Patton, 2015).

Berg (2007) and Dawson (2009) said a semi-standardized interview arrangement allows an interviewer to make clarifications during an interview and apply specific information. During this study, vital information surfaced from the interview process of 12 participants. It revealed the lived experiences of Part 145 repair station managers who had experienced enhanced, risk-based FAA oversight between 2007 and 2014.

Before interviews could be conducted, the researcher employed the Delphi method. It consisted of questionnaires to evaluate the clarity of the research questions by

a panel of three experts from the FAA, Part 145 repair station industry, and Oklahoma Aeronautics Commission. The Delphi method is used by researchers to gather expert opinions and rich details through the experts' voices (Delbecq, Van de Ven, & Gustafson, 1975; Boje & Murnighan, 1982; Cantrill, Sibbald, & Buetow, 1996; Patton, 2015).

There are no general rules according to Linstone and Turoff (1975) that determine the size of an expert panel. Therefore, a panel size of three aerospace experts who had the necessary skills (aircraft maintenance management and human factors) was adequate for this study.

The Delphi method consisted of three rounds with three expert panelists who reviewed, revised, and authenticated the open-ended research questions. Round one involved the preliminary feedback by these experts to validate if the research questions would clearly invoke an open-ended response.

Round two resulted in several revisions by the panelists to streamline the research questions. As a result, 5 of 12 (42%) research questions were considered redundant and eliminated or streamlined. The panelists also felt that it was relevant to add a brief synopsis of the FAA's ATOS surveillance program for the participants and a disclaimer that asked them to provide honest answers during their interviews.

Round three was the final session. All three panelists felt that the remaining seven research questions were sufficient for the study and would clearly evoke an open-ended response by participants of the study. The seven modified research questions were expeditiously reviewed and approved by the Oklahoma State University (OSU) IRB office. According to Delbecq et al. (1975), and Okoli and Pawlowski (2004), the Delphi method can be utilized to validate research questions.

After the Delphi process was completed, the interview questions were tested during a mock (practice) interview with a quality director at a Part 145 repair station in Oklahoma. The purpose of a mock interview is necessary to obtain feedback to validate the clarity of open-ended research questions (Seidman, 2006).

The next step involved the participants of the study (Part 145 repair station managers). The participants were provided with a participant letter (Appendix B) and informed consent document (Appendix C) before they could contribute in private and in-depth interviews. The letter and consent form explained the purpose of the research, location, and time of their interview, and how their identities would be protected. Participants were also contacted by telephone to finalize their appointment location and time between 24 and 48 hours before the interview.

Permission to digitally audio record the interviews was requested in advance. Oral and written assurances were rendered before, during, and after each interview to protect sensitive information. Audio media and paper notes were destroyed by the researcher after the research data was evaluated and dissertation successfully defended on March 2, 2016. Information that was known to be sensitive was not included in the final study.

Method for Collection of the Data

The initial contact with 12 of 12 (100%) participants began with a phone call to explain the purpose of the study. Once the participants agreed to an interview, a time and meeting location was scheduled with all but one participant, who elected to have a telephone interview. A follow-up email was submitted after initial telephone contact had been established. All interviews were recorded with a Sony Digital Voice Recorder ICD-UX533 and Olympus VN-702PC Digital Voice Recorder as a backup device. Audio

recordings were transcribed in verbatim format. The researcher also took field notes during each interview as an additional source of data. Each of the participants was given a thank you card after their interviews via the United States Postal Service (USPS).

Instead of hiring an outside transcriber, the researcher meticulously transcribed verbatim 12 digital audio recordings to benefit from the immersion of data. These transcripts were stored on a password-protected hard drive and external hard drive (backup media) in the event of a computer failure. The external hard drive was stored in a secured safe.

Validation of the Instruments

Triangulation was used to increase the validity and confidence of this study. Patton (2015) found that triangulation will strengthen a study by combining methods, while Miles et al. (2014) suggested triangulation is a corroboration of three different sources. Patton went as far as to suggest that triangulation is used to improve the trustworthiness of a researcher's analysis.

In quantitative studies, validity frequently refers to how well an instrument measures something that it was intended to evaluate while reliability refers to the consistency of the results from the evaluating instrument. According to Gibbs (2007), the term validity occurs when the researcher checks for the accuracy of the findings by applying detailed procedures, while reliability occurs from different researchers and projects.

In qualitative studies, conversely, due to a common link with quantitative studies, researchers often replace the terms validity and reliability with the following terms: transferability, trustworthiness, and credibility. Although Creswell (2014) appreciated the

terms validity and reliability, Patton (2015) preferred quality and credibility while others favored trustworthiness and rigor (Gelo, Braakmann, & Benetka, 2008; Bloomberg & Volpe, 2012).

Validity and Reliability of the Study

Creswell (2014) identified eight primary strategies for the researcher to maintain validity and eliminate or reduce bias from the findings of the data, while Gay, Mills, and Airasian (2012) contended that validity occurs when the data is not biased. Gathering data from multiple sources and methods yields a fuller and richer picture of the phenomenon under review. Patton (2015) said triangulation is one of those strategies to collect data from multiple sources as a means of cross-checking and corroborating evidence as a theory. In this study, the researcher employed data triangulation and investigator triangulation to improve the credibility of the data (Figure 3).

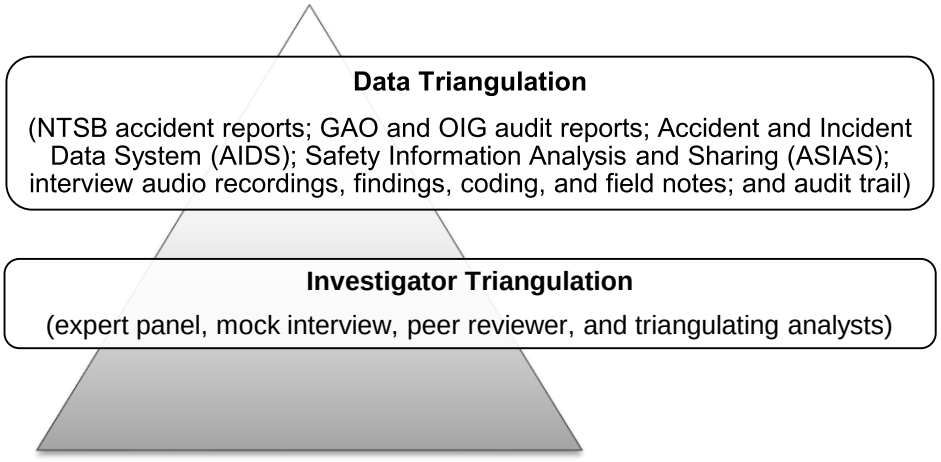

Figure 3. Triangulation Process.

Triangulation was used in a four-step process during this study. Step one involved the investigator triangulation of three expert aviation panel members who investigated,

revised, and authenticated the research questions. Each of the investigators had more than 30 years of aerospace experience.

Step two consisted of a mock interview with a quality director who had 27 years of experience at a Part 145 repair station in Oklahoma. This practice interview was necessary to verify if the research questions would clearly evoke an open-ended response. Feedback from the mock board led to the validation of seven out of seven (100%) research questions. The purpose of a mock interview is to receive additional feedback to increase the credibility of the data (Seidman, 2006).

Step three was comprised of the data triangulation of one GAO audit report and 11 OIG audit reports, 12 participant interviews (audio recordings, field notes, coding, and findings), four NTSB accident reports, the Accident and Incident Data System (AIDS) and Aviation Safety Information Analysis and Sharing (ASIAS) database, and the researcher's audit trail. The researcher believed that the NTSB accident reports and ASIAS data of U.S. air carrier in-flight incidents due to protracted and ongoing maintenance errors has enriched the credibility of this study.

The participants of the study were identified by an alias to protect their identities after the researcher personally transcribed verbatim the interview recordings. In order to obtain member feedback, a copy of the transcribed interview was emailed to the participants. All of the participants were given a seven-day suspense to review the accuracy of their manuscript and any changes concerning the interview data.

The researcher used Microsoft Excel, Word, and NVivo software to categorize responses from the participants into particular themes, a process known as coding. Patton

(2015) said the coding process is used by researchers to develop, manage, and classify raw data.

Step four consisted of investigator triangulation with three triangulating analysts (researcher, and evaluators A and B) and one peer reviewer to evaluate the consistently of research data. Coding categories were developed and refined on an ongoing basis, guided by the studies conceptual framework. The peer reviewer independently reviewed this study on several occasions so that the account reflected the views of someone other than the researcher. Patton (2015) said peer debriefing is a process intended to improve the accuracy of a described phenomenon. Patton also compared it to a review by inquiry while Rudestam and Newton (2007) and Creswell (2014) identified it as a peer review.

The two triangulating analysts (evaluators A and B) had no direct relationship with the researcher or the study and reviewed the non-coded interview manuscripts. Evaluator A was an executive vice president at an exclusive general aviation public use airport with more than 20 years of experience in the general aviation industry. Evaluator B was a DOT OIG employee with 32 years of experience and has served as an aviation senior analyst for the last 23 years. Patton (2015) encouraged the use of two or more individuals to independently analyze the non-coding and coding process, and compare their findings. A comparison of the results of the analysts and researcher is described at Appendix E.

Throughout the study, the researcher maintained an audit trail in case it became necessary for others to recapture certain steps and reach similar conclusions. Rudestam and Newton (2007) said an audit trail is a detailed record of a critical self-reflection, which may be necessary so that others could achieve comparable conclusions.

Ethical Assurances

Human subjects were an integral part of this study. Research was conducted in accordance with IRB requirements established by the OSU Office of University Research Compliance (URC). The researcher obtained IRB approval from the URC before conducting any research and gathering data (Appendix A). Researchers are morally bound to conduct research in a way that reduces plausible harm to those involved in a study. Academic institutions that conduct human research have IRB officials who review research requests. These officials ensure researchers have considered potential risks and benefits of the subjects with obligatory protocols that protect their identities (Rudestam & Newton, 2007; Patton, 2015).

Dawson (2009) said ethical precautions are essential to protect the anonymity or confidentiality of participants in a study. Accordingly, the researcher deliberately skewed the demographic data (names) of the participants to protect their identities.

Oral and written ethical assurances were rendered with an informed consent statement. A copy was provided to 12 participants (Part 145 repair station managers), three expert panel members, three triangulating analysts, and one peer reviewer. The consent form was sent to these participants by electronic mail (email) prior to their participation.

To ensure participants understood the consent form, it was read aloud to them before they signed the IRB document and participated in the study. Participants were informed that the researcher was not affiliated with any federal, state, or local law enforcement agency that could take legal action against the FAA certificate of the repair station under study. To minimize any disruption to the selected repair stations and

prevent unwanted bias of the data, the interviews were conducted in an area considered impartial to both the researcher and participants. None of the participants were offered any remuneration.

Anonymity was an important ethical consideration when examining regulated repair stations. In this study, anonymity was ensured with purposeful sampling strategies to reduce any traceability of the respondents. The participating repair station managers, expert panel members, peer reviewer, and triangulating analysts had the right to withdraw at any time during this study. To ensure anonymity, the identities of the repair station participants were not revealed to the expert panelists, peer reviewer, and triangulating analysts.

