January 2021

Airframe And Power Plant Certificate Continued Education Requirements And Renewals

Robert Teal

AIRFRAME AND POWER PLANT CERTIFICATE CONTINUED EDUCATION REQUIREMENTS AND RENEWALS

by

Robert James Teal III
Associates of Science, Morrisville State University, 2003
Bachelor of Science, Thomas Edison State University, 2013

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

May 2021

Name: Robert Teal

Degree: Master of Science

This document, submitted in partial fulfillment of the requirements for the degree from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

DocuSigned by:

6706D21C81124B7...

Shayne Daku

DocuSigned by:

0AC0753522AE45C...

Mark Dusenbury

DocuSigned by:

Brandon Wild

5B748286E761432...

Brandon Wild

This document is being submitted by the appointed advisory committee as having met all the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

DocuSigned by:

Chris Nelson

2E6AF000C733469...

Chris Nelson

Dean of the School of Graduate Studies

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Department	Aviation
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Robert James Teal III
March 20 2020

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ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to my Advisory Committee for their guidance and support during my time in the master's program at the University of North Dakota. Specifically, my academic advisor and committee chair, Shayne Daku for his continued advice and critical feedback. Additionally, Drs. Mark Dusenbury and Brandon Wild for their academic guidance and continual mentorship as chair members throughout the thesis process. The faculty and staff of the University of North Dakota Aviation Department for their patience and dedication to my academic success. The support and dedication of the Professional Aviation Maintenance Association enabled me to capture the dad crucial to the success of this thesis. Because of the dedication your organization has to the continued success of the Aviation Maintenance trade, we were able to capture data crucial to the success of this thesis. Finally, I would like to thank my family for their continuous support and encouragement. Without their, sacrifice, and motivation, I would not have achieved my goals.

ABSTRACT

The aviation industry is growing and estimated to continue to grow over the next ten years, to a point where passenger travel will almost double. With industry growth new aircraft will be introduced employing rapidly advancing technology, and larger commercial fleets will demand a growth in the aircraft maintenance workforce. As the baby boomer generation approaches retirement there is a greater need for aviation maintenance technicians. An interim approach to fewer mechanics and major changes in technology is to implement requirements for continued education and certification renewals for Airframe and Powerplant mechanics. This policy would mirror that of other agencies governed by the International Civil Aviation Organization. The results of this study show limited buy-in to these concepts by the current mechanic workforce. Those who support continued education, show interest in the topics of new technology and human error, and desire the ability to attend programs either online or remotely.

INTRODUCTION

"When you get it right, mighty beasts fly up into the sky.

When you get it wrong, people die."

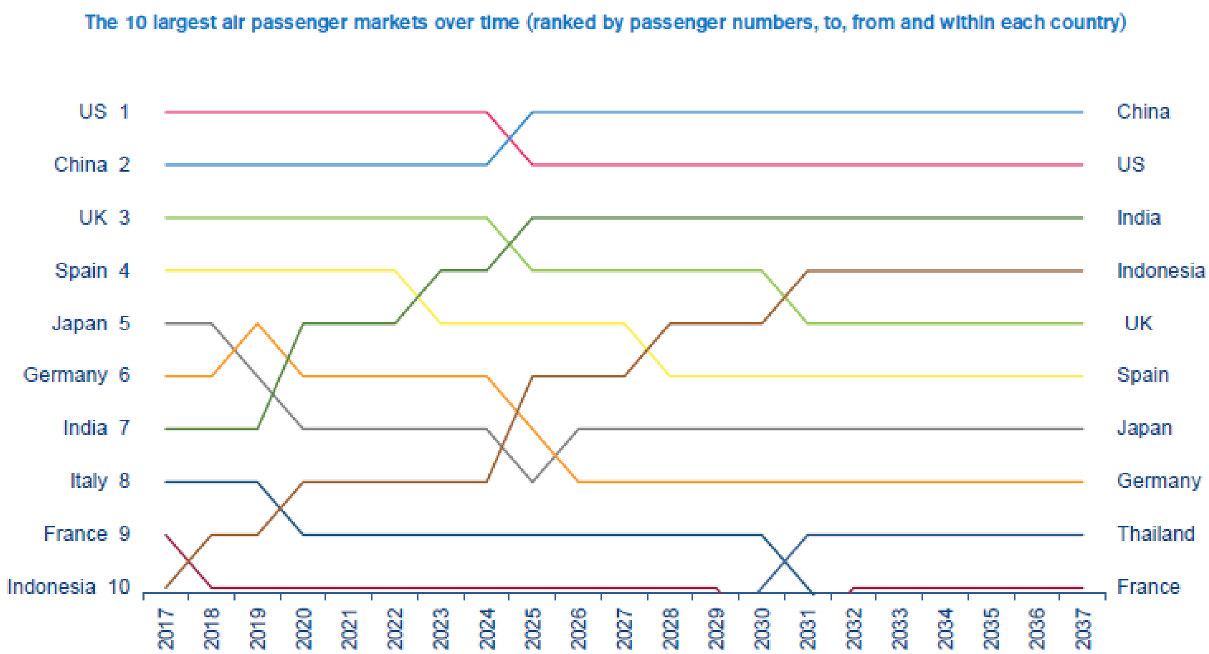
-Roger Bacon

Human error is recognized as a prime causal factor for incidents in numerous commercial applications, including medical, industrial, construction and aviation (Darabont, 2020). Furthermore, human error in some fashion is a contributing factor to roughly 80 percent of all aviation accidents worldwide (Rankin, 2007). However, it can be argued that 39 percent of all widebody aircraft incidents can be attributed specifically to human error involving maintenance personnel before reaching a classification of "pilot error" (Rankin, 2007). The human error label can restrict individuals from pinpointing the true causal factor of the error. The ability to determine what interactions between the person, the equipment and other situational variables leading to the error, will provide opportunities for training to reduce recurrent error (Rankin, 2000). Most of the existing literature focuses primarily on pilot error and the demographics of recurrent training and certificate renewals or check rides, often overlooking the human factors related errors associated with maintenance personnel.

