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AIRFRAME & POWERPLANT FACULTY & THEIR WORK-PLACE CHALLENGES:
IMPACTS ON AVIATION SUSTAINABILITY

MAKING A DIFFERENCE ONE STUDENT AT A TIME:
TEACHING TECHNIQUES TO IMPROVE STUDENT OUTCOMES IN FAA PART 147 SCHOOLS

PROMOTING EXCELLENCE IN AVIATION MAINTENANCE EDUCATION:
A REVIEW OF 14 CFR PART 147 STANDARDS AND INSTRUCTOR QUALIFICATIONS

About **the Council**

ATEC was founded in 1961. Its mission is to promote and support aviation maintenance technical education.

The council actively engages with regulatory and legislative bodies to advocate on behalf of the community, and provides resources, continuing education, and networking opportunities for our members.

Our membership is made up of employers, vendors, and educational institutions with aviation technical programs. The vast majority of member schools are certificated by the FAA to provide aviation mechanic programs.

- Membership supports the following activities and initiatives—
- Advocating for sound regulatory policy, the development of clear and concise guidance, and consistent enforcement and application
- Participating on industry and agency committees to further aviation technical education and workforce development
- Fostering and supporting career pipeline partnerships between industry and educational institutions
- Facilitating networking opportunities through the annual conference, Washington fly-in, regional outreach meetings, and virtual webinars
- Enhancing aviation technical career awareness through support of ATEC's sister organization, Choose Aerospace

About the Journal

The *ATEC Journal* (ISSN 1068-5901) is a peer-reviewed, biannual electronic publication. The publication provides an opportunity for educators, administrators, students and industry personnel to share teaching techniques and research. Authors are encouraged tosubmit their articles for publication consideration, whether scholarly, research, application, or opinion, by using the submission form below. Papers supporting the council's regulatory and legislative agenda may be considered for presentation via online webinar and at the annual conference. Suggested topics include:

- Technical and soft-skills curriculum integration
- A history of legislative actions affecting aviation maintenance workforce development
- A study on implementing employer-education partnerships
- Funding implications stemming from Bureau of Labor Statistics occupational outlooks
- Highlighted innovations in the aviation maintenance industry
- A look at successful online teaching methods and subject matter in other technical fields
- Surveying currently used computer-based teaching across aviation maintenance training schools

SUBMISSION DEADLINES

Fall Issue Closing Date: October 1 • Spring Issue Closing Date: May 1

SUBMIT AN ARTICLE FOR REVIEW AT ATEC-AMT.ORG/THE-JOURNAL.HTML

from the EDITOR

The Spring 2025 edition of the *ATEC Journal* brings together three timely articles that reflect the challenges and opportunities facing aviation maintenance education today.

Tracy Yother and Timothy Ropp examine the pressures on AMT faculty—from heavy teaching loads and low pay to limited institutional support. Their findings highlight how faculty working conditions directly affect program quality and industry readiness.

Dr. Glenn Brackin offers practical teaching strategies to improve student outcomes in Part 147 programs. His focus on mentorship, formative feedback, and differentiated instruction reminds us that a student-centered approach can drive both academic success and professional growth.

Richard Johnson and Brooke Wheeler explore regulatory gaps in AMT instructor qualifications. They raise important concerns about whether current standards ensure instructors are truly prepared to train students to a return-to-service level, particularly in schools with testing authority.

Together, these contributions emphasize that quality education depends on clear standards, strong support systems, and intentional teaching. As always, ATEC remains committed to advancing these priorities across the community.

Thank you for your continued dedication. We are proud to share and support your work through the *ATEC Journal*.

Best,

Karen Jo Johnson, Ph.D.
Journal Editor,
Aviation Technician Education Council

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Committee Updates

ATEC committees are comprised of dedicated individuals representing both educational institutions and industry partners. A full list of committees and current participants is available at www.atec-amt.org/committees. The council welcomes new voices and actively encourages member representatives to get involved. If you're interested in contributing to the council's ongoing initiatives, please reach out to learn more about joining a committee.

REGULATORY COMMITTEE

ATEC and industry partners continue to work closely with the FAA Mechanic Airman Certification Standards (ACS) Working Group to revise and realign the ACS with current industry needs. Member representatives from across the country are collaborating to develop a recommended update, building on prior proposals put forth by other trade association partners. These efforts are also informing proposed revisions to the FAA's Aviation Maintenance Handbooks. ATEC encourages members to submit feedback on both the ACS and the handbooks to help shape these foundational resources for aviation maintenance training and certification.

In addition to the ACS initiative, the committee is focused on reducing barriers to airman testing by streamlining processes for schools to offer written exams on-site and advocating for broader access overall. It continues to push for increased discretion and flexibility for designated mechanic examiners to support a more efficient and higher-quality certification system. The committee is also working with the FAA to implement congressional directives that will ease the transition for military personnel into civilian careers and allow mechanic candidates to begin the testing process earlier in their training journey.

For more information about the committee's work, visit **www.atec-amt.org/regulatory-priorities**.

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LEGISLATIVE COMMITTEE

The legislative committee continues to serve as the voice of aviation technical education, advocating for common-sense laws that support the industry and its workforce. While closely monitoring implementation of key provisions from last year's FAA Reauthorization Act, the committee is also advancing other initiatives aimed at reducing certification bottlenecks, supporting secondary and postsecondary programming, and promoting aviation maintenance as a STEM discipline. See ATEC's full list of legislative priorities at **www.atec-amt.org/legislative-priorities**.

Help move the needle by participating in the 2025 ATEC Fly-in, taking place Sept. 16–17 in Washington. Attendees will engage directly with policymakers, participate in agency briefings, and advocate for the future of aviation education.

Registration is now open—secure your spot today at **www.atec-amt.org/events/2025-fly-in**.

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ATEC ACADEMY

The ATEC Academy launched its fifth cohort this month with at two-day kickoff at Tulsa Tech's Riverside campus (held in conjunction with the **Choose Aerospace teacher training**). Since the program's debut last spring, more than fifty instructors have enrolled, reinforcing the Academy's mission to tackle the growing challenge of recruiting and retaining qualified aviation maintenance instructors in an era of rising technical workforce demand.

The Academy offers a comprehensive training experience that blends two days of in-person instruction with virtual coursework delivered over three months. Participants explore key topics such as active teaching strategies, student behavior management, assessment design, lesson planning, and current trends in technical education. Special focus is placed on delivering hands-on lab instruction and meeting FAA certification requirements.

Led by an experienced educator and supported by seasoned A&P instructors, the program is tailored specifically for new and emerging instructors in FAA-certificated schools. The sixth cohort will launch October 21 at United Airlines' headquarters in Houston. Registration is now open at **www.atec-amt.org/atec-academy**.

The Academy is actively seeking members of the community to join its pool of mentors. For more information visit **www.atec-amt.org/mentor-application**.