After the final study was completed and dissertation successfully defended on March 2, 2016, the audio recordings and other personal identified material was destroyed to safeguard the confidentiality of the participants. All written research data and electronic study material was placed under lock and key in a safe; it will be destroyed three years after the last interview, which was conducted on June 19, 2015. Upon request, a copy of the dissertation will be furnished to the participants.

Geographical bias was a nominal concern because Oklahoma is ranked eighth among the 50 states as having 63.2% of the MRO employment of the U.S. market; Oklahoma has a total economic activity of $1.2 billion (Wyman, 2015). There were seven domestic air carriers (Table 7) scheduled in Oklahoma as compared to an overall sum of 121 domestic air carriers scheduled in the U.S. (DOT, 2015; “Will Rogers World Airport,” 2015).

Table 7

Scheduled Part 121 Air Carriers in Oklahoma

Air Carriers	Significance
Alaska	Alaska Airlines offers daily nonstop service between the Will Rogers World Airport and Seattle-Tacoma International Airport.
Allegiant	Allegiant provides nonstop flights to Las Vegas for Oklahoma City travelers.
American	American Airlines is a major U.S. air carrier. American's primary maintenance facility (Part 121 and Part 145 certified) is located at the Tulsa International Airport. American offers nonstop departures to Dallas/Ft. Worth, Charlotte, Chicago, and Los Angeles.
Delta	Delta Airline is a major U.S. air carrier that provides nonstop service to Atlanta, Detroit, Minneapolis, and Salt Lake City.
Southwest	Southwest Airlines is a major U.S. air carrier that transports the most passengers in and out of Will Rogers World Airport.
United	United Airlines is a major U.S. air carrier and offers nonstop departures to Chicago, Denver, Houston, New York/Newark, San Francisco, Washington, and Los Angeles. United has plans to outsource all jobs at Will Rogers World Airport and Tulsa International Airport.
US Airways	US Airways is a major U.S. air carrier and offers nonstop departures to Dallas/Ft. Worth, Charlotte, Chicago, and Los Angeles. US Airways merged with American Airlines under a single operator's certificate on April 8, 2015.

Notes: Of the seven aforementioned air carriers, five are considered major U.S. airlines (American, Delta, Southwest, United, and US Airways). Adapted from "Flights," by the Will Rogers World Airport, 2015, *Will Rogers World Airport.*

There were 127 total Part 145 repair stations in Oklahoma as compared to an overall sum of 4,062 repair stations in the U.S. (FAA, 2015b; OIG, 2013). The limited ratio of 7 air carriers to 127 repair stations in Oklahoma (Figure 4) was consistent with the national ratio of 121 air carriers to 4,062 repair stations (Figure 5).

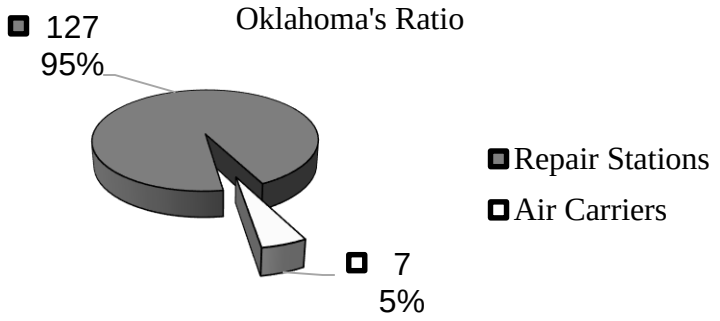

Figure 4. Oklahoma's Population of Part 145 Repair Stations and Part 121 Air Carriers. The pie chart indicates the total number of repair stations and scheduled air carriers in Oklahoma. Adapted from "Exhibit C. FAA-Certified Repair Station Locations," by Office of Inspector General, 2013, *FAA Continues to Face Challenges in Implementing a Risk-Based Approach for Repair Station Oversight*, p. 23, and "Repair Station – Search," by the Federal Aviation Administration, 2015b, *Repair Stations*.

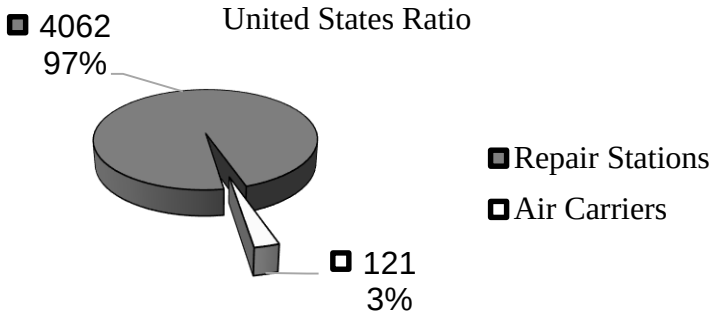

Figure 5. U.S. Population of Part 145 Repair Stations and Part 121 Air Carriers. The pie chart illustrates the total number of repair stations and scheduled air carriers throughout America. Adapted from "Exhibit C. FAA-Certified Repair Station Locations," by Office of Inspector General, 2013, *FAA Continues to Face Challenges in Implementing a Risk-Based Approach for Repair Station Oversight*, p. 23, and "Repair Station – Search," by the Federal Aviation Administration, 2015b, *Repair Stations*.

Delimitations

Delimitation is a method used to describe how the scope of a particular study will be narrowed in support of the problem statement. There were two delimitations concerning how the scope of this study was constricted:

1. This study was delimited to a qualitative phenomenological study concerning the lived experiences of Part 145 repair station managers.

2. This study was not attainable through other methods such as a case study or quantitative inquiry.

Timeline for Conducting the Study

The researcher's initial contact with Part 145 repair station managers to schedule 12 interviews took one week during May 2015. All interviews were completed the following month. The digital, audio-recorded transcriptions of the interviews and a comprehensive analysis of the data (findings, summary, conclusions, and recommendations) was completed by December 2015.

CHAPTER IV.

FINDINGS

Introduction

The purpose of this qualitative phenomenological study was to explore the lived experiences of domestic Part 145 repair station managers concerning changes in outsourced Part 121 air carrier maintenance practices between 2007 and 2014 after the FAA enhanced its risk-based oversight system in 2007. It was understood that the participants could offer valuable insight and make recommendations for future aviation management curriculum at technical-vocational schools, colleges, universities, and apprenticeship programs.

In-depth personal interviews were conducted with repair station managers from the commercial and private sector of Oklahoma. The 12 participants' interviewed for this study were selected from the Oklahoma repair station industry. These in-depth interviews were believed to have a rich source of data to define educational requirements not only in the Oklahoma aerospace industry, but also to academically provide insight into aerospace education requirements in general. The richness of the data in qualitative interviewing is directly related to the expertise of the participants' in their field as represented in the demographic information section of this chapter.

Demographics

To give the reader an idea of the participants' background, Table 8 briefly lists the 12 participants from the repair station industry in Oklahoma.

Table 8

Repair Station Managers

RSM Participants			Education	Military	Aerospace Experience	Employees
Name	M/F	Cert	Degree	Br, Rnk, Per	(Executive Managers)	Total
RSM 01	M	A&P		U.S. Army	Quality Director 13 years in RS 27 years in aviation	571
RSM 02	M	A&P		U.S. Air Force (Contractor)	Accountable Manager 40 years in RS 50 years in aviation	32
RSM 03	F	A&P	BS - Avn Mgmt	U.S. Army Major	Accountable Manager 7 years in RS 21 years in aviation	5
RSM 04	M		BS - Mech Eng		Accountable Manager 20 years in RS 28 years in aviation	50
RSM 05	M	A&P	BS - HR		Accountable Manager 20 years in RS 28 years in aviation	4
RSM 06	F	A&P	BS - Acct		Quality Director 16 years in RS 16 years in aviation	31
RSM 07	M	A&P	BS - Bus Admin		Accountable Manager 13 years in RS 29 years in aviation	5018
RSM 08	M	RM			Quality Director 22 years in RS 40 years in aviation	93
RSM 09	M				Quality Director 11 years in RS 30 years in aviation	561
RSM 10	M			U.S. Navy PO2 6 Years	Quality Director 12 years in RS 30 years in aviation	63
RSM 11	M	A&P	MBA	U.S Air Force 4 Years	Accountable Manager 20 years in RS 39 years in aviation	322
RSM 12	M	A&P			Accountable Manager 35 years in RS 35 years in aviation	7

Notes: Accountable Manager = A designated (FAA mandated) duty position at Part 145 repair stations. RSM = Repair Station Manager. A&P = Airframe & Powerplant certified mechanic rating by the FAA. RM = Repairman mechanic rating from the FAA. MBA = Master of Business Administration. BS = Bachler of Science. RS = Repair Station. HR = Human Resource. AVN Mgmt = Aviation Management. Mech Eng = Mechanical Engineer. Cert = Federal Aviation Administration Certificate. Bus Admin = Business Administration. Serv = Service. Yrs = Years. PO2 = Petty Officer Second Class. Br = Branch (military affiliation). Rnk = Rank (military rank). Per = Period (military term of service).

Themes

Data from the interview process was organized according to major themes and subtheme coding arrangements from the seven questions that were posed to the participants. Twenty-three individual codes emerged from the transcribed interview data (Table 9). The 23 individual codes of data were arranged into six major themes with 17 subthemes.

Table 9

Major Themes and Subthemes

Major Themes	Subthemes
Quality of oversight before 2007	Level of standardization Uncertainty
Quality of oversight after 2007	Level of standardization Employment Management changes No change
Advantages of oversight	Efficacy No advantage Uncertainty
Disadvantages of oversight	Burden No disadvantage
Status quo of oversight	Frustration Transparency Uncertainty
Process improvement	Inadequate oversight Inadequate training Lessons learned

Repair Station Participant Analysis

Question 1. How long have you been associated or employed with the Part 145 repair station industry?

The first interview question was intended to illustrate the years of experience each manager had in the Part 145 repair station industry. Only managers who had at least five years of experience with outsourced maintenance from the domestic air carrier industry could provide usable data concerning the phenomenon of enhanced, risk-based FAA oversight between 2007 and 2014. The years of experience for each manager in Table 10 ranged between 7 and 40 years, with an average of 20 years for the 12 participants.

Table 10

Participants: Number of Years in Repair Station

Years	No. of Participants	Percentage
5-10	1	8%
11-15	4	33%
16-20	3	26%
21+	4	33%

Although participants RSM03, RSM11, and RSM12 did not currently superintend outsourced maintenance for the U.S. air carrier industry, their interviews were considered part of the data because Participants RSM03 and RSM11 were former FAA ASI employees. Their insight was considered valuable for this study. Participants RSM11 and RSM12 also had previous management experience as Part 145 repair station managers who superintended outsourced maintenance by Part 121 air carriers.

Participants RSM03, RSM11, and RSM12 only represented 25% of the participant population. Since data saturation occurred after conducting 9 out of 12 interviews, it was assumed that three additional participants (25%) would not have a significant impact on the quality of data.

This study was designed to examine the phenomenon of FAA oversight changes between 2007 and 2014 in the Part 145 repair station industry. The majority of the participants (92%) had more than ten years of experience. Thus, the involvement of managers with more than ten years of industry experience was helpful in determining if the number of years of experience had any correlation to the responses of the interview questions.

Question 2. What changes in Part 145 repair station aircraft maintenance practices have you observed before the FAA's implementation of its enhanced, risk-based oversight system in 2007?