With the aviation industry expected to see more than double the number of passengers within the next 20 years, the safety status of commercial aviation could be at risk if human factors associated with aircraft maintenance are not addressed (IATA, 2018). The International Air Transport Association (IATA) estimates air travel to reach 8.2 billion passengers by year 2037 (IATA, 2018). With the largest growth in the Asian-Pacific regions. The growth estimates China to become the largest global passenger market surpassing the United States (IATA, 2018). Figure 1 displays the projected growth for the global commercial air passenger market, displaying the top ten countries. As new aircraft are added along with aging aircraft kept in service, the amount of maintenance required to keep aircraft airworthy will increase. This will create a greater opportunity for latent errors throughout the various maintenance functions. However, with the widespread implementation of mechanic certificate renewals, combined with continued education requirements, a reduction in maintenance related incidents will continue, further solidifying aviation as the safest form of travel (Stoop, 2020).

Figure 1

Global commercial passenger market forecast



PURPOSE OF THE STUDY

The purpose of this study is to determine the willingness and interest level of certified Aircraft Maintenance Technicians (AMTs) to obtain continued education credits toward required airman certificate renewals. The present study was designed to answer the following research questions:

1. What percentage of AMTs believe recertification requirements should be implemented?
2. Should airman certificates have an expiration date?
   a. If so, how often should renewal be required?
3. What percentage of AMTs currently have recurrent education/training requirements within their organization?
4. What percentage of AMTs believe continuing education credits should be required?
5. How many required credit hours would be beneficial for certificate renewal?
6. What type of media would be best suited for continued education delivery?

PROBLEM STATEMENT

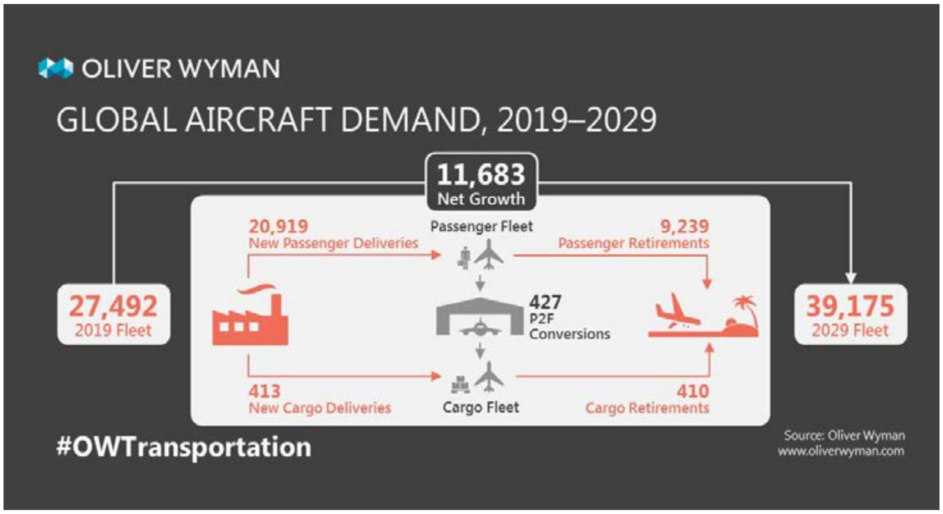
The estimated growth of commercial aviation creates multiple issues concerning human factors and maintenance. As with increases in domestic air travel, air cargo volume is increasing similarly, as a result of the booming e-commerce industry. As business expands in the commercial aviation industry, the maintenance, repair and overhaul (MRO) industry are expected to grow (Cooper, 2019).

In order to meet market demand, some airlines are opting to retain aging aircraft in the fleet, and in some instances reinstate aircraft previously placed in storage (Cooper, 2019). In China, India, Eastern Europe and Asia Pacific, fleet age will increase as the need for more aircraft arise. Newly purchased deliveries will supplement the fleet of older aircraft, causing the average age of the fleet to increase, leading to greater importance for maintenance programs and mechanic training (Cooper, 2018). Conversely, the average aircraft age will decrease five percent from 11.3 years old today to 10.7 in 2029 in North America, Western Europe, Latin America and Africa as over 21,000 expected aircraft deliveries are anticipated throughout the decade.

Roughly 45 percent of new aircraft purchases will replace existing aircraft while the rest will add to the current fleet. Figure 2 displays the projected growth to commercial aircraft fleets for both the passenger and cargo industries over the next decade. Newer aircraft provide greater fuel efficiency, higher average seating capacity, and lower maintenance costs particularly in the short to medium hauls (Cooper, 2019). An aging fleet levies greater burdens on maintenance due to decreased parts availability and dispatch reliability. To further complicate matters, new airframes rolling off assembly lines employ new developing technologies such as composite structures, glass cockpits, highly automated flight control systems, built in diagnostic test equipment, and solid-state fuel systems. With these technological advancements, aircraft maintainers need to be more knowledgeable and adept in their work than those who came before them (Chang, 2010). This creates a major knowledge curve and a lack of proficiency as maintainers lose the ability to specialize in their craft as technology advances. This will continue to happen as, over the next decade, 58 percent of aircraft flying will have been designed and manufactured after the year 2000 (Prentice, 2017).

Figure 2

Projected aircraft growth



The knowledge gap and opportunity for human error will only continue to grow as the baby boomer generation ages into retirement. The 2018 annual safety review lists experience, training, and competence of individuals among the top five key risk areas and safety concerns across all aviation platforms (EASA, 2018). Much like the pilot shortage, the aviation maintenance industry is beginning to feel the strains of worker shortages. The median age of aircraft mechanics in the U.S is 52 years old. This is ten years greater than the broader U.S. workforce (ATEC, 2020). Figure 3 shows the age break down of AMT workforce in the commercial MRO industry. Studies by Boeing predicts the need for approximately 601,000 new aircraft mechanics worldwide to replace the retiring baby boomers (Garner, 2014). Figure 4 depicts the projected supply and demand of AMTs through the year 2027. It is projected that around the year 2023 demand for technicians in commercial MRO field will see a sharp increase while the supply of mechanics continues the gradual decline.