MIKE SASSO
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Airframe & Powerplant Chief,
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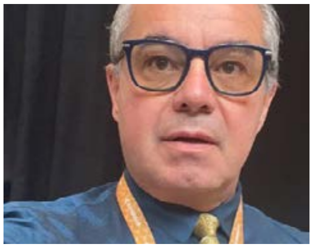
ANNUAL CONFERENCE COMMITTEE

The 2025 ATEC Annual Conference in Norfolk was a tremendous success! A heartfelt thank you to presenting sponsor Piedmont Airlines, host Aviation Institute of Maintenance, and all our sponsors, speakers, exhibitors, and attendees who made the event possible. Conference attendees and ATEC members can access presentations, recordings, and event photos **here**.

Planning is already underway for the 2026 Annual Conference in Portland, Oregon, taking place March 29–April 1. Early exhibitor and sponsorship opportunities are now open—**reserve your space today** to secure premium visibility.



ARCHIE VEGA
MEETING PLANNING CHAIR
Director of Maintenance and Development,
Horizon Air

CHOOSE AEROSPACE

The 2024–25 academic year came to a successful close, with 984 students across 46 schools participating in the Choose Aerospace general aviation maintenance curriculum. ATEC members can view a full directory of programs deploying the curriculum at **www.atec-amt.org/choose-aerospace-schools**.

This spring, we welcomed nearly 60 instructors to Tulsa Tech for our annual teacher training, led by a team of master instructors sourced directly from ATEC's membership. The event prepared both new and returning educators to deliver the Choose Aerospace curriculum and foster career pathways in aviation maintenance.

Choose Aerospace also marked an exciting milestone with the launch of the General Aviation Maintenance Credential, developed in partnership with ATEC. The industry-recognized certification validates a student's knowledge in the FAA Mechanic ACS general subject areas and is awarded to those who complete the curriculum and pass a comprehensive written exam with a score of 75% or higher.

In its inaugural year, a dozen Choose Aerospace graduates earned the credential. This third-party validation provides a measurable outcome for secondary and CTE programs, can give students a competitive edge when applying for non-certificated roles, and may qualify them for credit for prior learning at FAA-certificated AMTS. Exams are proctored by approved Choose Aerospace programs and are offered at set times throughout the year to maintain integrity.

Learn more about the credential at **www.atec-amt.org/atec-credential**.

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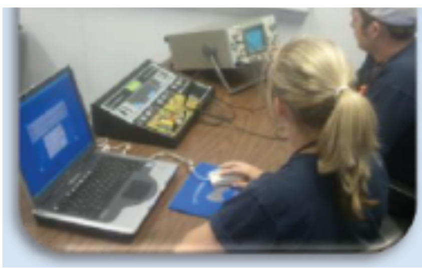

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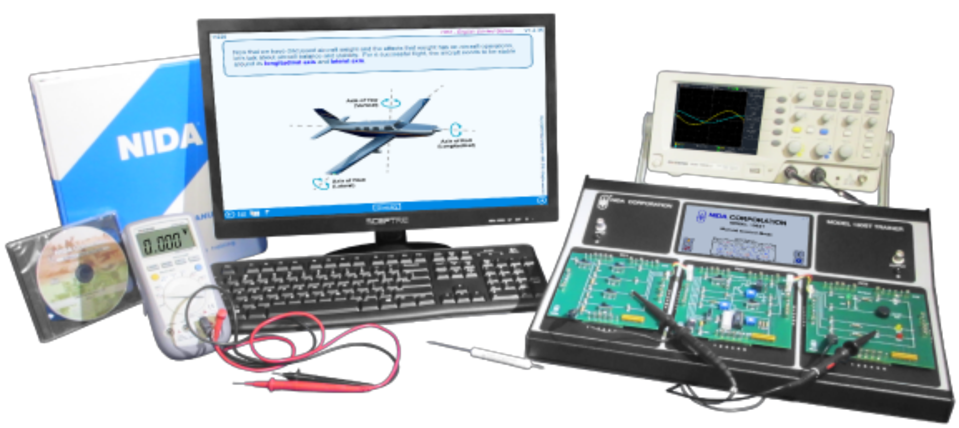

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Airframe and Powerplant Faculty and Their Workplace Challenges: Impacts on Aviation Sustainability

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is an FAA certificated Airframe and Powerplant Mechanic and Private Pilot. He is Professor of Practice in Aeronautical Engineering Technology in the School of Aviation and Transportation Technology's Part 147 program at Purdue University, joining as faculty in 2005. He teaches a senior capstone Aircraft Airworthiness Assurance course for large air vehicles, and two senior project design capstones, also serving as graduate faculty. Dr. Ropp has 18 years' experience working in high reliability technology industries, including Part 121 airframe heavy maintenance for a major U.S. air carrier. His research specialties are in Safety Management Systems, Human Factors, and Industry 4.0 technology integration into MRO and aerospace processes.

ABSTRACT

Airframe and powerplant faculty are vital to the aviation maintenance and support ecosystem, but very little is understood about their working environment and the challenges that they face. To better understand their situation the authors surveyed participants (n = 18) from FAA CFR Part 147 airframe and powerplant programs as phase II of a proposed three phase study. Phase II includes a survey with four sections where the first three use descriptive statistics and focus on the demographics, workload, and institutional support of the participants. The fourth section is the primary focus of this study and analyzes the written survey responses using qualitative methods. Using process, people, processes, parts, and performance, the 5Ps, the authors developed three themes from the data 1) institutions should increase salaries to hire qualified faculty; 2) Class sizes are too large; and 3) funding is needed to support the program.

Faculty members in collegiate programs continually face challenges from a changing landscape in the classroom, administration, and the industry where future graduates will work. While career challenges are a shared part of every job, aviation instructors face additional and little understood hurdles, which can become obstacles that, in turn, can negatively affect the aviation industry. Understanding the unique challenges aviation maintenance technician instructors face is critical for addressing the aviation industry's shortage of qualified technicians and the instructors who, subsequently, train those technicians (AAR Corp., 2023; Mishra et al., 2022; Wildes, 2024).

The challenge instructors face to continuously learn and advance pedagogy is significant (Yother & Ropp, 2023). Although it is not a new phenomenon, modern challenges include incorporating and adapting rapidly advancing technologies into the industry and the teaching and learning sphere. Similarly, once upon a time, the industry considered avionics a new technology, and its adoption drove changes to aviation maintenance curriculum(Hannon, 2007).

Statement of the Problem

This study continues a previously published study (Yother & Ropp, 2023) on aviation maintenance faculty challenges. The COVID-19 pandemic heavily influenced responses from the previous study. The researchers are interested in how instructors' perceptions change and their perceptions of career challenges, especially in the wake of a new teaching and learning landscape downrange from the pandemic. Aviation maintenance instructors and faculty have accountability across multiple end-user domains. Some of those domains include students, faculty, administration within the academy, and externally to regulators and industry employers. This Phase II study aimed to further explore career challenges articulated by aviation maintenance instructors in the Phase I survey on perspectives as instructors in a Federal Aviation Administration (FAA) Title 14 of the Code of Federal Regulations Part 147 aviation maintenance school.