Quality of oversight before 2007 was the major theme including the subthemes of level of standardization and uncertainty. As the participants continued to share their personal feelings, an overwhelming majority of 11 out of 12 (92%) of the participants indicated an unfavorable response with inconsistent levels of standards among other FAA inspectors. The primary finding of this study was that the FAA did not consistently apply a standardized surveillance process throughout the Part 145 repair station industry.

According to Participant RSM01 (May 27, 2015), "…there was no defined checklist that they [FAA inspectors] would come in here with…a defined set of attributes that they would inspect to….[and] they didn't really have an agenda" (personal communication). Participant RSM02 (May 21, 2015) commented, "Before 2007, [Part]

145, in my opinion, was a standalone document. It didn't rely on other documents such as Part 43" (personal communication). Participant RSM04 (June 4, 2015) said, "I always felt that the FAA [has] really failed in comparison to…[primary legacy air carrier audits] because of the quality of their audits" (personal communication) while Participant RSM05 (22 May, 2015) felt that FAA inspectors had placed less emphasis on "human factors training" before 2007 (personal communication). In response to Question 2, Participant RSM06 (May 29, 2015) revealed that FAA inspectors did not inspect very often and "pretty much drank coffee with our previous quality manager" (personal communication). Six of the remaining participants (RSM06, RSM08, RSM09, RSM10, RSM11, and RSM12) had a similar response to Participant RSM07 (May 29, 2015) who believed FAA inspectors were just "auditing to audit…rather it was high risk or not" (personal communication).

Of the 12 responses to this question, only one participant (8%) indicated the uncertainty subtheme and said, "…2007 is when I went to the FAA" to work as an ASI (RSM03, personal communication, May 21, 2015). Therefore, Participant RSM03 was not able to provide a different response for Question 2.

Question 3. What changes in Part 145 repair station aircraft maintenance practices have you observed after the FAA's implementation of its enhanced, risk-based oversight system in 2007?

Quality of oversight after 2007 was the major theme including the subthemes of level of standardization, employment, management changes, and no change. The level of standardization subtheme was linked to 6 out of 12 (50%) of the participants who felt there were inconsistent standards among other FAA inspectors. This was a significant

finding of the study because the FAA has not been consistent with applying a standardized surveillance process throughout the domestic repair station industry.

Of the six participants, Participant RSM02 (May 21, 2015) said, "our current [FAA] PMI [Principal Maintenance Inspector] got hung up on the deal where it said in order to call something overhauled–it must be *tested* [emphasis added]. Of course, our discussion became–what is a *test* [emphasize added]?" (personal communication). The PMI tabled this as an unresolved discussion that led Participant RSM01 (May 21, 2015) to believe it was "…little things [like this] that perhaps with another PMI—it wouldn't even be a question" and indicated a variance of standards among other FAA inspectors (personal communication). Upon further discussion, Participant RSM02 (May 21, 2015) said:

> It could be the new generation of PMIs coming up. The older ones are retiring. It appears that they do not have the background for piece part repairs, whole engine repairs, [and] airframe repair. It seems that they are more knowledge-based on rules and regulations and that type of thing (personal communication).

Participant RSM06 (May 29, 2015) pointed out, "The biggest problem with the FAA regulating us is that the majority of them could walk out in the shop and have no clue if were doing anything wrong or not" (personal communication). Participant RSM09 (June 8, 2015) mentioned that maintenance documentation has "at least doubled" since 2007 (personal communication) while Participant RSM10 (June 8, 2015) said, "…I get the double whammy because I always have one of the inspectors out here" as a result of enhanced, FAA risk-based oversight (personal communication).

Participants RSM11 (June 19, 2015) and RSM12 (June 19, 2015) discreetly agreed that any outcome of the risk-based FAA oversight change depends on the FAA's approach to address it (personal communication). Participant PSM11 (June 19, 2015) further explained:

> There are redundant inspections from multiple, different customers, and five different inspectors [for example] will show up in a six-month period of time...all of them wanting to see tool and calibration. I just dealt with an FAA inspector and now I've got *another FAA inspector wanting to take up my time with the exact same thing* [emphasis added]. There's a reason why that has to happen from an FAA prospective….Repair stations are dealing with some of the redundancy that's out there that could probably be done a little better (personal communication).

The employment subtheme was linked to 3 out of 12 (27%) of the participants. Participant RSM01 (May 12, 2015) found it necessary to hire two additional quality assurance auditors to cope with enhanced, risk-based FAA oversight. These full-time auditors increased the efficiency of the organization by 94% after reducing its lost employee work days from 1000 to six days. Aircraft maintenance damage incidents of dropped engines and sheet metal drilling errors were reduced from 63 to 4 events, and worker compensation costs decreased from $600K to less than $100K per year (personal communication). Participant RSM04 (May 22, 2015) said, "[Before 2007]…it took roughly 5 to 10 hours a week [to meet regulatory requirements]….Today, I have a full-time QC [Quality Control] person [to meet additional regulatory requirements]. He doesn't do anything else except QC" (personal communication).

The management changes subtheme was associated with 1 of 12 (8%) of the participants. In response to Question 3, Participant RSM 07 (May 29, 2015) said enhanced, risk-based FAA oversight "…actually changed the way we audited internally. It brought our level of auditing up because we went back and reviewed our checklists" (personal communication). On the contrary, Participant RSM10 (June 8, 2015) discussed an instance, "We've actually reduced the staff from what we had in the beginning and it's become a lot more effective if you ask me" (personal communication).

Of the 12 participants, only 1 participant (8%) indicated the subtheme of no change. Participant RSM05 (May 22, 2015) said, "They [FAA inspectors] still look at the same thing" (personal communication).

Question 4. What advantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

The major theme was advantages of oversight and the subthemes consisted of efficacy, no advantage, and uncertainty. An overwhelming majority (75%) of the participants indicated the efficacy subtheme of improved audits, quality, and safety in their organizations. Participant RSM01 (May 12, 2015) believed that FAA audits have been streamlined and shortened with a "…defined purpose and work scope" (personal communication) while Participant RSM03 (May 21, 2015) mentioned:

> I think the quality of the product that we have going out the door has greatly improved. There's a lot more things in place to ensure that. I think we are better today. In the past, we followed the manuals; but, all the things that support that—they're monitored, they're observed—and yeah, I think it makes for a good repair station. A good product (personal communication).

Participant RSM04 (May 22, 2015) said that due to enhanced, risk-based FAA oversight of the repair station industry, “I think there is no doubt that the quality has increased” (personal communication).

Two other participants indicated that the approachability of the FAA has improved since 2007. The administration has become more approachable to help the Part 145 repair station industry stay in compliance with changes in regulatory requirements and improved administrative procedures to detect unapproved (counterfeit) aircraft parts (RSM06, personal communication May 29, 2015; RSM10, personal communication, June 8, 2015).

Participant RSM07 (May 29, 2015) stated that the FAA has a standardized process and “it went back and eliminated those non-value—in my opinion—audits [and] that we were able to schedule low-risk audits every two years instead of every year" (personal communication), while Participant RSM09 (June 8, 2015) believed that the “quality management system” has improved as a result of enhanced, risk-based FAA oversight (personal communication).

The next two participants indicated that the efficacy of FAA oversight will improve with Part 121, 135, and 145 operations with its new SAS oversight program (RSM11, personal communication, June 19, 2015; RSM12, personal communication, June 19, 2015). Some encouraging information was revealed after RSM11 (June 19, 2015) proclaimed:

> Inspectors will start using SAS, which is more or less modeled after ATOS. But now they will start using SAS to do direct surveillance on 145 repair stations rather an air carrier is using them or not….But I think in the years to come, you

> will see more of those types of things taking place that will be, quite frankly, advantages to everyone: to the Flight Standard inspectors who are doing the inspection [and] the repair stations who won't get visited quite as often for the same thing—[equates to] better use of tax payer dollars (personal communication).

No advantage was the next subtheme and it related to 17% of the participants (RSM02 and RSM08) while the uncertainty subtheme was connected to Participant RSM05 (May 22, 2015) who stated, "I don't know if I have noticed any advantages. I really haven't noticed a lot of difference. To me, it seems like the FAA is always changing" (personal communication).

Question 5. What disadvantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

Disadvantages of oversight was the major theme including the subthemes of burden and no disadvantage. Over half of the participants, 8 out of 12 (67%) experienced the burden subtheme. Participant RSM02 (May 21, 2015) recalled a personal experience with the new generation of FAA inspectors as a 40-year veteran in the Part 145 repair station industry:

> With the younger generation coming in, [FAA inspectors] don't really know the hands-on part of aviation even though some of them have come out with A&Ps from various aspects of aviation. It seems to me that they are more interested in what you can't do or what you've done wrong rather than being a part of promoting aviation. To me, it appears [that] in aviation, if you're not an airline,

> [Part] 135 or [Part] 121, you're a nuisance more than you are an asset (personal communication).

Participant RSM05 (May 22, 2015) discussed a lived experience that personally distressed him after the FAA Office of Aerospace Medicine Drug Abatement Division audited his drug program:

> I didn't take a guy out of the program that had been laid off.…I [also] had a girl tested that didn't need to be tested because they said she wasn't in a safety-sensitive job.…They tried to fine me $6,000. I wrote a letter to the lawyer at Aerospace Medicine. I said I want a meeting with them and never heard back from them. That's been two and a half or three years ago.…That part of the FAA, the Office of Aerospace Medicine, is dysfunctional (personal communication).

Three participants felt that their time was hindered by the FAA (RSM04, personal communication, May 22, 2015; RSM08, June 5, 2015; RSM09, personal communication, June 8, 2015). Participant RSM08 (June 5, 2015) stated:

> They [FAA inspectors] may be here for two or three hours and nothing else is happening. I'm not doing anything else while they are here. And I don't ever say, I'm too busy today, get the hell out of here.…A lot of their visits don't seem like they're really asking me questions—show me this, show me that, how do you do this, how do you do that. It can get off onto the weather. It's almost like they feel they have to stay here that two or three hours (personal communication).

Participant RSM07 (May 29, 2015) said the lack of common sense is a disadvantage and it burdens the organization when the FAA does not know your repair station process, "…it [improper guidance] could really drive you into changing

something in your manual or things based on the vagueness of a question (personal communication). This participant oversees an aircraft maintenance organization that maintains Part 121 and 145 certificates. Participant RSM07 (May 29, 2015) also said, "Sometimes it's hard to make a split" between the two processes and meet the regulatory requirements of Part 121 and 145. This participant further elaborated:

> People [Part 121 air carrier and Part 145 repair station employees] couldn't make the switch [within the same organization]. And that's kind of why we are now going away from that. We're backing out [95% reduction] of the 145 [repair station] work just because of that. It's just the issues with the regulator piece and the distraction and trying to keep up with two certificates….Yeah, the new leaders of the airline said, you know, we're going to run the most efficient airline we can. We're going to do what we're good at. Third-party work right now as an airline is more of a distraction on our original customer…other than focusing, you know, on taking that focus off the customer. So that's the reason why we are going the direction that we are going today (personal communication).

The next two participants (RSM11 and RSM12) expressed their frustrations with obtaining and sharing inspection results from other inspectors and agencies, which is not readily available to use as a trend analysis. According to RSM11 (June 19, 2015):

> [FAA inspectors] have to come up with a way to share information [findings and trend analysis] so the repair station is not getting looked at over and over for the same thing by multiple people. Especially if [paused] he goes in one month and does tool calibration (personal communication).