Figure 3

Age distribution of AMTs in Commercial MRO Industry

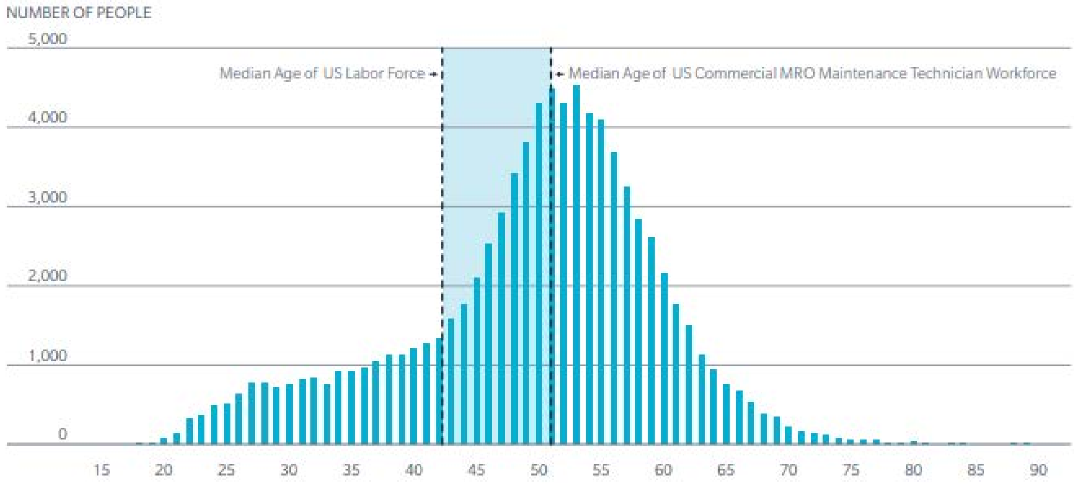
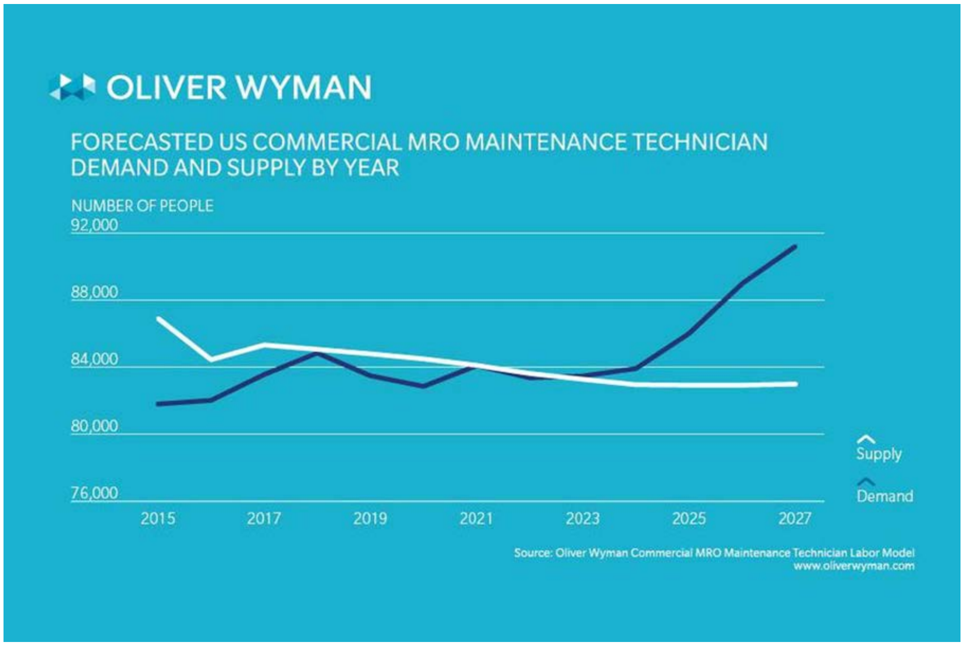


Figure 4

Projected AMT Supply and Demand



Further complicating the need for new mechanics there has been continuing decline to both people applying for training programs and the percentage of graduates who accept employment in the aviation industry (Dalkilic, 2017). Currently every two out of five seats remain empty in aircraft mechanic school programs across the U.S. (ATEC, 2020). Of the individuals who do complete the AMT program, only 81% continue on perusing the FAA A&P certification process and 8 percent of those individuals take employment outside of the aviation industry (ATEC, 2020). It is clear that human error is a considerable influence to failures, incident and accidents. Proper initial training and the implementation of continued education programs can reduce these failures (Le May, 2008).

BACKGROUND

To maintain the modern aircraft of today's time, mechanics must be both technically adept and highly educated. Certified AMTs are highly educated individuals, either receiving the equivalent of a bachelor's degree through a certified Title 14 Code of Federal Regulation (CFR) Part 147 aviation maintenance technician education program, or have years of experience and training through military aviation (Finnegan, 2005). For individuals with current aircraft maintenance experience, testing and certification requirements fall under title 14 CFR Part 65. This section outlines the certification requirements of all airman other than flight crewmembers. All mechanics seeking certification must complete a series of written and practical exams testing their knowledge from the respective training programs. After the testing is satisfactorily completed, the mechanic certificate is valid until surrendered, suspended or revoked. The only advanced FAA certification for a mechanic, is an Inspection Authorization (IA) certificate. This certification authorizes the holder to return aircraft or aircraft parts to an airworthy status after major repair or overhaul in accordance with 14 CFR Part 43 regulations, provided the aircraft is not maintained in a continued airworthiness program under 14 CFR Part 121. Part 43 regulations governs maintenance rules and standards of performance for maintenance, preventative maintenance, repair and alterations of aircraft and part. Whereas 121 regulations cover the certification of airlines to operate as a business in the United States. Unlike a mechanic certification, the IA certificate does require bi-annual renewal by completing an FAA certified renewal course (FAA, 2020).

Once a mechanic is certified and employed, the FAA requires that Federal Aviation Regulations (FAR) Part 121 operators have a training program on file in order to maintain compliance. This training program is designed to ensure mechanics are competent in maintenance procedures, techniques, new equipment and technology. However, 14 CFR §121.375 does not provide specific details as to what types of training are required of an employer to provide for its personnel.