Review of Literature

Aviation instructors face many types of challenges, including students, administration, and their own needs. The following is a discussion on the different types of challenges that instructors may face, including the changes to the aviation industry, changes in students, innovations in classroom equipment and teaching, new federal regulations, and the drive to perform and improve for promotion.

Aviation industry

Recent advances in technology have changed the aviation industry. Some changes seem simple but have larger ramifications, such as the switch to paperless record keeping (Karakilic et al., 2023). The industry continues to evaluate security considerations for both the records themselves and authorized signatures, and the cost to convert historical records. New technologies such as machine learning and artificial intelligence are slowly making their way into maintenance records, maintenance decision-making, and large data sets (Amin et al., 2022; Ichou & Veress, 2023). Augmented and virtual reality (AR/VR) are changing how maintainers access information and troubleshoot equipment (Brown et al., 2023).

Changes to classroom

New technology has not only driven changes to the industry, but also in the classroom. Traditional pedagogy and applied learning approaches for a new age of digital fusion of modern technologies into legacy aviation/aerospace operations occurring within the industry must evolve to encompass digital thread technologies as tools for teaching and learning (Ropp et al., 2020).

In many cases, training equipment now integrates simulation/visualization technologies like AR/VR or even replaces some physical classroom/laboratory components altogether (Ainakulov et al., 2022; Bernard et al., 2022; Wilson & Stupnisky, 2022). Of course, learner acceptance and the efficacy of using these technologies (learning "with" not just "about" them) is critical, as there are learning curves and user orientation times that can add to the overall time on task (speed of learning) (Borgen et al., 2021; Gavish et al., 2015; Wang et al., 2016).

In their writing on the fifth wave evolution of American universities, Crow and Dabars (2020) further emphasize the need for pedagogical innovation. They emphasize resilient approaches to university education's teaching and learning delivery format, calling for transforming traditional academy practices to be more deliberately outward facing resources for "continuing education to society, acting as providers of retraining and upskilling for learners" (p. 23). They characterize the vision for the university as evolving to that of a knowledge enterprise (p. 7), partnered with industry and the notion of continuous learning as a key competency.

Bjerregaard (2020) similarly notes a significant paradigm shift for educators and learners amplified by the pandemic crisis of 2020, citing rapid adaptation to new teaching and learning methods as necessary for instructors. While these advances and changes to the "art of the practice" of teaching have positive connotations, one must keep in mind the instructors who must learn, wield, and integrate ever-changing tools and methods into the curriculum to avoid suddenly finding themselves teaching a history lesson.

Students

In addition to expected generational changes in how students learn, the pandemic accelerated changes due to new technologies, giving instructors new avenues for presenting and assessing students (Shakour et al., 2021). Should instructors present material online, and if so, how should they present it synchronously or asynchronously (Wilson & Stupnisky, 2022)? Instructors should use AR as a teaching tool to expose students to it prior to working in the industry. But how much of it should instructors use? Do students learn faster using AR (Borgen et al., 2021)? What skills should students have with the incorporation of new technologies (Thulasy et al., 2022)?

Many universities are reaching out to nontraditional populations with the shortage, but that comes with other barriers (Albelo & O'Toole, 2021). One of those populations is women. As of 2022, women make up less than three percent of maintenance technicians (Women in Aviation Advisory Board, 2022). Considering women were three percent in 1991, there seems to be serious unknown challenges in recruiting women (Shepherd & Parker, 1991). However, current research is trying to understand and overcome those challenges (Marete et al., 2022; Rouscher, 2021; Yother et al., 2021).

International students are already training to be maintainers, and there is some push to make pathways easier to help alleviate the shortage. However, international students come with additional challenges (AAR, 2023). One of those challenges is English proficiency (Embryany & Ratmanida, 2020; Mahmood et al., 2023).

Faculty performance

One of the greatest challenges some faculty members face is the ability to obtain promotion and tenure. The requirements to make tenure vary per institution but, generally, there are three main areas faculty must show mastery: service, teaching, and scholarship, where the requirement to publish carries a heavier load (Kaps & Phillips, 2004; Pavel et al., 2012; Pavel & Harrison, 2013). The teaching load is another consideration and can significantly affect faculty members' ability to perform the required research and publication, especially in aviation programs (Kaps & Phillips, 2004; Pavel & Harrison, 2013).

Identifying a fruitful area of research can be challenging, and the challenges continue after selection. Building a rigorous and valid research program requires knowledge that may not be part of the instructor's background. The background of many aviation maintenance instructors may not include research methodology fundamentals, such as interview techniques or building surveys. Creating a reliable and validated research survey for aviation is not as simple as writing and sending questions (Ison, 2011; Kaps & Phillips, 2004).

While scholarship or research is a critical pillar, an instructor's performance in teaching is another critical pillar that is vital to the success of an aviation maintenance program and is important to both students and faculty (Aragón et al., 2023). However, evaluating an instructor's performance is often not perceived as fair or accurate (Babin & Hussey, 2023; Pavel et al., 2012; Potvin & Hazari, 2016). Student evaluations are generally the primary form of evaluation for instructor performance, and give the responsibility to properly evaluate instructors to people who do not have the background and training to understand what constitutes a "good" class. Additionally, evaluations can include bias. People often underrate female instructors in STEM-related fields and male-dominated positions.

New Regulations

In 2023 the FAA issued a notice that new airman certification standards (ACS) replaced the previous practical test standards (PTS) (Federal Aviation Administration, 2023; Gilbert, 2023). Aviation maintenance training schools can use competency standards to assess their programs (Scarbrough, 2022). These are significant changes to the program, and programs had limited time to incorporate the changes.

Methodology

Study procedures

Our purpose in this study is to understand some of the challenges faculty members face who teach in an FAA Title 14 CFR Part 147 airframe and powerplant (A&P) program. We used mixed methods for this study. We used descriptive statistics to report on the background and current experiences of the participants to provide context for the primary research area of this study. Our primary focus uses qualitative analysis of the participants recounting a recent challenge they faced in teaching and how they and their institutions responded to that challenge.

Instrument development and delivery

For the 2024 Qualtrics™ survey, we revised the survey instrument from the 2021 study to include inquiries on their education, teaching load, and ability to balance teaching and other responsibilities. The Aviation Technician Education Council (ATEC) and personal contacts distributed the instrument via email. We received responses in July, August, and September 2024.

The survey has four major sections. The first section gathers demographic information on the participants (questions 1 through 9). Section two questions the participants on their teaching responsibilities, including their teaching load, courses taught, and industry connections (questions 10 through 17). The third section reports the participants' institutional responsibilities, institutional support, and ability to balance their responsibilities (questions 18 through 21). These first three sections provide the background and context for the fourth and primary research area, a qualitative analysis of a participant's recent experiences facing a challenge (questions 22 to 29).