Thirty-three percent (33%) of the participants (RSM01, RSM03, RSM06, and RSM10) related to the no disadvantage subtheme.

Question 6. How do you feel about the argument to increase the frequency of FAA inspections at Part 145 repair stations to improve the safety of the U.S. air transportation industry?

Status quo of oversight was the major theme including the subthemes of frustration, transparency, and uncertainty. Most of the participants, 10 out of 12 (84%) related to the frustration subtheme. Participant RSM02 (May 21, 2015) plans to fib to FAA inspectors if they resort to web-based desktop audits verses on-site facility inspections due to a limited pool of inspector resources. Participant RSM02 conveyed:

> They [FAA inspectors] just don't have time to increase. They would have to hire more manpower to do it. I don't see that in the current system that they're promoting, the SMS [Safety Management System]. I got a letter from the FAA the other day that we are going to be participating in their system. It appears to me that they are moving away from increased oversight to more of a paper world....I'm going to be quite frank with you, I wouldn't put myself in a bad light. I'm going to answer the question and fib. A personal audit—comes in and sees—there is no denying. That is human nature (personal communication).

Participant RSM03 (May 21, 2015) indicated that the FAA is too busy and needs to "hire additional people [inspectors]" for the administration to adequately inspect the Part 145 repair station industry (personal communication). Another participant was frustrated with duplicated audits and said:

I think my biggest squawk is going to be how much time is spent on audits. As a [Part] 145 repair station, we're working for the airlines—we're under Part 121. My biggest squawk—and I have written letters on this and belong to ARSA, Aeronautical Repair Station Association—is how much time is spent on audits. So every airline that we work for, they come in and do the exact same audits that the FAA does. There are 20 or so operators. We do a lot of work for third parties. They are the folks out there—they buy and sell leased components. They don't operate an aircraft. They support that industry. With all the operators coming in, FAA coming in, ARSA coming in—I think we are excessively audited. They are always the same audit. They all march to the same paper….It's an excessive amount of time. I don't know what the solution is, but I think if an airline comes in and the FAA has had a recent audit or an operator, we would share that with them. Share the findings and the corrective actions if there were any, and what we did to clean them up. But that is probably the biggest disadvantage for me (RSM04, personal communication, May 22, 2015).

Participant RSM05 (May 22, 2015) stated:

I would think that [Question 6] is probably the OIG's office justifying their existence more than anything. I think they do a good job. I think that if you have some fly-by-night operation, they're going to get caught….If it's broke, it would be broke on the part of the [FAA] inspector….I think if it's broke, it's because they [Part 145 repair stations] don't care….I've talked to them enough times over the years to know there are people in this city that have been shut down or suspended because they are not doing things right. I think they [FAA inspectors]

> are doing a great job. You know, if an airplane falls out of the sky because an engine shelled or something in flight, is that because they didn't catch something? Or was someone at the repair site having a bad day? Or some supervisor or inspector did not do his job? (personal communication).

Participant RSM06 (May 29, 2015) stressed, "[FAA inspectors are] not going to know if we're doing anything wrong or not….They already go through all of our quality system….They already go through so much that I don't know what else they could do" (personal communication). Participant RSM07 (May 29, 2015) criticized the intent of some FAA audits after he said:

> They are trying to hit a quota and I've seen audit programs like that, just trying to get a quota. [If] I'm going to go in every shop once a year [paused] depending on how much resources you have, it can just be [that] they really don't have time. Are they just trying to touch every area or are they really spending time in that shop needed based on, again, risk—the criticality of the shop. A cleaning shop may not be as hard as an engine shop. The risk is just not there (personal communication).

Participant RSM09 (June 8, 2015) stressed that the repair station must maintain its international quality system certification in addition to Part 145 requirements; therefore, the repair station is audited frequently by other external inspectors in addition to the FAA. Participant RSM09 also said:

> We have special process approvals from OEMs [Original Equipment Manufacturers]. We have special process accreditations—industry of accreditations for processes. We probably undergo over 50 major audits a year [at

our repair station]. And so, we're audited a lot. There's kind of a tendency that you know [paused] we don't need any more audits. We're reluctant to say, *oh yeah, we need more audits* [emphasis added]. And we have an aggressive internal auditing program as well. So, we're auditing ourselves constantly. So, if somebody asks me, do you think you should get audited more? I would say no (personal communication).

Participant RSM11 (June 19, 2015) pointed out:

I used to teach the oversight of contract maintenance [at the FAA Academy] and maintenance providers classes [at the FAA Mike Monroney Aeronautical Center]. So, I am pretty familiar with the [OIG] reports that came out in 2003, 2005, [or] 2006. I mean, I think it's important. I think it's probably wise that they [the FAA] figure out a consistent, standardized way in which to do it….I think we have to improve how it gets done. So, to do the inspections and increased inspections is probably good, but we don't want to take it too far to the other extreme. Thus, that is the human way. We all do that sometimes. We go from one extreme to another extreme before we find the middle ground that makes the most sense. And that would be my only concern….If you look at the statistics of ATOS, it will basically tell you that the air carrier's track record has improved over the years with the implementation of ATOS. Based on that, you hope that SAS basically helps the same thing. Not only for the continued improvement of the 121 world, but also the improvement of the 135, 145, 91 etc. (personal communication).

Participant RSM12 (June 19, 2015) said:

> All of a sudden now, they're [the FAA is] paying attention to their budget. Now they've got budget problems. Now they've got all this travel expense and all this stuff. They didn't care how much it cost the industry when they were doing their surveillance. They had unlimited budgets. Well, that all changed now. They've got budgets to go by and now they're feeling the same impact that a lot of these other companies did—you know, in a different way that they have to stay within their budget, too. So, cost is getting a lot more consideration and efficiencies (personal communication).

The transparency subtheme was limited to Participant RSM01 (May 12, 2015) who said that the OIG is probably justified to promote increased FAA audits and "I feel that sometimes the more transparent you are, the better organization you are….We have nothing to hide and we are very transparent" (personal communication).

Uncertainty was the last subtheme that only applied to Participant RSM10 (June 8, 2015) who suggested, "I don't really think it is necessary [additional FAA oversight]. Like I said, since 2007, their frequency has increased a lot. I guess that's voluntary. I don't know" (personal communication).

Question 7. What would you like to add as further opinion that I have not covered during this interview?

Process improvement was the major theme including the subthemes of inadequate oversight, inadequate training, and lessons learned. The inadequate oversight subtheme surfaced after 42% of the participants stated that their continuous process improvement was hindered by inadequate FAA oversight. Participant RSM05 (May 22, 2015) recalled a personal experience when he said:

My only negative opinion with the whole FAA system, like I said, is with the Office of Aerospace Medicine. As a taxpayer, I am resentful. You come in my office. You go through all my drug programs. You have some findings. They're just as nice as can be and don't tell me that they have findings. I get a registered letter almost six months later after the inspection telling me they have findings. They want to impose a fine. Then I send a letter to Washington to the attorney that they tell me to notify if I want to fight this thing. I never hear back from them (personal communication).

Participant RSM06 (May 29, 2015) recalled a personal experience:

I think a lot of it had to do with a particular inspector. You can get an inspector, even nowadays, that walks through the shop and that's it. You never see him again. Then you got the inspector that actually really goes through the checklist. I think my biggest complaint with inspectors is they're not consistent. Every time I get an inspector, I have to change my quality manual because they want it to look different than the other inspector did (personal communication).

Participant RSM08 (June 8, 2015) remembered a personal experience:

Well, my opinion is that most of the repair stations out there actually doing work for the aviation industry are doing a good job. But I think there's probably more that are out there that are undetected that are not doing a good job. They're getting by with it because they don't have in-depth inspections….It's almost like every year it seems like we've had new inspectors. I don't know that they really get to know you and know your processes and how you do things that well if it's a revolving door with inspectors. I think they get to know more about you and how

you do things. One of my other jobs that I worked at [paused], I had the same inspector for 14 years and he knew us pretty well. Even though he was only coming a few times a year, he still knew us better [than] what I feel like the inspectors do today (personal communication).

Participant RSM09 (June 8, 2015) recalled a personal experience and stated:

I think that FAA surveillance will stay the course. I think the industry is down a little bit. I think that airlines, for example, are not routinely pulling planes off for repairs. I think there's more of a tendency to fly them until they break. As far as FAA oversight, I think there is more of it then there was in 2007 (personal communication).

Inadequate training was the next subtheme that pertained to 4 out of 12 (33%) of the participants. Participant RSM01 (May 12, 2015) said, "So, I think you got, I don't want to say better inspectors, but I think you got better educated inspectors" (personal communication). Participant RSM02 (May 21, 2015) wants a change in the A&P certification process that would require all technician students to complete an apprenticeship program to get hands-on training at a repair station, and pointed out:

Education without experience is a loaded gun. I coined a phrase many years ago because I worked with some young engineers who came out of school. They were book smart and application stupid. When we circumvent applications—and this goes strictly for learning—I admire their knowledge. But knowledge without wisdom is a dangerous thing. I can go on the Internet and get all the knowledge I need. Any subject I want to look up, I guarantee it is there; it is there in volume. But without the wisdom to know what's going to happen if I use that knowledge, I

can become very destructive. And that is the problem with our young people of today. I am not downing, but we have a very smart crowd coming up. They are smart. They are intelligent. They are capable, but they have a lack of knowing how to apply. In an aviation application, it's unforgiving. If you don't know how to apply your knowledge correctly, you do more damage than you will good (personal communication).

Participant RSM03 (May 21, 2015) indicated that some repair station employees are lacking in training and confidence, and said:

I'd have to say, being in the FAA—and I saw the FAA—don't let the FAA intimidate you. Just don't let them intimidate you. If they can't find it in their manual, you don't have to do it. I don't care how many times they ask you to do something. If it's not in writing and it's not in their guide and not in the FARs, they can't make you do it. So don't be intimidated (personal communication).

Participant RSM04 (May 22, 2015) stated:

Something that we are seeing here is [that] people are not going into this business, especially in avionics. It's getting really tough to find a Spartan. I'm not up exactly on their numbers, but even ten years ago—maybe 300 techs a year. Now [paused] 28. ARSA is doing studies on this, but we need these people and they're not going to school. They're not getting an education. So where are they going to come from in the future? I don't think we understand or know why more students are not going into electronics. I thought it was math; compared to other countries, we suck at it. But, it takes a lot of math for electronics. I'm not sure if that is it or not. People say no, that's not it at all, they're just not interested in this type of

> business. It's not glamorous enough. I think we have a problem with Spartan's 15 or 18-month class: $35,000. You don't start out making 50 or $60,000 dollars a year like an engineer does. So maybe that is it—the starting pay. It is certainly different throughout the country, the cost of living, this and that. But again, we need these people to do this work and it's really getting tough to find them. I don't have an answer for it, but the schools are trying. They are doing their best to get them to come in and enroll. Supply and demand. We're not getting the supply we use to (personal communication).

The remaining three participants (25%) were linked to the lessons learned subtheme. Participant RSM07 (May 29, 2015) said, "It's interesting, though. I was over getting our 145 repair station certificate from the CAAC [Civil Aviation Administration of China]…and it's remarkable how much they have modeled their regulations off of our 145 guidelines" (personal communication). Participant RSM10 (June 8, 2015) mentioned:

> [The FAA hasn't] really been able to interact; we do a lot of international business. So you got a lot of the regulatory requirements for, let's say, the Chinese, Vietnamese, [and] Thai. Everybody has their own version of the FAA. It seems as though they all come to the FAA for training….For example, the Chinese is CAAC. It's not EASA [European Aviation Safety Agency]. It's not FAA. It's the Chinese certification (personal communication).