HOW OTHER COUNTRIES HAVE ADDRESSED AMT TRAINING

There is more than one approach to accomplishing AMT training and certification requirements within the international aviation community. Transport Canada (TC), European Union Aviation Safety Agency (EASA), and the Civil Aviation Safety Authority of Australia (CASA) all have specific, yet differing regulations and programs regarding the training and certification of their particular AMTs (Hackworth, 2007). The International Civil Aviation Organization (ICAO) is the technical body that adopts and implements international aviation standards. ICAO does not actually issue any certificates for pilots or mechanics, rather states are required to establish their AMT licensing program and issue their own licenses in accordance with their national regulations (Yadav, 2010). Initial certification for Aircraft Maintenance Engineers (AME) in Canada must meet all requirements outlined in subpart 403 of the Canadian

Aviation Regulations (CAR) and the Airworthiness manual (AWM) chapter 566 Division I. Depending on the certification sought, a minimum of 500 hours of theory training is required in combination with at least 36 months of maintenance experience. After certification, Transport Canada (TC) requires all AME's to renew certifications every 10 years. In order to qualify for certification renewal, continued training requirements are necessary as outlined in CAR 2019-1 Part V Standard 576.06. An update in training is required in technical, regulatory and human factors issues for all areas related to the work an AME is responsible for. Additionally, update training can be provided via TC approved training courses, classroom seminars or on-the-job training (Canadian Aviation Regulations, 2020).

Aircraft Maintenance Licenses (AML) issued by the European Union Aviation Safety Agency (EASA), have a wide range of requirements based on the specific certificate and types of training completed by the applicant. EASA presides over member states of the European Union (EU) providing mutually acceptable standards for the aviation community. Some countries outside of the EU, like Turkey have adopted the regulations and procedures of EASA part 66 (Usanmaz, 2011). Various licenses and certifications are available under EASA regulations, depending on the intended maintenance to be completed by the holder. Experience requirements can be as little as one year for individuals graduating from an approved Part 147 training program, to as much as three years for individuals with no technical training. Regardless of initial training, EASA Part 66 regulations place an expiration of 5 years from the issued date on all AML certificates (EASA, 2014).

Similarly, to the FAA, the Civil Aviation Safety Authority of Australia issues perpetual AME licenses. In order to further align CASA regulations with that of EASA, in June of 2011 the certification and licensing of mechanics was transitioned to closely mirror the regulations set forth by EASA and the FAA (Naweed, 2020). The previous regulation 31 of CAR 1988 and five license system was replaced by the current Civil Aviation Safety Regulations Part 66 regulations holding a three-category licensing. CASA experience requirements continued to remain stricter than the current requirements set forth by EASA part 66 regulations, requiring minimum experience of 2 years for basic licensing and more for high levels of certification in according with CASA Part 66.120 (CASA, 2009). One major difference from Australia in comparison to all other certifying agencies is CASA, provides the ability for mechanics to complete initial and further education exams online, via the use of CASA basics. CASA basic is an online courseware and examination software that has been further implemented as a result of COVID-19 mitigation (CASA, 2015).

Unlike many other countries, the FAA only implements recertification requirements for the Inspection Authorization (IA) Certificate. Certified IA's are required to complete recurrent certification seminars, which include human factors training bi-annually. However, for basic Airframe and Powerplant mechanics, there is no expiration to the airman certificate, nor is any recurrent training required to maintain an active certificate (FAA, 2013). Despite these requirements the US and the FAA are lagging in overall AMT initial certification, and recurrent training requirements as can be seen in Table 1. As foreign countries in ICAO have adapted to changing time and significantly increased AMT training requirements, the United States places increased responsibility on the industry and AMT training providers to address the knowledge and technical acumen gap that exists between the industry needs and capabilities on school graduates (White, 2000). Not only does the FAA require the least amount of approved schooling hours, if an individual graduates from an approved school there is no required work experience for certification as an Airframe or Power Plant mechanic.

Table 1

AMT Certification and Training Requirements

AMT Certification and Training Requirements

	FAA	EASA	Canada
Regulations	FAR 65, JAR 147	ECAR 66, ECAR 147	STD 566, Div I & II
License Types	Airframe and/or Powerplant (A&P)	Cat A Task – Specific B1 – Airframe/Powerplant B2 – Avionics C - Base Maintenance	M1/M2 Comp. Aircraft E - Electronics S - Structures
Approved School (Hours)	1900	2400 - 3000	2000 - 2400
Work Experience Summary (with school)	None Required	Cat A – 1 year B1 or B2 – 2 years C – 3 years with Degree C – 5 years with B1 or B2	M1/M2 4 years
Type Ratings	No	Yes	Yes

Human factors are an integral part to aviation safety, especially as it relates to AMTs and the maintenance industry of aviation. Much like the differing requirements for initial AMT training, human factors training and requirements vary with-in the international aviation community. Transport Canada (TC), the European Aviation Safety Agency (EASA), and The Civil Aviation Safety Authority of Australia all have specific requirements for recurrent training on human factors (Hackworth, 2007). Unlike other agencies the FAA has created an Advisory Circular (AC) and guidance documents addressing human factors for maintenance facilities. FAA AC 120-72A, released in 2017, discusses the implementation of maintenance human factors programs, but emphasizes that an AC is not a mandatory requirement like a regulation (FAA, 2013). As for guidance the creation of a Human Factors Operators Manual was completed in 2005, and last updated in 2014, geared towards engineering personnel. The FAA has only required initial training in human factors for certificated Aviation Safety Inspectors (ASI) and Inspection Authorization (IA). However, for basic Airframe and Powerplant mechanic, no certificate renewals are required, nor is initial human factors training required to obtain certification (FAA, 2013). Despite this requirement the US and the FAA are lagging in the maintenance human factors training as can be seen in table 2. As EASA and TC all have regulations in place that not only require initial training in human factors, but continued recurrent training for all licensed maintenance personnel (Johnson, 2008).