Participants and sample

Participants are instructors at FAA Title 14 CFR Part 147 aviation maintenance technical schools. We received a total of 18 responses (n = 18). On July 3, 2024, the institution granted a modification to the human subject's research approval (IRB-2021-1320) to expand the population. Questions one through nine collected demographic information about the participants, their institutions, and their previous experience.

Demographics (survey section one)

Q1 Highest level of education obtained. Eighteen (n = 18) participants responded to question one (see Table 1). Participants with a master's degree provided the most responses.

Table 1: Q1 Highest education obtained

Degree	Count
High school diploma	1
Associate's degree	2
Bachelor's degree	4
Master's degree	10
Doctorate	1
Prefer not to answer	0

Q2 Current rank. Seventeen (n = 17) participants answered the question on their current rank (see Table 2). Participants who identified their rank as "Other" responded "part time faculty," "director of AMT," "previous instructor currently professor," and "program director/instructor."

Table 2: Q2 Current rank

Rank	Count
Tenured	1
Tenure Track	1
Clinical	5
Visiting or adjunct professor	0
Instructor/lecturer	3
Other	7
Prefer not to answer	0

Q3 Type of program. All eighteen (n = 18) participants responded to the question about the type of their program (see Table 3).

Table 3: Q3 Type of program

Program Type	Count
High school program	1
Technical/vocational school (certificate only program)	2
2-year school (Associate's degree)	6
4-year school (Bachelor's degree)	9
Prefer not to answer	0

Q4 Years of teaching. All eighteen (n = 18) participants responded to the question about the number of years they have been teaching in a Part 147 aviation maintenance program (see Table 4).

Table 4: Q4 Years teaching in a Part 147 program

Years	Count
0 to 3 years	2
3 to 6 years	7
6 to 10 years	1
10 to 15 years	4
More than 15 years	2
Prefer not to answer	2

Q5 Type of certificate. Eighteen (n = 18) participants identified their FAA certificate type (see Table 5).

Table 5: Q5 Type of certificate

Certificate	Count
Airframe only	1
Powerplant only	0
Airframe and Powerplant	15
Certificated repairman	0
Neither	2
Prefer not to answer	0

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Table 7: Q8 Participant count and average years of industry experience

	Aircraft Maintenance n = 16		General aerospace industry experience n = 13		Non-aerospace industry experience n = 10	
	Count	Average	Count	Average	Count	Average
No industry experience	0	N/A	1	0	2	0
0 to 3 years	1	1	2	2	2	1
3 to 6 years	1	5	2	4	2	5
6 to 10 years	1	7	0	N/A	1	10
10 to 15 years	1	14	1	10	1	15
More than 15 years	12	28	7	29	2	38

Q6 Age. Seventeen (n = 17) participants responded to the question about their age (see Table 6).

Q7 Gender. Seventeen (n = 17) participants identified their gender. Fifteen identified as male and two as female.

Q8 Years of industry experience (non AMTS instructor). We asked participants about their experience working in different industries. The first was working directly in aviation maintenance. The second was their experience working in the aerospace industry, but not necessarily in aviation maintenance. Finally, we asked the participants to provide their years of working experience outside the aerospace industry. Table 7 provides the number of participants, the number of years of the participants' experience, and the average years of experience in the three domains.

Q9 Primary area of industry experience. Question 9 asked the participants to describe their primary area of professional experience (see Table 8). Sixteen (n = 16) participants answered this question. Aviation maintenance/maintenance, repair, and overhaul (MRO) was the most common response at over 50 percent. Those participants who answered "Other" responded with "Aviation maintenance, aviation operations, and training," "Heavy cargo aircraft KC-10, C-5, C17," and "Metal press."

Table 8: Q9 Industry Experience

Industry	Count
Aircraft maintenance/MRO	9
Pilot (Airline, Corporate)	0
Airline operations (Revenue management, planning, etc.)	0
Commercial manufacturing	1
Aircraft finance/leasing/acquisition	0
Government/Regulatory	0
Air traffic control	0
Training	2
Airport operations	0
Commercial space	0
NASA	0
Military	1
Other	
Aviation Maintenance, Aviation Operations and Training	1
Heavy cargo aircraft KC-10, C-5, C-17	1
Metal press	1

Participants were overwhelmingly male (88 percent) and older; 53 percent were over 50. Regarding experience, 50 percent have been teaching for less than six years and 75 percent have more than 15 years of aviation maintenance industry experience. This seems to imply teaching in Part 147 programs is frequently a second career for the participants. They are educated; 78 percent have either a bachelor's or master's degree. Most of them (84 percent) hold an A&P certificate.

Regarding their rank, 30 percent hold clinical positions, and another 18 percent hold an instructor or lecture position. Another 41 percent identified their position as "other," but the survey did not include a space for further description; therefore, the authors are unclear on those other positions. Most participants teach in a four-year bachelor's program at 50 percent. Participants still have connections to their industry experience where 88 percent use their industry connections in the classroom, and 75 percent continue working with industry in areas such as consulting or research.

5P Framework

For this study, the researchers used the 5Ps as a framework from the first study to analyze participants' responses with one change (Yother & Ropp, 2023). Researchers replaced "Placement" with "purpose" because purpose appears more frequently in the literature. Therefore, the researchers used the following five Ps as codes for this study:

Purpose
The reason the task is done.

People
Both the creators and customers of the task, whether it be curriculum, university-level requirements, or FAA requirements.

Parts
Equipment or electronic tools used in the delivery of curriculum or daily tasks of the instructor job. Including funding.

Processes
The sequence of tasks required to perform the duties of the instructor. Including curriculum.

Performance
How well the program or course meets its objectives.

Results

We separated the analysis of the data into four areas with different evaluation methods. The first three sections include demographic information, courses, and institutional responsibilities, and are reported using descriptive statistics. These sections provide the background and context for the fourth and primary research area, a qualitative analysis of a participant's recent experiences facing a challenge (questions 22 to 29).

Teaching responsibilities (survey section two)

Q12 Courses, Q13, Credit hours, Q14 Hours in the classroom. Question 12 asked the participants to indicate the number of classes they taught in an academic year. We counted lecture-only classes as one, as well as classes with an additional recitation or lab. Questions 13 and 14 asked the participants about the number of credit hours they teach in an academic year and the number of hours they spend in the classroom per week (see Table 9).

Table 9: Q12, Q13, and Q14 Courses and Teaching Load

Courses (per academic year)	Count	Credit Hours (per academic year)	Count	Hours in the classroom (per week)	Count
n = 15		n = 14		n = 15	
1	0	1	0	1	0
2	2	2	2	2	2
3	3	3	3	3	3
4	1	4	1	4	1
5	3	5	3	5	3
6	1	6	1	6	1
7	0	7	0	7	0
8	1	8	1	8	1
9	0	9	0	9	0
10	4	10	4	10	4

Q15 Courses with lab sections. We asked participants (n = 14) to provide the number of courses they taught with multiple lab sections (see Table 10).

Table 10: Q15 Courses with Lab Sections

Lab courses	Count
1	3
2	0
3	2
4	1
5	2
6	0
7	0
8	1
9	0
10	3
None	2

Sixty percent of the participants teach more than five courses per year with 73 percent spending at least 21 hours in the classroom per week and 40 percent with more than 26 hours per week.