It was noted that other Part 145 repair station managers have confided in Participant RSM10 as the Subject Matter Expert (SME) of Part 145 compliance and how to set up internal audits. Monthly, Participant RSM10 performs internal audits using

maturity assessments, EASA and FAA regulations, and Coordinating Agency for Supplier Evaluations (CASE). Maturity assessments consisted of an audit process that this individual has created and combined with aerospace AS9100 regulations. Participant RSM10 (May 29, 2015) said, "Now with the new SAS program rolling out, we'll incorporate that as well" along with Part 121 air carriers and other customers who also audit the repair station every month (personal communication). In comparison, Participant RSM11 (June 19, 2015) said things are "constantly evolving" (personal communication).

Discussion of Findings

Findings were examined in accordance with procedures of the study and results of the data. Major themes have been discussed by examining their emergence from the raw data to include subthemes. The disseminations of major and subthemes have been presented in Appendix E.

In particular, two Part 145 repair station managers, although they met all the criteria for an interview, declined to participate in the study due to conflicting schedules. The last two interviews involved conversing simultaneously with two Part 145 repair station managers (Participants RSM11 and RSM12) who were employed in the same organization. Data saturation, the point at which no new emerging themes become apparent, was evident during the ninth interview.

The coding responses from the research and three triangulating analysts (researcher, and evaluators A and B) were identical with Questions 2, 3, 4, 5, 6, and 7. However, evaluator B had a different response for Question 3. The researcher and two analysts reviewed the non-coded responses five or six times before initiating the coding

process. This reinforced what Patton (2015) said about data coding, which is an interactive process involving continual immersion of the data before analysis can occur.

Themes

Research data derived from the interview responses was organized according to major coding categories with seven research questions. The researcher repeatedly reviewed the written transcriptions of all 12 participants to create a comprehensive list of individual codes that described the lived experience phenomenon of each participant.

During the coding process, 23 individual codes emerged from the transcribed interview data. Twenty-three individual codes of data were arranged into six major themes with 17 corresponding subthemes to bring the diverse and often overlapping elements of the individual codes into an essential and comprehensive relationship (Appendix E).

Interview Results

Data from the interviews was collected and transcribed word for word from 12 digitally-audio recorded interviews. Field notes were written on a notepad during the interviews. The transcriptions were emailed to all of the participants to ensure accuracy. To benefit from the research with the immersion of data, the researcher personally transcribed verbatim the digital-audio recordings rather than hire a transcriber.

The next step involved the software application of NVivo to classify, sort, and arrange non-numerical interview data, and organize the coding analysis in an Excel spreadsheet. NVivo is a qualitative, data-analysis computer software program that is designed for a qualitative researcher who works with rich, test-based information, where deep levels of data analysis are vital for the study (Miles et al., 2014).

Anonymous names were assigned to each of the Part 145 repair station managers who were interviewed. Data from each manager was indiscriminately arranged in several spreadsheets for each of the seven research questions. The researcher carefully examined the data several times to validate and verify accurate coding, a process described by Manen (2014) and Patton (2015) as immersion and incubation. As the researcher proceeded, recurring themes emerged from the data.

CHAPTER V.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Overview

Consistent with the purpose of this study, the findings in this research provided a snapshot of the lived experiences of Oklahoma Part 145 repair station managers who superintended outsourced U.S. air carrier maintenance to explore the phenomenon of enhanced, risk-based FAA oversight in Oklahoma between 2007 and 2014.

Summary

The aviation industry suffered a series of financial setbacks after the 9/11 terrorist attacks, and Afghanistan and Iraq conflicts, including the high costs of in-house air carrier maintenance and escalating jet fuel expenses, coupled with a sporadic U.S. economy (Richardson et al., 2014). Experts estimated monetary losses in the air carrier industry between 2000 and 2009 were $54 billion (GAO, 2009; Borenstein, 2011). Those losses caused many U.S. air carrier managers to change airline operations by outsourcing all or most of their aircraft maintenance to the domestic Part 145 repair station industry and non-certificated repair facilities (Al-kaabi, Potter, & Naim, 2007).

The OIG has become more concerned with the increase in aviation maintenance outsourcing over the past 16 years and decreased safety of domestic air carriers due to several U.S. airline mishaps. The NTSB (1997; 2002; 2003; 2004) determined that the

probable cause of four fatal U.S. air carrier accidents were linked to maintenance errors committed by employees from Part 145 repair stations and non-certified facilities. Auditors from the GAO and the OIG uncovered systemic and chronic gaps in the FAA's oversight system that has hindered its ability to adequately monitor the increased practice of outsourced maintenance by the Part 145 repair station industry (GAO, 1997; OIG, 2013). The FAA agreed with recommendations from the GAO and the OIG to correct significant gaps in the U.S. air transportation system to properly monitor outsourced aircraft maintenance for domestic air carriers at Part 145 repair stations (GAO, 1997; OIG, 2013).

The OIG (2003; 2005b; 2013) determined that more FAA oversight would reduce the likelihood of additional accidents, notwithstanding the FAA's issuance of several million in civil penalties to domestic repair stations and U.S. air carriers found to be in violation of substandard aircraft maintenance. Although maintenance-related accidents are rare events, only four in the past 16 years compared to the hundreds of thousands of annual U.S. flights; however, many of those flights have become declared emergency landings (engine and landing gear malfunctions) due to outsourced maintenance errors. Thus, outsourced maintenance errors were extensive throughout the U.S. air carrier transportation system between 2007 and 2014 (Tables 11 and 12).

Table 11

Declared Aircraft Engine Emergencies

Date	Make/Model	Event Remarks
12/24/10	Boeing 737	Master caution and fire warning light illuminated
12/30/10	Boeing 757	Engine did not respond to throttle movement
02/23/11	Airbus A310	Engine fire on #2 engine and compressor stalled
05/10/11	Embraer 170	Engine #2 low oil pressure indication
09/22/11	DC-6	Zone 2 and 3 fire indication and a loud thump
02/22/12	Boeing 747	Fire protection system loop "B" failed
04/03/12	Embraer ERJ-145	High vibration with #2 engine and cabin smoke
09/09/12	Challenger 600	Right engine failure
09/11/12	Boeing 747	Four engine generators failed due to maintenance errors
09/17/12	Embraer ERJ-145	Engine #2 shut down after high EGT and cabin smoke
10/12/12	Embraer 190	Engine #1 failure
11/15/12	ATR-43 300	Engine #1 fire and failure
12/22/12	Embraer ERJ-145	Master caution light illuminated after electrical odor
01/22/13	Challenger 600	Right engine thrust degraded to 60% N1, N2 surging
05/15/13	Embraer ERJ-145	All four engine-driven DC generators failed in flight
07/16/13	Airbus A300	Engine #2 failure
07/25/13	DHC-8	Cabin smoke due to deteriorated #1 engine seals
12/17/13	Airbus A319	Engine failure
09/18/14	Airbus A320	Engine #2 failure

Notes: Adapted from "AIDS Search Form," by the Federal Aviation Administration, 2015d, *FAA Aviation Safety Information Analysis and Sharing (ASIAS).*

Table 12

Declared Aircraft Landing Gear Emergencies

Date	Make/Model	Event Remarks
06/03/07	Boeing 737	Nose landing gear collapsed after a malfunction
09/26/07	Challenger 600	Overheat (brake #4) warning indication illuminated
03/16/08	Raytheon 1900	Landing gear failed to extend (crew manually extended)
08/02/08	Embraer ERJ-145	Left main inboard tire blown and flap fail message
10/05/08	Challenger 600	Landing gear failed to retract
12/15/08	Challenger 600	Unsafe LMG indication due to improper maintenance
12/21/08	Challenger 600	Nose gear disagree indication
06/11/09	Challenger 600	Left main landing gear failed to extend and was reported as an NTSB incident
03/25/10	Challenger 600	Nose gear failed to retract after takeoff
05/23/10	Challenger 600	Unable to extend the nose landing gear upon landing
05/28/11	MD-80	Right MLG tires (3 & 4) blown, hot brakes and fire
09/02/11	Embraer ERJ-135	Right main strut failure
01/23/12	Embraer ERJ-145	Left main landing gear unsafe light illuminated
02/27/12	Embraer 170	Unsafe landing gear indication with nose landing gear
06/25/14	Embraer 170	No weight on nose gear warning, nose gear canted 90°

Notes: Adapted from "AIDS Search Form," by the Federal Aviation Administration, 2015d, *FAA Aviation Safety Information Analysis and Sharing (ASIAS).*

According to the analysis data in Chapter 4, the FAA enforcement process of civil penalties for Part 145 repair station violations does not provide the highest level of safety. Although it gets the attention of those affected by the imposed fines, suspensions, and revocations, does it really improve safety while there is little to no FAA oversight at non-certificated repair facilities? Accordingly, does outsourcing commercialized aircraft maintenance to less regulated repair stations or facilities make a difference in safety?

Conclusions

The conclusion of this study was primarily based on the results of seven research questions:

Question 1. How long have you been associated or employed with the Part 145 repair station industry?

The 12 participants of this study had between 7 and 40 years of experience in the domestic Part 145 repair station industry. Cumulatively speaking, they had an aggregate total of 6757 employees and 236 years of repair station management experience.

Question 2. What changes in Part 145 repair station aircraft maintenance practices have you observed before the FAA's implementation of its enhanced, risk-based oversight system in 2007?

Based on Chapter 4 analysis, a significant finding was identified after the vast majority (92%) of the participants felt that the FAA's level of standardization lacked consistency. Specifically, these participants felt that the FAA failed to follow a standardized and consistent surveillance process throughout the U.S. Part 145 repair station industry. This finding indicated that the FAA's policy of a risk-based oversight system in the Part 145 repair station industry was lacking in terms of quality of oversight before 2007. Only 1 out of 12 participants (8%) was uncertain because this person was a former FAA ASI (prior to 2007).

Question 3**.** What changes in Part 145 repair station aircraft maintenance practices have you observed after the FAA's implementation of its enhanced, risk-based oversight system in 2007?

Based on Chapter 4 data, a significant finding was discovered after 50% of the participants voiced their concerns about inconsistent standards among other FAA inspectors during enhanced, risk-based FAA oversight between 2007 and 2014. The remaining five participants related to changes in employment—3 of 12 (25%), management changes—1 of 12 (8%), and no change—2 of 12 (17%). In comparison to Question 2, the FAA failed once again to adhere to a standardized and consistent surveillance process throughout the domestic repair station industry. Six (50%) of the participants complained that when FAA inspectors interpreted federal regulations, they were frequently inconsistent with other FAA inspectors.

A conclusion to be drawn from this finding is that the FAA's policy of enhanced, risk-based oversight in the Part 145 repair station industry was lacking in terms of quality of oversight between 2007 and 2014. The participants of this study suggested that they have always wanted FAA inspectors to apply oversight in a standardized manner. Specifically, they felt that FAA inspectors should be consistent among other FAA inspectors when they interpret regulations. Some of the younger-generation FAA inspectors have a much different interpretation of federal regulations than the older-generation FAA inspectors, which has hindered the administration's quality of oversight. Several repair station managers believed that if FAA inspectors collectively enforce policies of standardization and interpret regulations accurately, repair stations will be more productive and safer in the U.S. air transportation system.