Table 2

Human Factors Training Requirements

FAA has the fewest Human Factors requirements

Topic	ICAO	EASA	TC	FAA
HF for Initial Certification	Annex 1	145.A.30(e) incl AMC&GM 145.A.30(i)	CAR 573.06	No
Continuation Training for HF	Annex 6	145.A.35 (d)	CAR 573.06	Recommended in ACs
Error Management System	Guidance	145.A.60	CAR 1	Rec, 145.211
Fatigue Management System	Guidance	145.A.30(d) incl. AMC	Proposed, now awaiting consul.	Guidance in Tech Pubs 121.377
Accountable Executive	No	145.A.30	CAR 106	145
Published HF Guidance Materials	Doc 9683-AN/950	GM145.A.30 (e) &Part 66 Appendix I M9	TP 13459	AC120-72, Ops Manual, FAA Website
Documentation Reporting Requirement	Guidance	145.A.45	CAR 573.08	145.109 121.369
Safety Culture/Safety Management System	Under development Annex 6	145.A.65	CAR 573.30	Continuing Analysis and Surveillance System
Procedural Non-compliance	Guidance	145.A.65 (c)	CAR 571.05	ASAP
Planning of tasks, equipment, and spares	Guidance	145.A.47	No	145.109
Shift and task handover	Guidance	145.A.47	CAR 573.08	121.369 (b) 9 135.427(b) 9
Error capturing (duplicate inspections)	Guidance	145.A.65 (b)3	CAR 571.10	121.371

CONTINUED EDUCATION IN OTHER INDUSTRIES

Continued education (CE) is employed throughout multiple technical fields, with the medical field being the most notably recognized in the use of CE. Ongoing professional training is a necessary part in the development of high-quality professionals, and is necessary for complex technical professions. Accountants, engineers, lawyers, commercial pilots, teachers, and the skilled trade workforce also have an ongoing need to improve their skills and stay competent to perform at high levels, spurring the advancement of CE activities in these fields (Warden, 2010). The main focus of CE programs is to provide skilled technicians the ability to improve specialty knowledge through various conferences, formal courses, workshops and in person symposiums (Ahmed, 2013). As with any highly skilled trade there is a need for lifelong education, to stay up to date in the many rapidly evolving technologies, changing rules and regulations. As a result, CE is becoming an increasingly important, standardized method of ensuring professional competence (Warden, 2010). In some professions CE is mandated for license renewal at state and or national levels, while other professions still view CE as a voluntary elective (Warden, 2010). It has been propounded that CE is a vital tool allowing technicians to "catch up" with technological advances in sciences and changing industry techniques, as well as improving overall technician performance (Dionyssopoulos, 2014). Studies performed, prove the concept of CE as an effective tool for the medical field, at least to some degree. Participants have been noted as achieving and maintaining knowledge, attitudes, skills, practice behavior, and clinical practice outcomes after the employment of CE (Marinopoulos, 2007). Some studies report an improvement of knowledge in 79% of participants, with a greater motivation for continued learning after participation in CE (Al-Ansari, 2018). Commonalities from studies illustrate live media is a more effective method of training over other forms of CE. The employment of a multimedia format with multiple exposure rates is shown to be the most receptive form of CE with the highest content retention. (Marinopoulos, 2007). With the effectiveness of multimedia formats for CE studies have noted that technicians within a specific industry will have similar educational needs and requirements. With learning variations within the groups and the diversity of the technicians there is a need for a variety of CE formats and programing (Barret, 2012).

RESEARCH DESIGN

With little to no research completed on the topic of CE for aircraft mechanics, organic data needed to be collected. CE is used as a means to keep technicians' skills proficient, enabling performance at a high level under stressful conditions. The global Aviation maintenance industry is facing multiple concerning issues. Employed aircraft technology is rapidly advancing, and the aviation industry is growing at a rate disproportionate to the growth rate of the mechanic workforce. Education has the opportunity to address some of these concerns while managing the impact of the others. This study used an original qualitative survey designed to capture raw data from FAA certified A&P mechanics. Qualtrics Experience Management Software was employed as a means to design and deliver the questionnaire to mechanics. Participants responses were collected and stored securely on Qualtrics servers for statistical analyzing. The 16-question survey was published in Professional Aviation Maintenance Association's (PAMA) monthly member newsletter. Multiple questions referenced the respondents' background. Gathering data on age, gender, employment category, and how long they have held an A&P certificate. No personal identifiers were collected in the survey responses. All demographic information collected during the survey was solely for the purpose of categorizing the data. Additional questions queried participants, if recurrent training was required by their present employer or offered as an opportunity. In terms of CE, participants responded to whether or not mechanics certificate should have renewal requirements and if CE should be associated with certifications. Data was collected over a 60-day period, with the survey opening on January 14, 2020 when it was published in PAMA's newsletter (PAMA News) on January 27,2020, which is sent out to all members. Additionally, PAMA News is available on the website, which allows nonmember access to view the newsletter. Provided in the newsletter was a link to the survey hosted by Qualtrics with a closing date for the survey of March 15, 2020.

PAMA membership is comprised of individuals connected to the aviation maintenance profession and therefore have a vested interest into the state of the profession and changes within the industry. Current PAMA membership includes 389 published members, four major aviation companies and seven educational institutions.