Q10 and Q11 Industry connections. Questions 10 and 11 asked the participants (n =16) to indicate their connection to the industry by either bringing the industry into the classroom (Q10) or by their participation in industry-related activities (Q11) (see Table 11).

Table 11: Q10 and Q11 Industry connections

Question	Yes	No
Q10 Do you connect with the industry as part of your class? (student projects, site visits, speakers, internships)	14	2
Q11 Do you connect with the industry doing consulting, technical assistance, or research?	12	4

Q17 Average time spent. Question 17 asked the participants to indicate the average amount of time they spent in different areas of responsibility, including teaching, research, administration, mentoring, and other (see Table 12). Sixteen (n = 16) participants answered this question.

Table 12: Q17 Average time spent in different areas of responsibilities

Responsibility	Average
Teaching	63%
Research	15%
Administration	11%
Mentoring	7%
Other	14%
Prefer not to answer	0%

Institution responsibilities (survey section three)

Q18 Areas of responsibility ranked. Question 18 asked participants to rank the areas of responsibility according to their institution (see Table 13). In other words, what did the participants believe were the most important responsibilities of their institution? Of the 14 participants (n = 14) who answered, nine indicated that their most important task was teaching, and no one felt it was the least important. Participants ranked research and administration as other areas of highest responsibility.

Table 13: Q18 Institution's most important responsibilities ranked

	Most important				Least important
	1	2	3	4	5
Teaching	9	3	1	1	0
Research	1	2	5	2	4
Administration	3	7	0	3	1
Mentoring	1	2	5	6	0
Other	0	0	3	2	9
More than 15 years	12	28	7	29	2

Q19 Ability to find balance. We asked participants (n = 14) to indicate their perception of their ability to balance their responsibilities (see Table 15). Most participants felt they were able to find balance most of the time. Only two participants felt confident they consistently found balance. We asked the question using a stoplight with associated colors.

Table 14: Q19 Ability of participants to balance their responsibilities

	Green = I am confident in my ability to balance my responsibilities	Yellow = I am able to reach balance most of the time	Red = I am rarely able to reach balance
Participants	2	9	4

Q20 Encouraged to keep up with industry advances and trends. Maintaining currency with the latest trends, advances, and technologies in the aviation industry is difficult. We asked participants to indicate their agreement with the idea that their institutions encourage them to stay current. Thirteen participants (n = 13) answered the question (see Table 15).

Table 15: Q20 Encouraged to keep up with industry advances and trends

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Count	2	3	3	1	4
Percentage	15%	23%	23%	8%	31%

Q21 Time and funding for continuing education. Question 20 was about the institution's desire for participants to maintain currency in the industry, and question 21 asked about the institution's support for continuing education and learning. It appears that while the institution encourages participants to keep up with technology changes, there is minimal support. Thirteen (n = 13) participants indicated the time and monetary support they received to continue education and training (see Table 16).

Table 16: Q21 Intuition provides time and monetary support

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Count	4	4	1	3	1
Percentage	31%	31%	8%	23%	8%

Responsibilities and institution support summary

On average, participants spent 63 percent of their time teaching with research (15 percent) and other (14 percent) as distant second place responsibilities. The time spent teaching seems to align with participants' perceptions of their institution's priorities where 64 percent of the participants believe the most important responsibility they have, according to their institution, is teaching, and 88 percent ranked teaching as either the first or second priority.

The authors feel there might be a disconnect between where participants spend their time against where their institution wants them to spend their time. Participants spent on average only about 11 percent of their time on administration tasks, but 71 percent felt the administration was either the first or second most important responsibility they have according to their institution. This may only reflect how long it takes to accomplish administrative tasks. Further study would be needed to determine if this contradicts priorities.

Keeping up with industry trends and advancement is another possible disconnect. Participants responded to either agree or strongly agree at 38 percent that their institution wanted them to stay up to date with the industry. Only 31 percent felt their institution provided support, and 62 percent responded either disagree or strongly disagree.

The authors wanted to know how the participants felt about achieving or maintaining a balance between their responsibilities and found that 87 percent felt they were either able to reach balance most of the time or rarely able to find balance. The mismatch in responsibilities and support to keep up with the industry may be contributing factors to the 27 percent who said they were rarely able to reach balance.

Participant challenges (survey section four)

We accomplished qualitative analysis of this study using the built-in tools in QualtricsXM®, specifically Text iQ. Both researchers completed coding of the responses. If any conflicts arose in how they coded the comments, the two researchers discussed them. Each comment could have multiple associated codes. We coded each question using the same five primary codes: people, parts, purpose, process, and performance. However, each question could also generate unique subcodes. For instance, we coded a response to question 22 under two codes and two subcodes. Question 22 asked participants to briefly describe a challenge they faced in the last 3 years. One response was "Increased class sizes and uncertainty about ACS introduction." We coded this individual response using codes and subcodes in Table 17.

Table 17: Question 22 individual response codes and subcodes

Codes	Subcodes
People	Students
Processes	Curriculum

Q22 Describe a challenge from the last three years. Thirteen participants (n = 13) answered question 22. Codes and subcodes are listed in Table 18. We found two areas to have the greatest responses of people and parts. Three participants indicated the lack of new, repaired, or modern lab equipment as a problem in their program. One participant mentioned a lack of understanding of the cost of training and resources. The responses people coded were more varied, including the succinct "communication." Two participants discussed the qualifications for new hires were very low: "No one is qualified, they keep hiring students with zero industry experience because they consider 'part 147 school seat time as a student' as they come through the program to obtain an A&P license as 'experience' and then turn around and hire them as instructors" and "University Instructor Qualification, only qualification is holding an A&P, no experience necessary. Hiring just graduated students is common." Two other participants discussed how the students in their classes challenged them, including student accommodations and how one facilitated "the timely removal of a student from the class, and eventually the program, that was disruptive to learning by the rest of the class."

Table 18: Q22 Recent participant challenge

Codes	Subcodes	Count
People	Students	2
	Communication	1
	(Un)Qualified hires	3
	Respect	1
Purpose	Institution expectations	1
	Student expectations	1
Parts	Purchase or repair of equipment	3
Performance		0
Processes	Class sizes	1
	Curriculum	1

Q23 Which of the following categories did the challenge best fit into? We asked participants to self-identify which category their challenge fell into. Thirteen participants (n = 13) responded (see Table 19). Most participants felt their challenge was about people.