Although the FAA implemented an enhanced, risk-based oversight system in 2007 to help its safety inspectors target those Part 145 repair stations that posed a higher risk, data from Chapter 4 indicated that this system does not include timely and accurate

risk assessments of domestic repair stations. Atypically, FAA inspectors will often rely on their personal knowledge of repair stations to conduct audits and communicate the results of those inspections. As a result of these weaknesses, FAA's oversight lacks the rigor needed to identify deficiencies and verify corrective actions. At the same time, the FAA has not developed or enforced a reliable process for placing its inspectors at repair stations that are more susceptible to risk or have a history of violations.

Question 4. What advantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

According to the analysis of Chapter 4, a significant finding was detected after an overwhelming majority of the participants (75%) experienced some improvements with the efficacy of their organizations as an advantage of oversight between 2007 and 2014. The remaining three participants indicated there was no advantage—2 of 12 (17%) while another participant was uncertain—1 of 12 (8%).

Based on Chapter 4 analysis, some FAA audits were legitimate and helped Part 145 repair stations improve their quality and safety systems to produce reliable products. Some of the repair station mangers believed this improvement was only possible after they hired additional quality inspectors to conduct more internal audits and oversee a magnitude of external audits from various customers.

In conclusion of this finding, most of the participants understood that their safety and quality management systems go hand-in-hand. Without these systems, it is difficult to have a safe aircraft or component. There was a general understanding that supervisors, managers, quality inspectors, and aircraft technicians must work together as a team to promote safety and quality-management systems. Several participants implied that

aircraft technicians are on the front line in this process because they are the touch labor for the organization.

Question 5. What disadvantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

Analysis of Chapter 4 indicated a significant finding after a large majority of the managers (67%) felt burdened by FAA inspectors who do not perform inspections according to a standardized process and the invasive nature of audits. A conclusion to be drawn from this finding is that there are high costs associated with the safety implications of faulty aircraft maintenance and oversight. The remaining four participants (33%) said there were no disadvantages.

Chapter 4 analysis also suggested that several Part 145 repair stations may play safety and quality against probable financial consequences due to little or no FAA oversight. Revenue operations normally have the predisposition to value these things alike, which has the tendency to compromise both safety and quality. Therefore, when a premium is placed on time and money, safety and quality will likely be neglected.

Question 6. How do you feel about the argument to increase the frequency of FAA inspections at Part 145 repair stations to improve the safety of the U.S. air transportation industry?

According to the data in Chapter 4, a significant finding was observed after an overwhelming majority of the participants (84%) felt frustrated with inadequate FAA oversight because the administration does not follow a consistent, risk-based surveillance process. Most concerning, a seasoned Part 145 repair station manager shared a lived experience when he said:

> It appears to me that they [FAA inspectors] are moving away from increased oversight to more of a paper world....I'm going to be quite frank with you, I wouldn't put myself in a bad light. I'm going to answer the question and fib (RSM02, personal communication, May 21, 2015).

Participant RSM02 (May 21, 2015) further commented that the new generation of FAA inspectors are handicapped because they do not "really know the hands-on part [technical processes and procedures] of aviation even though some of them have come out with A&Ps" (personal communication). Another participant believed that "[FAA inspectors are] not going to know if we're doing anything wrong or not" at her repair station (RSM06, personal communication, May 29, 2015). The next participant—1 of 12 (8%)—thought transparency was important for an organization's image while another participant—1 of 12 (8%)—remained uncertain with the question.

A conclusion to be drawn from these findings is that the enhanced, risk-based FAA oversight approach is not a complete substitute for all regulatory requirements to remain compliant. This is particularly true in potentially high-hazard work settings that involve aircraft maintenance.

Question 7. What would you like to add as further opinion that I have not covered during this interview?

A significant finding was observed after 42% of the participants voiced concerns about a weak FAA oversight system that has hampered the continuous process improvement program at their Part 145 repair stations. For example, 5 out of 12 (42%) of the participants placed emphasis on inadequate FAA oversight. The remaining 4 out of 12 (33%) participants felt that AMTs should have on-the-job training to have a better

understanding of maintenance concepts before they are issued an A&P certificate by the FAA.

Based on Chapter 4 analysis, there was a shortage of qualified Part 145 repair station personnel, particularly avionics technicians. It became apparent during this study that the numbers of trained, certified, and experienced AMTs are not keeping pace with the expansion of the aviation industry. Data indicated that AMT training curricula and equipment is antiquated in comparison to current technologies. Data also indicated how the younger generation preferred more lucrative and office related occupations such as information technology (IT) because of the stigma associated with aircraft maintenance careers. The average aircraft mechanic will be expected to labor under extreme weather conditions, increased physical demands, and receive lower wages.

Three participants (25%) connected to the lessons learned subtheme that was discussed in Chapter 4. There were three primary conclusions that can be drawn from the significant finding of Question 7:

1) The FAA's failure to follow a standardized and consistent process while conducting inspections.
2) The FAA's lack of resources to sustain a standardized and consistent process with the necessary manpower and expertise to provide an in-depth examination of Part 145 repair station operations.
3) The FAA's oversight failure of the Part 145 repair station industry, specifically an inadequate training program for new AMTs and reoccurring training for all repair station employees (technicians, managers, supervisors, and inspectors).

Recommendations

The researcher provided eight recommendations based on the findings, analysis, and conclusion of this study:

1) Future studies could explore the FAA's effectiveness of its enhanced, risk-based oversight of U.S. or foreign Part 145 repair stations.
2) Future studies could examine the FAA's replacement of its ATOS with a Safety Assurance System, a new risk-based approach to improve the air transportation system. According to the FAA, SAS may correct the administration's flawed oversight system of the U.S. air transportation system (OIG, 2013).
3) Future studies could inquire about the FAA's progress to effectively implement its oversight of the European Union (EU) in response to the U.S. air carrier industry's increased reliance on foreign Part 145 repair stations. As of 2015, there were 474 Part 145 repair stations in Europe that perform work on U.S. registered aircraft and components. The FAA has not provided adequate training for its inspectors to conduct surveillance at European repair stations with foreign authorities (OIG, 2015).
4) Future studies could examine the U.S. air carriers' oversight of non-certificated or foreign repair facilities in the U.S. or foreign countries.
5) New training academia should be created using a web-based, cogitative apprenticeship model for all new aviation maintenance personnel at Part 145 repair stations, Part 121 air carriers, and non-certificated repair facilities. Training would include a professional foundation of aviation standards, tool usage, regulations, record keeping, and other fundamental skills. The Aeronautical

Repair Station Association, the Federal Aviation Administration, along with other aerospace organizations, should enter into a partnership to market the program locally and nationally.

6) A web-based training tutorial should be created for Part 145 repair station and Part 121 air carrier personnel (aircraft mechanics, supervisors, managers, and quality inspectors). This tutorial would be used to improve their communication skills to provide clear and concise answers to external auditors and reduce audit anxieties. The Federal Aviation Administration, the Aeronautical Repair Station Association, along with other aerospace organizations should enter into a partnership to market the program locally and nationally.
7) Require that all outsourced aircraft maintenance from the U.S. air carrier industry be maintained at Part 145 repair stations.
8) Require the FAA to revise 14 CFR 145 and 191 to obligate all Part 145 repair station and Part 121 air carrier technicians to obtain A&P in addition to Repairman certificates. Members of the U.S. military, the DOD, and the DHS may qualify under a U.S. Air Force sponsored Joint Service Aviation Maintenance Technical Certification Counsel Program to obtain an A&P at reduced costs. The hallmarks of an enduring safety program, most notably—personal pride and technical excellence, are at stake when non-certificated technicians do not have a basic aviation maintenance technology education.

REFERENCES

Al-kaabi, H., Potter, A., & Naim, M. (2007). An outsourcing decision model for airlines' MRO activities. *Journal of Quality in Maintenance Engineering, 13*(3), 217-227. doi:10.1108/13552510710780258

Berg, B. L. (2007). *Qualitative research methods for the social sciences* (6th ed.). Boston, MA: Allyn & Bacon.

Berg, B. L., & Lune, H. (2011). *Qualitative research methods for the social sciences* (8th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Bloomberg, L., & Volpe, M. (2012). *Completing your qualitative dissertation: A roadmap from beginning to end* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Boje, D. M., & Murnighan, J. K. (1982). Group confidence pressures in interactive decisions. *Management Science, 28,* 1187-1196.

Borenstein, S. (2011). Why can't US airlines make money? *American Economic Review Journal, 101*(3), 233-237.

Cantrill, J. A., Sibbald, B., & Buetow, S. (1996). The Delphi and nominal group techniques in health services research. *International Journal of Pharmacy Practice, 4*(2), 67 -74.

Chapter 9 Part 145 inspections: Section 1 introduction to repair station risk-based oversight system. (2014). In J. Ballough (Trans.), *Flight standards information management system* (Vol. 6). Washington, DC: U.S. Department of Transportation. Retrieved September 12, 2015, from http://fsims.faa.gov/

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage Publications, Inc.

Crotty, M. (1998). *The foundations of social research*. Thousand Oaks, CA: Sage Publications, Inc.

Dawson, C. (2009). *Introduction to research methods: A practical guide for anyone undertaking a research project* (4th ed.). Oxford, UK: How to Books, Ltd.

Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and Delphi processes*. Glenview, IL: Green Briar Press.

Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Department of Labor. (2014). *Occupational employment statistics.* Washington, DC: Author. Retrieved November 1, 2015, from http://www.bls.gov/oes/current/naics4_481100.htm

Department of Labor. (2015). *Occupational employment and wages, May 2014: 49-3011 aircraft mechanics and service technicians*. Washington, DC: Author. Retrieved November 1, 2015, from http://www.bls.gov/oes/current/oes493011.htm

Department of Transportation. (2015). *Data and statistics*. Washington, DC: Author. Retrieved September 19, 2015, from http://www.rita.dot.gov/bts/data_and_statistics/index.html

Federal Aviation Administration. (2003). *Practices and perspectives in outsourcing aircraft maintenance* (AR-02/122). Washington, DC: Author. Retrieved from http://www.faa.gov/about/initiatives/maintenance_hf/library/documents/media/human_factors_maintenance/ar02-122.pdf

Federal Aviation Administration. (2008). *History of aviation safety oversight in the United States* (DOT/FAA/AR-08/39). Washington, DC: Author. Retrieved from http://www.tc.faa.gov/its/worldpac/techrpt/ar0839.pdf

Federal Aviation Administration. (2012). *Conduct of Airman knowledge tests* (Order 8080.6F). Washington, DC: Author. Retrieved from http://www.faa.gov/documentlibrary/media/order/8080.6f.pdf

Federal Aviation Administration. (2015a). *Airline certificate information: Search for an airline*. Washington, DC: Author. Retrieved May 18, 2015, from http://av-info.faa.gov/OpCert.asp

Federal Aviation Administration. (2015b). *Repair station: Search*. Washington, DC: Author. Retrieved May 18, 2015, from http://av-info.faa.gov/repairstation.asp

Federal Aviation Administration. (2015c). *Resulting safety initiatives.* Washington, DC: Author. Retrieved from http://lessonslearned.faa.gov /ll_main.cfm?TabID=4&LLID=10&LLTypeID=10

Federal Aviation Administration. (2015d). *FAA aviation safety information analysis and sharing (ASIAS)* (AIDS Search Form). Washington, DC: Author. Retrieved from http://www.asias.faa.gov

Federal Aviation Administration. (2015e). *News type: Press release.* Washington, DC: Author. Retrieved from http://www.faa.gov/news/search

Franco, B. (2009). *Exploring the effects of increased FAA oversight on part 145 maintenance practices* (Doctoral dissertation). Retrieved from ProQuest Digital Dissertations databases. (Publication No. 3348172).