STUDY POPULATION/SAMPLE SIZE

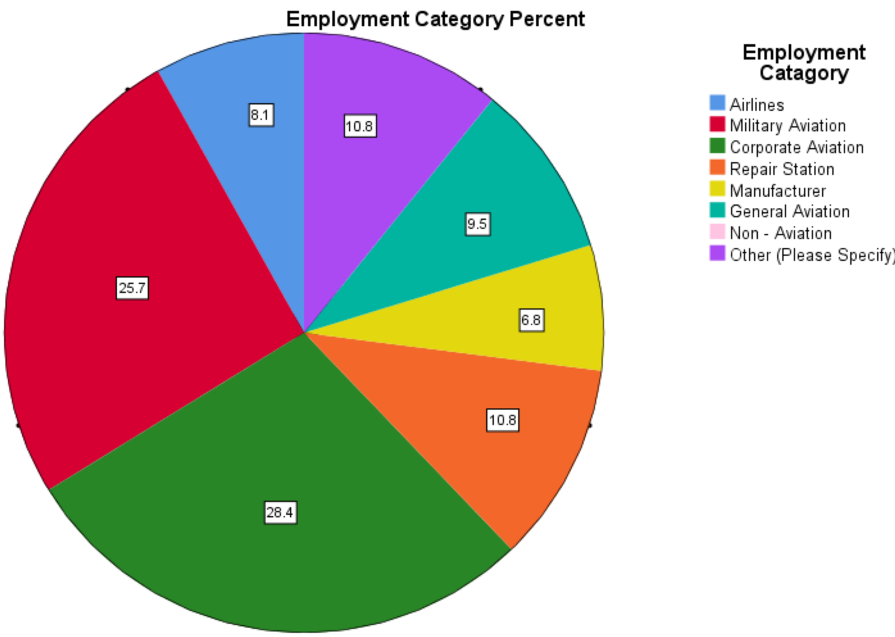
The desired population for this research was AMTs who possess an FAA Airframe and/or Powerplant mechanic's certificate. The bureau of labor and statistics lists approximately 157,400 aircraft mechanics and technicians as of 2018. This number is not an accurate representation of the true population size of FAA certified mechanics, as not all aircraft maintenance technicians are required to hold an FAA A&P certificate. Aircraft Manufacturers employ technicians working under a production certificate who qualify as an aircraft mechanic for the purpose of workforce statistics as reported by the Bureau of Labor, but do not hold an FAA mechanics certificate. Additionally, technicians have the ability to work for a certified aircraft repair station certificate or under a certified A&P mechanic at a Fixed Base Operator (FBO) while working towards their required time for testing eligibility and certification. These individuals also add to Bureau of Labors' total mechanic statistical numbers. The study sample was drawn from members of PAMA, which includes membership from various aviation organizations. PAMA members were solicited to voluntarily participate in the study. Other members eligible to participate were mechanics holding equivalent certifications from other member states of the International Civil Aviation Organization (ICAO).

SAMPLE

A total of 79 participants responded to the survey. Of these responses, three were incomplete. All three failed to answer any questions other than the agreement to participate in the study. These three responses have been omitted from the data set, leaving 76 participants for the study sample size. Of the 76 participants there were 74 males and two female participants with an age range of 24 to 77. The mean age of the sample was 48 years old with a median of 46 years. However, only 44 participants provided their age in the survey questionnaire. One participant chose to answer the age demographic question by listing his/her age as “60+” in the answer blank. Because the age was not a whole number the participates age was omitted in calculating any statistical data for the purpose of this study. All other responses from this individual were included for the remainder of the statistical analysis for responses to the survey. Two participants who completed the survey did not hold an A&P Certificate. This was a requirement to continue through the questionnaire, so these two individuals were able to provide demographic data. They, however, were not allowed to proceed further in the questionnaire. Of the remaining participants holding an A&P certificate, experience as a certified mechanic ranged from one month to 52 years of experience. A mean of 23.4 years employed in various sectors of the aviation industry. This metric represents the total experience while certified by the FAA as an A&P mechanic, not total experience as an aircraft mechanic. The Figure 5 represents the breakdown of employment category for the sample population. Of the 8 individuals in the other category, three were employed by an aviation training facility, three were government or defense contractors, one, a retired chief pilot and the final was a Maintenance, Repair, Overhaul (MRO) software vendor.

Figure 5

Sample Employment Category



RESULTS

The results of this study were calculated using IBM SPSS Statistics 26 software. All data was retrieved from the 76 individuals who fully participated in the study. The mean age for the participants within the sample was calculated at 47.6 years with a median age of 45 years old. These ages are slightly below age of aircraft mechanics in the US with a mean of 51, and median of 52 years old, as reported by the Bureau of Labor. Of the individuals surveyed, just over 67% or 52 individuals reported the company they work for has mandated training requirements currently in place for mechanics. Additionally, sixty or 77.9% respondents report their employment organization provides opportunities for employees to attend continued education or advanced training programs.

In terms of certificate renewal requirements, a majority of participants opposed the implementation of renewal requirements for FAA A&P certificates. A total 58 percent of participants surveyed disagreed with the implementation to any mandated renewal requirements for certificate holders. Individuals in favor of renewal requirements were calculated at 31 percent and the remaining one percent of participants declined to respond to the question. Of the 24 individuals in favor of renewal requirements there was a close split as to how often A&P certificates should be renewed. Participants had the option to select annual, bi-annual (2 years), tri-annual (3 years), five years or other with a text entry to explain their choice. The most selected response was five years with nine individuals opting for that specific time frame. This mirrors the renewal timeline for AMTs certified under EASA regulations in the European Union. Eight individuals opted for a three-year renewal requirement, six selected bi-annual requirements and the final individual chose annual renewals.