Table 19: Q23 Participant perception of the challenge category

Codes	Count
People	7
Purpose	0
Parts	2
Performance	0
Processes	2
None of the above	2

Q24 What actions did you take to resolve the challenging situation? While thirteen (n = 13) participants responded, we were able to code only ten of the responses. One response was "none" and two others indicated they were still working on the issue. Codes and subcodes are in

Table 20. The majority of the remaining responses were about the qualifications, or lack of qualifications, of new hires and funding. Both subcodes fall under people. Two respondents highlighted the need to hire qualified faculty. One felt the hiring of unqualified students was detrimental to the program, including the loss of experienced faculty. "I have been fighting against this hiring of students since I was hired and consequently we have lost tons of good and real-world experienced technicians because they couldn't take it anymore." The other added the need to increase salaries. Generally, issues with money fall under parts, but because this is salary for an individual, we added salary as a subcategory under people. "Trying to encourage leadership to hire experienced technicians as instructors, increase salaries to recruit industry professionals." Additionally, participants found the lack of funding to provide adequate lab equipment. "Asked for funding, which did not happen. Repaired existing equipment or created new labs to work around issues." One participant found they needed both personal and professional development to respond to the challenge, "asked questions, researched, got professional counseling." Another felt the need for better time management to deal with the increase in class sizes: "Manage time to enable completion of tasks with [sic] increased class sizes." Only two participants used institutional resources: "Work with College Services" and "Continued to collaborate with the college's Student Services to identify the inappropriateness of the student's behavior." One participant informed senior leaders to help resolve their problem.

Table 20: Q24 Participant actions

Codes	Subcodes	Count
People	(Un)Qualified hires	2
	Communication	1
	Mentorship	1
	Personal Development	1
	Professional Development	1
	Students	1
	Salary	1
Purpose	Information sharing	1
Parts	Funding	1
	Purchase or repair of equipment	1
Performance		0
Processes	Institution resources	2
	Larger class sizes	1
	Time management	1

Q25 Was the situation resolved to your satisfaction? We asked participants (n = 13) to indicate if their issue was resolved to their satisfaction. Twelve participants said no, and only one said yes.

Q27 What did your department administration do that was helpful in this situation? Eleven participants (n = 11) responded to this question. Four participants responded with either none or N/A. One participant responded that they are still working to elevate the issue. Two participants felt the administration provided education and support for student issues, but another wanted more education on the handling of "student matters." One felt the administration helped in providing an updated curriculum. One generally felt the administration supported them. Two participants wanted their institution to stop hiring inexperienced faculty. One administration increased faculty salaries and increased the experience level from none to 1 to 2 years. One felt the administration did nothing to help and continued to undervalue experience.

Q28 What additional information or resources do you feel would have been helpful to you? This question provides the intended space for participants to identify what information or resource could have helped them that we did not already provide. Ten participants (n = 10) answered this question. Codes and subcodes are in Table 21. Two participants did not provide an answer but said "unknown" or "Good question. I'm not sure." The participants felt that people were the greatest resource. Two participants felt face-to-face communication and a more diverse faculty would be helpful. One also felt better communication would help, but they wanted their administration to speak with other institutions to get a "better understanding the cost of running a legitimate and valuable FAR 147 pgm [sic]." Another felt they needed "better training to deal with this ever-changing dynamic." Others wanted the FAA to establish instructor standards. One participant's comment fell across both people and processes, and they felt that the institution's student services were too concerned

Table 21: Q28 Helpful additional resources

Codes	Subcodes	Count
People	(Un)Qualified hires	1
	Communication	2
	Diversity	1
	Students	1
	Faculty training	1
Purpose		0
Parts	Funding	2
Performance		0
Processes	Institution resources	1
	Class sizes	1
	Grant writing	1
	Time management	1

with the individual student, and they wanted them to address the situation as a whole. When it came to processes, participants wanted the administration to assist with "More manageable class sizes, more time to complete projects." We coded assistance in writing grants to purchase equipment as parts.

Q29 What actions could your institution have taken to make the situation easier for you to navigate? Twelve (n = 12) participants answered this question. Codes and subcodes are in Table 22. When it came to funding, one participant felt that they needed to spread funding sources across majors, not just one. Smaller class sizes and more time to complete projects were the concerns on processes. Participants had multiple perspectives when it came to the purpose of their program. One felt they needed better ways to navigate expectations. Another felt that programs need to align better with the aviation industry. The last one wanted to maintain the original purpose of the program, Part 147. However, by far, the area where most participants want their institution to focus its attention is in the realm of people. Participants want more focus on experience and training, "an onboarding that talked about the job not just the rules you're expected to follow while doing the job," "Have an overall belief that experience as an A&P is necessary for instruction." "Nothing." "They like the way things are [sic] because they can also save money by not having to hire and pay for the experience of seasoned technicians," and "better preparation."

Table 22: Q29 Desired institutional actions

Codes	Subcodes	Count
People	(Un)Qualified hires	1
	Diversity	1
	Faculty training	2
	Salary	1
Purpose		3
Parts	Funding	1
Performance		0
Processes	Class sizes	1
	Time management	1

Discussion

The authors' purpose in this study is to understand some of the challenges faculty members face who teach in FAA Title 14 CFR Part 147 A&P programs. The authors used qualitative analysis to evaluate the participants' responses to questions on a challenge they faced, their response, and the response of their institution. The authors used the 5P framework to evaluate the participants' data. The authors assigned all the data to the 5Ps: people, processes, purpose, performance, or parts. The authors developed subcodes using the participants' responses.

The authors developed three themes from the data. Each of the themes came from different areas in the 5Ps: people, parts, and processes. The authors list the themes below.

Theme 1: Institutions should increase salaries to hire qualified faculty. (People)

Theme 2: Class sizes are too large. (Processes)

Theme 3: Funding is needed to support the program. (Parts)

Theme 1: Institutions should increase salaries to hire qualified faculty. (People)

Participants frequently discussed the challenge their programs face from hiring unqualified faculty. Three participants identified this as a recent challenge they faced, and overall, this idea is 13 percent of the codes made by the participants across all questions and 27 percent of the codes under people. Participants mentioned that institutions are "Hiring just graduated students..." and "they keep hiring students with zero industry experience because they consider 'part 147 school seat time as a student' as they come through the program to obtain an A&P license as 'experience.'"

Participants found that the lack of qualified faculty was not a problem just for the unqualified faculty, but the other faculty in the program. One participant found that their program "...lost tons of good and real-world experienced technicians because they couldn't take it anymore." Unfortunately, it is unclear if institutions understand the importance of experience as one participant put it "experience is not valued." Another, when asked what institutions could do to improve the situation, was to "Have an overall belief that experience as an A&P is necessary for instruction."

Participants identified two ways to resolve the issue. One is to increase faculty salaries. One participant said, they are, "Trying to encourage leadership to hire experienced technicians as instructors, increase salaries to recruit industry professionals." The second is to have the FAA create new regulations to force institutions to hire experienced faculty that mirrors flight instruction, "The FAA should set realistic and professional instructor standards, they should reflect the same standards as required for flight instructors." One participant's institution has started to make changes: "They have increased salaries, which has helped in bringing some experienced technicians, but only with 1 to 2 years of experience."