Furterer S. & Elshennawy, A. (2005). Implementation of TQM and lean six sigma tools in local government: A framework and a case study. *Total Quality Management & Business Excellence, 16*(10), 1179-1191. doi: 10.1080/14783360500236379

Gay, L. R., Mills, G. E., & Airasian, P. (2012). *Educational research: Competencies for analysis and application* (10th ed.). Boston, MA: Pearson, PLC.

Gelo, O., Braakmann, D., & Benetka, G. (2008). Quantitative and qualitative research: Beyond the debate. *Integrative Psychological and Behavioral Science, 42*(3), 266-290. doi:10.1007/s12124-008-9078-3

General Accounting Office. (1997). *FAA oversight of repair stations needs improvement* (GAO/RCED 98-21). Washington, DC: Author. Retrieved from http:// www.gao.gov/archive/1998/rc98021.pdf

General Accounting Office. (2014). *Additional oversight planning by FAA could enhance safety risk management* (GAO-14-516). Washington, DC: Author. Retrieved from http://www.gao.gov/assets/670/664402.pdf

Ghobrial, A. (2005). Outsourcing in the airline industry: Policy implications. *Journal of Transportation Law, Logistics and Policy, 72*(4), 457-473.

Gibbs, G. R. (2007). *Analyzing qualitative data*. Thousand Oaks, CA: Sage Publications.

Goldsby, R. P., & Watson, J. (2000). *Evaluation of US military AMT training and experience and its applicability to civil qualification and certification requirements.* Retrieved from http://www.faa.gov

Government Accountability Office. (2009). *Airline industry contraction due to volatile fuel prices and falling demand affects airports, passengers and federal government revenues* (GAO-09-393). Washington, DC: Author. Retrieved from http://digital.library.unt.edu/ark:/67531/metadc301015/

Government Printing Office. (2015). *Title 14—aeronautics and space.* Washington, DC: Author. Retrieved October 31, 2015, from http://www.ecfr.gov/cgi-bin/text-idx?SID=a76ea38cffd1b2d8f86ebd70789d51b8&mc=true&tpl=/ecfrbrowse/Title14/14cfrv3_02.tpl#0

Government Publishing Office. (2012). Air carrier contract maintenance requirements (Docket Number: FAA–2011–1136; Notice No. 12–07). *Federal Register, 77*(219), 67584-67592. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2012-11-13/pdf/2012-27433.pdf

Guest G., Bunce A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Fields Methods Journal, 18*(1), 59-82. doi:10.1177/1525822X05279903

Hung Y.F., & Chen C.H. (2013). An effective dynamic decision policy for the revenue management of an airline flight. *International Journal of Production Economics, 144*(1), 440-450. Retrieved from http://www.sciencedirect.com/science/article/pii/S092552731300128X

Kinnison, H.A., & Siddiqui (2013). *Aviation maintenance management* (2nd ed.). New York, NY: McGraw-Hill, Inc.

Leedy, P.D., & Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Linstone, H. A., & Turoff, M. (1975). *The Delphi method: Techniques and applications* (Vol. 29). Reading, MA: Addison-Wesley.

Lofland, J., Snow, D.A., Anderson, L., & Lofland, L. H. (2006). *Analyzing social settings: A guide to qualitative observation and analysis* (4th ed.). Belmont, CA: Wadsworth, Inc.

Loong, M. (2015). *The essentials of airplane maintenance*. Singapore: Partridge Publishing.

Lunsford, L. (2010). *Press release – FAA proposes civil penalty against American Airlines*. Federal Aviation Administration. Retrieved from http://www.faa.gov/news/press_releases/news_story.cfm?newsId=11777

Lunsford, L. (2014). *Press release – FAA seeks $12 million civil penalty against Southwest Airlines*. Federal Aviation Administration. Retrieved from http://www.faa.gov/news/press_releases/news_story.cfm?newsId=16754

Manen, M. (2014). *Phenomenology of practice: Meaning-giving methods in phenomenological research and writing (developing qualitative inquiry)*. Walnut Creek, CA: Left Coast Press.

McCartney, S. (2004). The middle seat: Who's inspecting your airplane? Carriers now outsource more of their maintenance, but FAA supervision is lax. *Wall Street Journal*, *12*(3), 3.

McFadden, K. L, & Towell, E. R. (1999). Aviation human factors: A framework for the new millennium. *Journal of Air Transport Management, 5*(4), 177-184. doi:10.1016/ S0969-6997(99)00011-3

McFadden, M., & Worrells, S. D. (2012). Global outsourcing of aircraft maintenance. *Journal of Aviation Technology and Engineering, 1*(2), 177-184. doi:10.5703/1288284314659

Miles, M. B., Hubberman, A.M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

NAICS Association. (2015). *Commercial and industrial machinery and equipment and electronic (except automotive and electronic) repair and maintenance* (NAICS Code 811310). Rockaway, NJ: Author. Retrieved from www.naics.com

National Aeronautics and Space Administration. (2015). *Aviation safety reporting system*. Moffett Field, CA: Author. Retrieved November 1, 2015, from http:// asrs.arc.nasa.gov

National Transportation Safety Board. (1997). *Aircraft accident report: In-flight fire and impact with terrain ValuJet airlines flight 592 DC-9-32, N904VJ Everglades, near Miami, Florida May 11, 1996* (NTSB Report No. AAR-97/06). Washington, DC: Author. Retrieved August 9, 2015, from http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR9706.pdf

National Transportation Safety Board. (2002). *Loss of control and impact with Pacific Office: Alaskan Airlines flight 261, McDonnell Douglas MD-83, N963AS, about 2.7 miles north of Anacopa Island, California, January 31, 2000* (NTSB Report No. AAR-02/01). Washington, DC: Author. Retrieved from http://www.ntsb.gov/investigations/AccidentReports/Reports/ AAR0201.pdf

National Transportation Safety Board. (2003). *Loss of pitch control on takeoff, Emory Worldwide Airlines, flight 17, McDonnell Douglas DC-8-71F, N8079U, Rancho Cordova, California, February 16, 2000* (NTSB Report No. AAR-03/02). Washington, DC: Author. Retrieved from http://libraryonline.erau.edu/online-full-text/ntsb/aircraft-accident-reports/AAR03-02.pdf

National Transportation Safety Board. (2004*). Loss of pitch control during takeoff, Air Midwest flight 5481, Raytheon (Beechcraft) 1900D, N233YV, Charlotte, North Carolina, January 8, 2003* (NTSB Report No. AAR-04/01). Washington, DC: Author. Retrieved from http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0401.pdf

Office of Inspector General. (2002). *FAA oversight of passenger aircraft maintenance* (OIG Report Number: CC-2002-146). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/30686

Office of Inspector General. (2003). *Review of air carriers use of aircraft repair stations.* (OIG Project No. 04A3007A000). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29187

Office of Inspector General. (2004). *Audit initiated of air carriers' use of non-certificated repair facilities* (OIG Report Number: AV-2005-062). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/31030

Office of Inspector General. (2005a). *Safety oversight of an air carrier industry in transition* (OIG Report Number: AV-2005-062). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/30765

Office of Inspector General. (2005b). *Air carriers' use of non-certificated repair facilities* (OIG Report Number: AV-2006-031). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29182

Office of Inspector General. (2006). *Observations on FAA's oversight of aviation safety* (OIG Report Number: CC-2006-074). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/30397

Office of Inspector General. (2007). *Inspector general testified before the house aviation subcommittee regarding FAA's oversight of outsource air carrier maintenance* (OIG Report Number: CC-2007-035). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/30079

Office of Inspector General. (2008). *Air carriers' outsourcing of aircraft maintenanc*e (OIG Report Number: AV-2008-090). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29183

Office of Inspector General. (2009). *Actions needed to improve safety oversight and security at aircraft repair stations* (OIG Report Number: CC-2010-005). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29186

Office of Inspector General. (2010). *Follow-up review initiated on FAA's oversight of foreign and domestic repair stations* (OIG Report Number: 11A3004A000). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29185

Office of Inspector General. (2013). *FAA continues to face challenges in implementing a risk-based approach for repair station oversight* (OIG Report Number: AV-2013-073). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29179

Office of Inspector General. (2015). *FAA has not implemented repair station oversight in the European Union* (OIG Report Number: AV-2015-066). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/32565

Oklahoma Aeronautics Commission. (2016). *About the OAC: Oklahoma Aeronautics Commission (FY2015).* Oklahoma City, OK: Author. Retrieved from https://www.ok.gov/OAC/

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information & Management, 42*(1), 15-29. doi:10.1016/j.im.2003.11.002

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Thousand Oaks, CA: Sage Publications, Inc.

Richardson, H. W., Gordon, P., Moore II, J. E., Kim, S., Park, J., & Pan, Q. (2014). *National economic impact analysis of terrorist attacks and natural disasters*. Northampton, MA: Edward Elgar Publishing.

Roth, G. (2006). Distributing leadership practices for lean transformation. *Reflections, 7*(2), 15-29.

Rudestam, K.E. & Newton, R.R. (2007). *Surviving your dissertation: A comprehensive guide to content and process*. Thousand Oaks, CA: Sage Publications, Inc.

Schwandt, T.A. (1994). *Handbook of qualitative research.* Thousand Oaks, CA: Sage Publications, Inc.

Seidman, I. (2006). *Interviewing as qualitative research: A guide to researchers in education and the social sciences* (3rd ed.). New York: Columbia University.

Sheehan, J. J. (2013). *Business and corporate aviation management* (2nd ed.). McGraw-Hill: New York, NY.

Stat Trek. (2015). *Random number generator*. Seattle, WA: Author. Retrieved from http://www.stattrek.com

Videtich, D. M. (2012). *Aircraft maintenance in America: Who is fixing my plane?* Transport Workers Union of America: Hurst, TX. Retrieved from http://d3n8a8pro7vhmx.cloudfront.net/teamstersforademocraticunion/legacy_url/17275/TWUAirMaintReport.pdf?1438829263

Will Rogers World Airport. (2015). *Will Rogers World Airport*. Oklahoma City, OK: Author. Retrieved September 12, 2015, from http://www.flyokc.com

Williams, P.K. (2012). *Air carrier contract maintenance requirements* (Docket Number: FAA-2011-1136; Notice No. 12-07). Washington, DC: Government Printing

Office. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2012-11-13/pdf/2012-27433.pdf

Wyman, O. (2015). *Global fleet & MRO market economic assessment*. Aeronautical Repair Station Association. Retrieved from http://arsa.org/wp-content/uploads/2015/03/ARSA-CAVOK-2015AssessmentExecSummary-20150330.pdf

APPENDICES

APPENDIX A

IRB APPROVAL

Oklahoma State University Institutional Review Board

Date:	Friday February 20, 2015
IRB Application No	ED159
Proposal Title:	Exploring the Effects of Enhanced Risk-Based FAA Oversight on Part 145 Maintenance Practices in Oklahoma
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved Protocol Expires: 2/19/2016

Principal Investigator(s):

Bryan Sheehan
P.O. Box 721913
Norman, OK 73072

Timm Bliss
318 Willard
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

■ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principle Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title. PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Hugh Crethar, Chair
Institutional Review Board

APPENDIX B

PARTICIPANT LETTER

Dear Mr./Ms. _____

As you know, Oklahoma's Part 145 repair station industry employs some 12,188 workers at highly specialized repair stations that are regulated by the FAA. Airlines rely on repair stations to reduce costs while achieving the highest level of safety to complement a 70 percent rise in outsourced aircraft maintenance. The annual impact from repair stations on Oklahoma's economy has exceeded $1.2 billion.