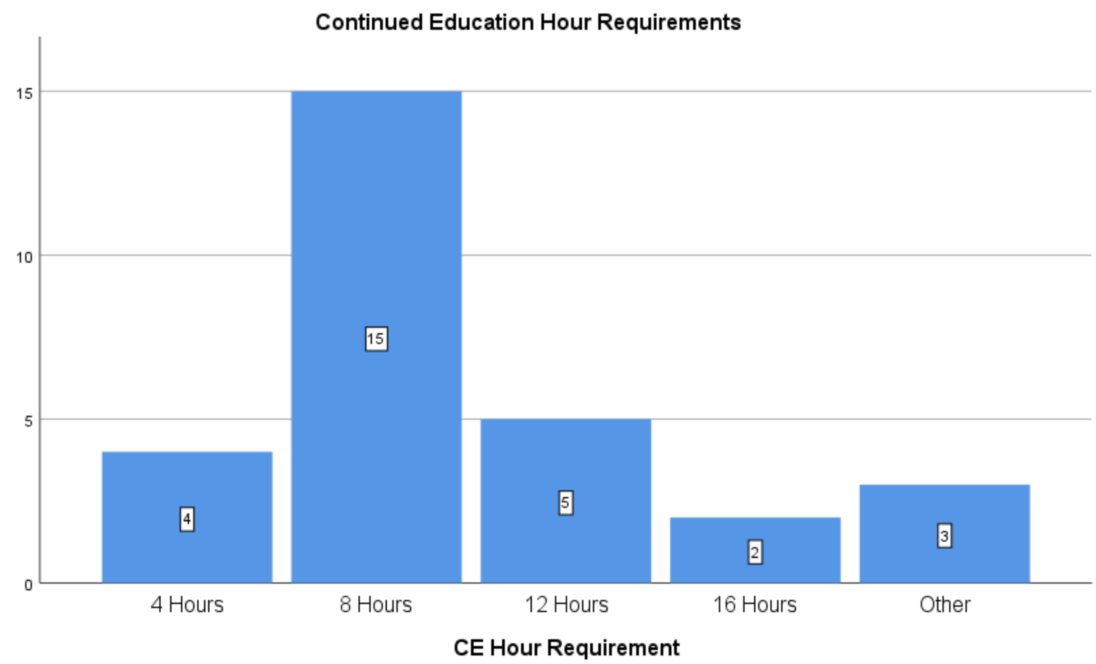
Similarly, to renewal requirements, a majority of survey responses were opposed to the addition of requirements for continued education credits. With a total of 39 or 50% of responses opposing the implementation of continued education requirements for A&P mechanics. Thirty participants or 39% were in favor of CE requirements and the remaining 11% declined to respond to the question. Among the individuals who participated in the study there was a positive correlation between the variables for CE requirements and A&P certificate renewal $r(68) = .27$, $p = .024$. This indicates participants opposed to A&P certificate renewals were most likely to oppose CE requirements and vice versa. The thirty individuals supporting the implementation of CE requirements were further questioned as to how many hours should be required. Below figure

6 depicts the responses to how many CE hours should be required. Of the thirty individuals in favor of CE requirements one declined to respond as to how many CE hours should be required. If other was selected in the survey a text box was offered to further explain the choice. The three individuals who selected other, did provide additional details explaining selection. One individual recommended that 20 hours of CE be the mandatory requirement.

A second participant responded that a total of eighty hours of formal education should be mandated for CE requirements. The final participant that selected other left a statement saying the requirements for CE should vary based upon the aircraft the individual mechanic works on.