Theme 2: Class sizes are too large. (Processes)

Participants also frequently mentioned the challenge faced by increasingly larger class sizes. The subcode "class sizes" comprised 33 percent under all process codes and 8 percent overall. Participants found that larger class sizes made it more difficult to "Manage time to enable completion of tasks." Students are required to complete projects to qualify to take the certification exam. Suppose the faculty are finding it difficult to complete the projects. In that case, this has a tangible effect on the number of students who take the exam and the number of certificated A&P technicians for the workforce.

Theme 3: Funding is needed to support the program. (Parts)

Participants also found that the expense of establishing and maintaining an A&P program, including functional lab equipment for students to complete their projects, is expensive and needs funding. This subcode was 15 percent of all codes and all (100 percent) of the subcodes under the code parts in later questions. Participants identified the lack of equipment in their labs as a challenge, including comments like the "Lack of functioning and or current lab equipment" or the "access to new equipment."

Despite an identified need, participants found it difficult to gather appropriate funding to support the program. One participant mentioned they were denied funding, "Asked for funding, [sic] which did not happen. Repaired existing equipment or created new labs to work around issues."

Alleviating the issue is also challenging. One participant wanted their institution's help "...with the process for writing grant proposals." Participants also felt that the institution did not have an appreciation for the costs associated with the maintenance of the program. One participant stated "my institution's senior leaders talking with someone in their same position at an actual aviation school and better understanding the cost of running a legitimate and valuable FAR 147 pgm." Another wanted to "Find funding sources that can be spread evenly across all of the majors instead of focusing on just one major."

Conclusion

The purpose of this Phase II study was to further clarify the challenges expressed by instructors and faculty in teaching and learning curriculum for FAA Title 14 CFR Part 147 programs, which were reported by the Phase I study (Yother & Ropp, 2023). The goal of this study was for a follow-up on data of interest that would have further insights provided on it, and for a Phase III plan to be informed, including focus groups, where participants will be questioned on their day-to-day, in-class, and overall career challenges, which are articulated by Part 147 aviation maintenance instructors.one who would like to create similar models of their own design.

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Making a Difference One Student at a Time: Teaching Techniques to Improve Student Outcomes in FAA Part 147 Schools

By **Dr. Glenn Brackin**

ABSTRACT
This paper examines how targeted teaching strategies can positively affect student achievement in Federal Aviation Administration (FAA) Part 147 programs, which are designed to prepare aviation maintenance professionals. By adopting a student-centered mindset and tailoring instructional approaches, educators can significantly influence learning outcomes. The key strategies discussed include differentiated instruction, formative assessment, mentorship, and experiential learning, all of which support individual student success while aligning with FAA standards.

Making a Difference One Student at a Time: Teaching Techniques to Improve Student Outcomes in FAA Part 147 Schools

Schools operating under Federal Aviation Administration (FAA) Part 147 guidelines are tasked with preparing students to become skilled aviation maintenance technicians. This highly technical education must meet rigorous federal standards while also addressing the diverse needs of learners. By embracing the mindset of "making a difference one student at a time," educators can implement methods that support each learner's development and lead to better overall outcomes. Focusing on personalized instruction is essential for student success in such demanding programs.

Tailored Instruction for Diverse Learners

Differentiated instruction provides a framework for reaching students with varying backgrounds, skills, and learning preferences. As Tomlinson (2014) explains, this approach involves modifying the content, process, or assessment based on each learner's needs. In FAA Part 147 classrooms, educators might vary how theoretical material is taught or adjust hands-on activities to better align with student readiness. These adjustments ensure that all students, regardless of their entry point, have access to meaningful learning experiences that meet certification requirements.

The Role of Ongoing Assessment

Formative assessment plays a crucial role in supporting individualized learning. By offering ongoing feedback and evaluating progress continuously, instructors can guide students more effectively (Black & Wiliam, 2009). In aviation maintenance programs, this could involve brief knowledge checks, practical skill assessments, or structured self-reflection. The ability to catch misunderstandings early allows educators to intervene and help students stay on track toward meeting FAA standards.

Mentorship as a Support System

Mentorship is another key factor in student success, particularly in the context of a technical training environment. Building personal relationships with students helps foster trust, motivation, and confidence. When instructors take the time to understand each student's goals and challenges, they are better equipped to offer tailored support. Knowles (1984) emphasized that adult learners respond well to relevance and autonomy—principles naturally supported by mentorship. This approach reinforces both academic performance and professional identity development.

Experience-Based Learning Approaches

FAA Part 147 programs already include hands-on training, but instructors can further enhance this component by incorporating reflective and real-world learning. Kolb's (1984) theory of experiential learning underscores the importance of learning through direct experience. Practical tasks such as diagnosing simulated aircraft issues or documenting maintenance processes not only reinforce technical knowledge but also encourage critical thinking. Linking practice to future job functions helps students find purpose in their training and stay engaged.

Fostering a Student-Centered Culture

Making a difference one student at a time also involves cultivating a classroom culture that values each learner. Simple acts—such as knowing students' names, recognizing small achievements, or offering flexible office hours—can make students feel supported and seen. This environment encourages persistence and engagement. When students feel connected to their instructors, they're more likely to seek help, stay motivated, and complete their training.

Conclusion

Enhancing student outcomes in FAA Part 147 programs requires more than just delivering a set curriculum. It demands that instructors intentionally reach out to each student as an individual. Strategies such as differentiated instruction, formative feedback, mentorship, and experiential learning provide multiple pathways for improving success. By focusing on each learner's progress and potential, educators not only help students meet certification requirements but also shape the future of aviation safety and excellence.

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Promoting Excellence in Aviation Maintenance Education: A Review of 14 CFR Part 147 Standards and Instructor Qualifications

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ABSTRACT

Although the term aviation instructor is often viewed as synonymous across all instructors within the aviation industry, in practice, instructors for pilot and maintenance personnel could not be further separated. This literature review pertains to aviation instructor experience and student success as well as Federal Aviation Administration (FAA) 14 Code of Federal Regulations (CFR) Part 147 regulations. Research concerning Certified Flight Instructors (CFIs) and student success, competency-based training (CBT), hands-on training and evaluation, and specific realms of aviation where training and instructor qualifications are pertinent to the student's success will be examined. Furthermore, areas of focus concern an instructor's credentials, certification, and expertise within the aviation environment, including secondary and tertiary factors related to human error (HE), human factors (HF), situational awareness (SA), risk assessment (RA), aeronautical decision making (ADM), and similar constructs; additional elements of Aviation Maintenance Technician (AMT) instructor inferences concern experience and expertise as mitigation factors pertaining to HF-related safety incidents, HE in maintenance tasks, overall competencies, and quality of instruction. The student's future success within the aviation industry greatly depends on the instructor's effectiveness and skill concerning these topics, as well as understanding the implications of instructor characteristics.