The Office of Inspector General (OIG) provides civil aviation oversight and has expressed their frustration with FAA's impasses to prioritize surveillance based on risk. Meanwhile, repair stations with the greatest risk are at jeopardy. Along with this concern complements a responsibility to advance a repair station workforce of highly trained, educated, and conscientious technicians to perform outsourced maintenance for the U.S. air carrier industry.

Your role as a repair station executive manager is critical to the growth of your business. I am conducting a study in pursuit of my dissertation for a doctoral program at Oklahoma State University and respectfully ask for your participation to be interviewed to benefit your intellectual capital needs within your organization.

The purpose of the research is to examine the insights of repair station executive managers in Oklahoma to understand if there has been any changes of maintenance practices in Oklahoma between 2007 and 2014 after the FAA enhanced its repair station oversight system in 2007. I will be interviewing a number of Oklahoma's top repair station executive managers in the field of aviation and would appreciate the opportunity to interview you in person at your convenience during the month of _____.

Findings of the study could be especially helpful to the repair station community and Oklahoma State University in looking at future curricula to keep Oklahoma competitive in the aerospace business.

Please review the enclosed Informed Consent Document. It details the purpose and procedures of the study, as well as providing you with important information regarding confidentiality. If you would be willing to participate in my study, please sign and date the document and return it to me. Should you have any questions about the study or the interview process, please do not hesitate to contact me. I may be reached by email at bryan.sheehan@okstate.edu or (405) 305-1176. Thank you.

Best Regards,

Bryan G. Sheehan

APPENDIX C

INFORMED CONSENT DOCUMENT

INFORMED CONSENT DOCUMENT

Project Title:

A qualitative phenomenological study of enhanced, risk-based FAA oversight on Part 145 maintenance practices in Oklahoma.

Investigator:

Bryan Sheehan, Department of Aviation and Space, Oklahoma State University
Dr. Timm Bliss, Department of Aviation and Space, Oklahoma State University

Purpose:

The purpose of this study is to explore the insights of repair station executive managers in Oklahoma to understand any changes of maintenance practices in Oklahoma between 2007 and 2014 after the FAA enhanced its repair station oversight system in 2007. Findings of the study could be especially helpful to the repair station community and Oklahoma State University in looking at future curricula to keep Oklahoma competitive in the aerospace business.

Procedures:

To increase the credibility of this study, three expert panel members from the aerospace industry of Oklahoma will pretest the research questions and compare their results with the Primary Principle Investigator (PPI). The open-ended research questions must be written in a manner that is clear and simple for the participants (repair station managers) to answer. The identities of each panel member will remain anonymous among the group to eliminate intimidation or invoke a more candid response; however, they will not remain anonymous to the PPI. There will be approximately three sessions between January and March 2015. Each session will take approximately two weeks to accomplish by email, mail, or fax.

A peer reviewer from the Maintenance Repair Overhaul (MRO) industry will conduct periodic peer reviews throughout the study, i.e., review data coding analysis to increase the credibility of this study.

Participants who are interviewed will be selected from approximately 20 repair station facilities within the Oklahoma aerospace population. The private interviews will consist of a predetermined set of research questions; interviews are anticipated to take about 30 minutes and will be limited to one setting unless clarification of unreadable audio recordings are necessary after the interview.

Risks of Participation:

There are no known risks associated with this study that are greater than those ordinarily encountered in everyday life.

NOTE: The PPI is not affiliated with any federal, state, or local law enforcement agency that could take legal action against the certificate of the repair station under study.

Confidentiality:

With the permission of the participants, a digital voice recording will be made of the interview to analyze the data. The records of this study will be protected and kept private. Written results will only discuss the group findings and not include information that identifies the participant. Expert panel members and the peer reviewer may experience some loss of privacy; however, the research team and peer reviewer will keep your records as confidential as possible. We will also ask panel members and the peer reviewer not to tell anyone outside the sessions what any particular person said during the sessions. However, we cannot guarantee that everyone will keep the discussions private. Once the digital voice recordings have been transcribed, they will be deleted from the audio recorders. All paper and electronic study materials will be destroyed three years after the last interview.

Compensation:

There will be no compensation given for participation in this research project.

Benefits:

This project will be significant because it could provide a detailed list of industry needs centered upon the effects of enhanced, risk-based maintenance practices, education and training program requirements, and future qualified workers with the recommendations and best practices to complement the repair station industry of Oklahoma.

Contacts:

Primary Investigator:
Bryan G. Sheehan
P.O. Box 721913
Norman, Oklahoma 73070-8457
Work Phone: (405) 305-1176
Fax: (405) 310-2703
Email: bryan.sheehan@okstate.edu

Faculty Advisor:
Dr. Timm Bliss
Aviation and Space Program
318 Willard Hall
Stillwater, Oklahoma 74078

If you have questions about your rights as a research volunteer, you may contact Ms. Dawmett Walloms, IRB Manager, University Research Compliance, 219 Cordell North, Stillwater, Oklahoma 74078, telephone (405) 744-5700 or <irb@okstate.edu>.

Participant Rights:

Your participation in this research is voluntary. There is no penalty for refusal to participate, and you are free to withdraw your consent and participation in this project at any time.

Signatures:

I have read and fully understand the consent form. I sign it freely and voluntarily. I understand that the interview/focus group session will be audio-recorded. A copy of this form has been given to me.

_____ _____

Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

_____ _____

Signature of Researcher Date

APPENDIX D

INTERVIEW GUIDE

DISCLAIMER

Good day _____ (participants name), my name is Bryan Sheehan and I am conducting a study as part of my dissertation for a doctoral program at Oklahoma State University. Thank you for allowing me to interview you today.

This interview is comprised of seven research questions to explore changes in aircraft maintenance practices at Oklahoma Part 145 repair stations between 2007 and 2014.

The basis for my study hinges upon the FAA's creation of an Air Transportation Oversight System (ATOS) in 1998. In 2007, the FAA upgraded ATOS with an enhanced, risk-based surveillance system.

As you know, ATOS is the FAA's primary risk-management tool for overseeing the nation's airlines. It is used to identify and correct high-risk safety problems for the air carrier industry. When an air carrier uses a Part 145 repair station to repair its aircraft or parts, the repair station becomes an extension of the air carrier's maintenance organization.

The informed consent document that you signed is your agreement to be a confidential participant of this study. Our interview will be audio recorded and last about 30 minutes.

I welcome and appreciate your candid opinions. Your insight is essential to the outcome of this study. If you want to stop at any time and take a break, please let me know.

If I ask a question that you do not want to answer, please feel free to let me know and we can skip that question. Do you have any questions before we get started? (pause). Then, let's begin.

RESEARCH QUESTIONS

1. How long have you been associated or employed with the Part 145 repair station industry?

2. What changes in Part 145 repair station aircraft maintenance practices have you observed before the FAA's implementation of its enhanced, risk-based oversight system in 2007? Clarification: Describe what a typical FAA inspection looked like before 2007 and how FAA oversight impacted your repair station (i.e., compulsion to hire additional personnel or modify management practices).

3. What changes in Part 145 repair station aircraft maintenance practices have you observed after the FAA's implementation of its enhanced, risk-based oversight system in 2007? Clarification: Describe what a typical FAA inspection looks like

today and how FAA oversight impacts your repair station (i.e., compulsion to hire additional personnel or modify management practices).

4. What advantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

5. What disadvantages have you noticed from enhanced, risk-based FAA oversight at your repair station between 2007 and 2014?

6. How do you feel about the argument to increase the frequency of FAA inspections at Part 145 repair stations to improve the safety of the U.S. air transportation industry? Clarification: The Office of Inspector General (OIG) has been advocating for an increase in FAA surveillance of repair stations since 1998. Recent reports by the OIG indicate that future increases in surveillance will be necessary.

7. What would you like to add as further opinion that I have not covered during this interview?

Research questions were derived from the following sources:

Office of Inspector General. (2002). *FAA oversight of passenger aircraft maintenance.* (OIG Report Number: CC-2002-146). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/30686

Office of Inspector General. (2013). *FAA continues to face challenges in implementing a risk-based approach for repair station oversight*. (OIG Report Number: AV-2013-073). Washington, DC: Author. Retrieved from https://www.oig.dot.gov/library-item/29179

APPENDIX E

CODE NUMBERING TRIANGULATION COMPARISON

No.	Major Themes	Subthemes	Researcher	Evaluator A	Evaluator B
2	Quality of oversight before 2007	Level of standardization	29	29	29
		Uncertainty	1	1	1
3	Quality of oversight after 2007	Level of standardization	24	24	25
		Employment	8	8	8
		Management changes	1	1	0
		No change	2	2	2
4	Advantages of oversight	Efficacy	21	21	21
		No advantage	2	2	2
		Uncertainty	1	1	1
5	Disadvantages of oversight	Burden	15	15	15
		No disadvantage	4	4	4
6	Status quo of oversight	Frustration	28	28	28
		Transparency	4	4	4
		Uncertainty	2	2	2
7	Process improvement	Inadequate oversight	15	15	15
		Inadequate training	10	10	10
		Lessons learned	7	7	7

VITA

Bryan G. Sheehan

Candidate for the Degree of

Doctor of Education

Dissertation: A QUALITATIVE PHENOMENOLOGICAL STUDY: ENHANCED, RISK-BASED FAA OVERSIGHT ON PART 145 MAINTENANCE PRACTICES

Major Field: Applied Educational Studies

Biographical:

Education:

Completed the requirements for the Doctor of Education in Applied Educational Studies with an option in Aviation Sciences at Oklahoma State University, Stillwater, Oklahoma, 2016.

Completed the requirements for the Master of Science in Aerospace Administration and Logistics at Southeastern Oklahoma State University, Durant, Oklahoma, 2010.

Completed the requirements for the Bachelor of Science in Aviation Management with an option in Safety at Southeastern Oklahoma State University, Durant, Oklahoma, 2008.

Experience:

Thirty-two years of aviation experience as an Part 145 Repair Station Accountable Manager, Inspector General (IG) and Quality Assurance (QA) lead auditor, KC-135 lead aircraft mechanic, Operational Iraqi Freedom II—OH-58D *Kiowa Warrior* U.S. Army First Sergeant, Cessna 172 and Piper A&P mechanic, Aviation Proponency manager, UH-60 *Black Hawk* and UH-1 *Huey* Quality Control (QC) supervisor and inspector, maintenance supervisor, crew chief and helicopter mechanic.

Professional Memberships:

Aviation Safety Bureau, Association of Inspectors General, Aircraft Maintenance Professional, and Military of the Purple Heart.