Figure 6

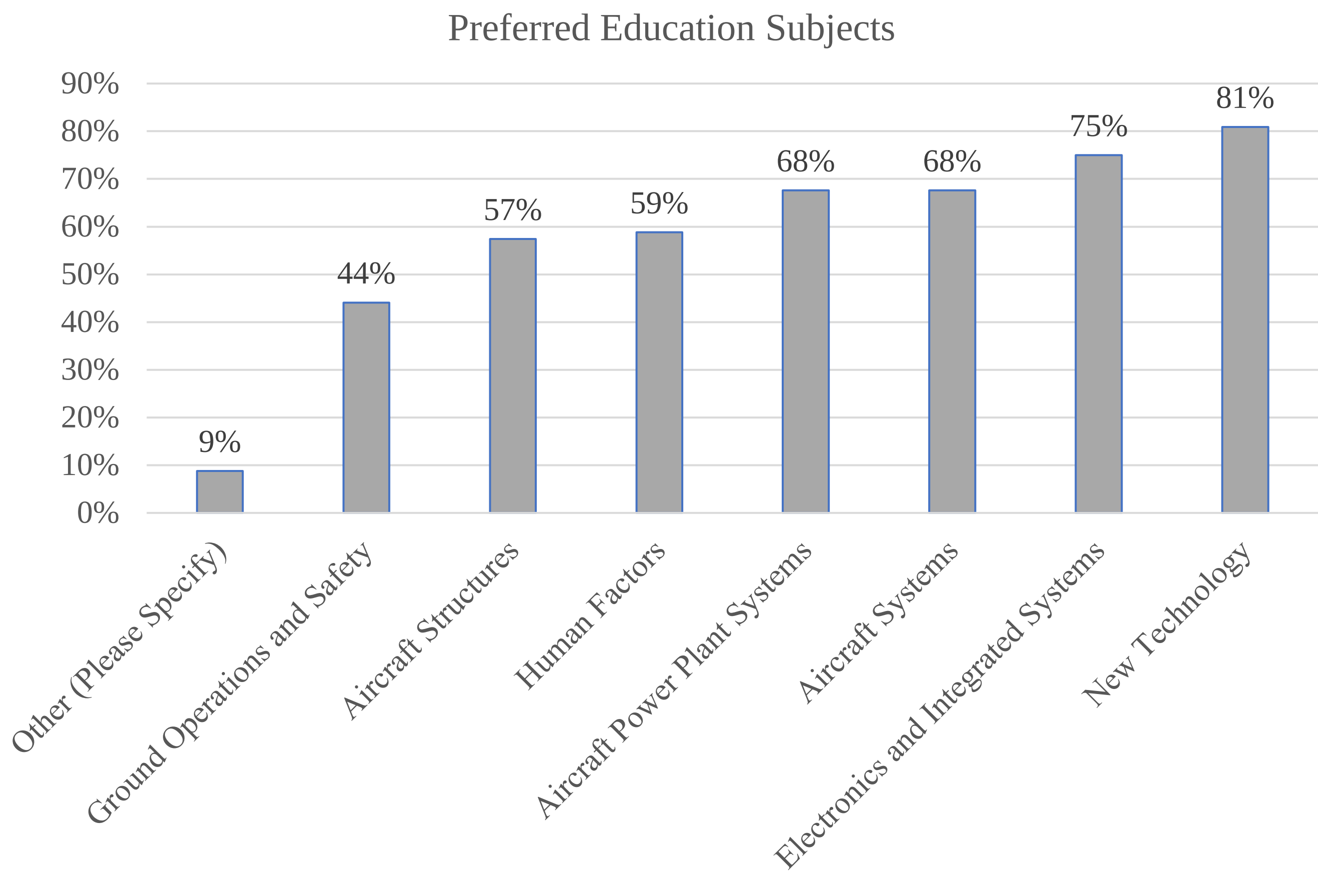
Recommend CE hour requirement



Regardless of the participants interest in making CE a mandatory requirement, all individuals received the question as to what topics were of interest for a CE program. Those surveyed were able to choose from the following topics: new technology, aircraft power plant systems, electronics and integrated systems, aircraft systems, aircraft structures, ground operations and safety, human factors, and other. If members selected other topics the intention was to further describe additional topics of interest. However, due to an error in the design of the survey anyone who selected “Other” did not receive the text entry prompt. Therefore, the six participants who selected other were not able to provide their input as to what other subjects they would like to see for CE. As shown in Figure 7, New Technology was the most desired topic of interest for CE among those who responded. With a seventy five percent selection, electronics and integrated systems was the second most desired topic falling six percent lower than new technology. Both aircraft systems and power plant systems had sixty eight percent of mechanic surveyed interested in these topics as a means for CE instruction. The remaining topics provided for selection in the survey were human factors, aircraft structures and ground operations and safety. Human factors and aircraft structures had a selection rate of fifty-nine percent and fifty seven percent respectively. Only ground operations and safety had lower than a fifty percent selection rate with forty four percent of mechanics surveyed showing interest in this topic for CE instruction.

Figure 7

Preferred Subjects for Continued Education



The delivery methods of CE can be a major concern for both employers and employees. Participants were asked to select what type of courseware they would be interested in to complete CE requirements. The options available were: in-person seminar, in person classroom, on-line seminar, online courseware, or other with the option to explain their selections. The responses of the individuals who answered the question are displayed in figure 8. Online courseware was the preferred method of instruction with 49% of those surveyed opting for that type of

CE. The other selection asked for a text entry to explain the selection. The three individuals who selected other all stated they would have liked to select more than one option for delivery method of CE.

Figure 8

Preferred Course Delivery Method

LIMITATIONS TO THE STUDY

Early in research for this study, it was noted that a small amount of literature currently exists on training and education of AMT's, both in the United States and other countries united under ICAO regulations. Articles are plentiful on the subjects of training, education, and recertification of pilots and technicians employed in other industries focusing on heavily human error. This creates and opportunity for organic research to be conducted on CE education with-in the aviation maintenance industry. Due to the lack of previously existing research and data, this study required the collection of data using an organic study. Another limitation to the study was the design of the survey instrument. The survey failed to include questions referencing the FAA's Inspection Authorization (IA) Certificate. There were multiple comments from participants mentioning the IA renewal procedures. This data could have been useful for correlation between IA holders and the interest for A&P renewals. Future collection of data should include a question relating to the value of current IA renewal procedures. The IA renewal seminar could also serve as partial A&P renewal requirements and education credits. The addition of these questions could have altered the data outcome.

Another noted limitation was the lack of participation of mechanics from other countries. Individuals holding a mechanic's certification equivalent to the FAA A&P certificate were eligible to participate in the survey. However, the survey question was specific in asking if a participant held an A&P certificate. This oversight could have caused confusion with participants, and if the answer "No" was selected to the A&P certificate question, the participant was prevented from progressing through the questionnaire for not meeting the minimum requirements. This limitation could have easily been rectified by adding "or equivalent" to the question. Allowing mechanics from other countries to participate could have increased the sample size, providing for more accurate calculations of statistics. Another way to increase the sample size would have been to partner with more organizations that would share interest in the results of the study. Both the Aircraft Mechanics Fraternal Association (AMFA) and the

Aviation Technical Education Council (ATEC) could have vested interest and provide additional members for the sample. Additional feedback from comments in the survey identified that the course delivery method question created restrictions. Survey participants noted they would like to attend different style training based on the individual topics. The current survey design only allowed participants to select a single training type. This limitation could have been easily corrected by allowing participants to select multiple training types or an “All of the above” selection.

Further limitations to the study include the influence of issues associated with the Boeing 737 max. With the global grounding of the Boeing aircraft, it is possible to see changes to statistical outcomes as a result. The global event has the ability to affect future passenger travel, aircraft deliveries, and MRO requirements. A final noted limitation is the global influence of the COVID-19 pandemic. All statistical references and survey data were taken prior to the effects of the pandemic on the aviation industry. The pandemic has created major changes globally and potentially could have significant lasting impacts that may alter the outcome of this study.

FUTURE RESEARCH

Future research will need to be conducted to provide a cost analysis and feasibility of implementation of a formal renewal process, including continued education requirements. This would require the FAA to employ a department to implement and oversee the renewal process. New certificates would need to be issued to current mechanics with expiration dates and renewal procedures outlining the process and future requirements. It is of high importance that AMT training is improved to provide the ability to reduce the knowledge gap, with the unprecedented growth in the aviation industry (Salas, 2010). However, with the effects of COVID-19 on training and classroom education, the groundwork has begun for distance learning and education.

According to the data acquired, a majority of mechanics would prefer the flexibility and accessibly offered by an online style of learning and educational seminars. With both generic and industry-specific training which recognizes the significance of the human factor in the industry's failures, is therefore vital when considering the reduction of risk (Le May, 2008). Further considerations to account for while creating a training program are the overall cost of training, time-consumption and mode of delivery. These elements can increase resistance by employees and employers from embracing CE supporting their trade. This reigns especially true to smaller organizations, with the costs of training and the possible loss to productivity to attend training (Le May, 2009).

CONCLUSION

Aircraft maintenance is a vital component of the aviation industry. Accidents caused by human error forcefully emphasizes the potentially dire consequences of maintenance errors and its impact on aviation safety. The rarity of these accidents, however, does not imply that maintenance errors are as rare as they seem. Many times, accidents are attributed to other human factor taxonomies overlooking the maintenance error causation. Lengthy investigations impede the timely feedback required in order to make adjustments on the root cause of the accident, possibly preventing future accidents. Issues relating to specific airframe components may need timely industry wide inspections on similar aircraft. How can the industry improve effectiveness, (cost or otherwise) of maintenance programs if continued education opportunities are overlooked and mechanics continue to use tools of the past to address modern aviation issues (Fabian, 2010)?

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