Federal Aviation Administration (FAA) Verbiage on Part 147

The understanding and nomenclature concerning an airframe and powerplant (A&P) certification is often used synonymously with the term license. For an overall better understanding of the distinction, a brief description is provided,

> In order to sign off on much of the work performed on United States (US) aircraft, aircraft mechanics are required by the Federal Aviation Administration (FAA) to prove their knowledge by obtaining specific certifications. Individuals who earn both the airframe and powerplant certifications are authorized to perform maintenance, repairs, or tests on an aircraft. Note that the A&P are certifications, although the term "license" is often used instead throughout the industry. (PIA, program introduction, 2024)

The FAA governs policies and procedures pertaining to the 14 Code of Federal Regulations (CFR) Part 147 domain. A clearer understanding of some of the difficulties of interpreting FAA regulations, and the lack of mandatory experience leaves much of the 14 CFR Part 147 community to devise individual experience mandates. Another part of the problem lies in the rhetoric of CFR § 65.77, with the word "experience" following § 65.77, specifically concerning paragraph a.

Each applicant for a mechanic certificate or rating must present either—

> (a) An authenticated document from a certificated aviation maintenance technician school in accordance with § 147.21 of this chapter; or

(b) Documentary evidence, satisfactory to the Administrator, of—

(1) At least 18 months of practical experience with the procedures, practices, materials, tools, machine tools, and equipment generally used in constructing, maintaining, or altering airframes or powerplants, appropriate to the rating sought; or

(2) At least 30 months of practical experience concurrently performing the duties appropriate to the airframe and powerplant ratings. (Federal Aviation Administration, 2024, § 147.65)

The nomenclature of subparagraphs a and b introduce two separate and unequal components. Subparagraph b is straightforward and relevant to hands-on practical experience and documentation, which allows a technician (or prior military member) to test for their civilian A&P certificate utilizing the FAA Form 8610-2. This approach is commonly used by military-trained mechanics seeking a civilian endorsement of their military experience to obtain a commercial aircraft mechanic certificate (Summey et al., 2004). In this instance, the terminology is correct; paragraph b applies to hands-on practical experience pertaining to airworthy aircraft. However, subparagraph a is aligned under the same header and fails to relate to experience in the same hands-on, real-world concept, but rather a training environment and not on airworthy aircraft.

The understanding of subparagraph a concerning "experience" is more of an exposure or event; for this section, the working definition of exposure suffices. Subparagraph a focuses on a 14 CFR Part 147 school: a school trains individuals, and personnel in attendance at a school are learning skills for their future vocations within a training environment occupying a training role. In essence, "individuals, who complete the school curriculum are deemed by the FAA to be qualified to take the written examinations for airframe and powerplant (A&P) mechanic certification" (Summy et al., 2004, p. 4). This picture contrasts sharply with paragraph b, where the individual provides evidence of work performed.

Furthermore, a clear distinction is made in the general privileges and limitations, specifically, what tasks a certificated mechanic is allowed to complete. The direct understanding of CFR § 65.81, speaks to maintenance actions a mechanic can or cannot perform.

§ 65.81 General privileges and limitations.

(a) A certificated mechanic may perform or supervise the maintenance, preventive maintenance or alteration of an aircraft or appliance, or a part thereof, for which he is rated (but excluding major repairs to, and major alterations of, propellers, and any repair to, or alteration of, instruments), and may perform additional duties in accordance with §§ 65.85, 65.87, and 65.95. However, he may not supervise the maintenance, preventive maintenance, or alteration of, or approve and return to service, any aircraft or appliance, or part thereof, for which he is rated unless he has satisfactorily performed the work concerned at an earlier date. If he has not so performed that work at an earlier date, he may show his ability to do it by performing it to the satisfaction of the Administrator or under the direct supervision of a certificated and appropriately rated mechanic, or a certificated repairman, who has had previous experience in the specific operation concerned.

(b) A certificated mechanic may not exercise the privileges of his certificate and rating unless he understands the current instructions of the manufacturer, and the maintenance manuals, for the specific operation concerned. (Federal Aviation Administration, 2024, § 65.81)

The vernacular of § 65.81 speaks to a mechanic's ability to perform and supervise various preventative maintenance or alterations, of various components, systems, or subsystems. However, the caveat is the mechanic must have previously performed the work satisfactorily at an earlier date, or the individual must be supervised by a mechanic who has satisfactorily completed the work previously. The inherent problem lies in verbiage and should clarify work as being performed on an airworthy aircraft, or a potential misinterpretation to mean previously complied with and be sought to be met while in a 14 CFR Part 147 school can be misunderstood, although the examples given clearly illustrate airworthy aircraft. The additional regulation citations speak of airworthy aircraft, not training or being within a training environment. Hence, a regulatory misinterpretation cannot be garnered or misread to denote "training," as the § 65.85 citation speaks in part to a 100-hour inspection and return-to-service concerning an airframe rating, § 65.87 speaks to the same for a powerplant rating, and lastly, § 65.85 speaks directly to the Inspection Authorization (I.A.) endorsement. All three stated examples refer precisely to the return-to-service of airworthy aircraft; hence, a potential misinterpretation of the context applying to training cannot be a viable option. Therefore, a mechanic can only execute work that they have previously performed satisfactorily on airworthy aircraft, which affords the mechanic the ability to return the aircraft to service after work is complete, signing off that the aircraft is in a safe, airworthy condition.

Furthermore, in the FAA order 8900.1: Flight Standards information management system, Volume 5, Chapter 5, Section 11, Paragraph D; Evaluating Applicant Performance, Subpoint 3, the FAA requires that during O&P testing, projects are completed to a return to service standard (FAA, 2024). If an AMT instructor has not performed the work previously, the instructor cannot teach the return to service standard if they have not performed the task themselves or know what a return to service standard looks like. Previous training in a 14 CFR Part 147 maintenance school was not performed to a return to service standard on airworthy aircraft.

An additional legal interpretation from Carpenter 2012 legal interpretation, gives some clarification of § 65.81 considering a manufacturer requiring additional initial training. The document notes that neither the regulation nor any regulation, for that matter, requires any additional initial or recurring training. The assumption is implied that the return to service work is performed on airworthy aircraft, given the §§ 65.85, 65.87, and 65.95 examples. However, the FAA also makes a strong recommendation for both mechanics and repairmen to obtain both initial and recurrent training (FAA, 2012). Furthermore, the crux of the issue is the verbiage of the mechanic, who has previously performed the work. As noted, the examples given clearly do not illustrate a training environment and refer to airworthy operational aircraft. A potentially glaring misinterpretation would be reading the intent of the legal interpretation to apply to a training environment (citing the examples given). Furthermore, the legal interpretation does not specifically address the 14 CFR Part 147 maintenance school environment, which is likely a point of contention as the regulation does not speak specifically to 14 CFR Part 147. However, FAA order 8900.1: Flight Standards Information Management System, Volume 6, Chapter 10, Section 2 speaks to the qualifications of instructors and notes that the AMT instructor is not exercising the privileges of their certificate while instructing within an AMT maintenance school and is not required to meet the 14 CFR Part 65 requirements as a return to service standard (FAA, 2022). Unlike CFIs, who can log time for time building as an instructor, the AMT instructor cannot. Additionally, if the AMT instructor cannot count the time as experience under their certificate while teaching, how than can the AMT student can track this same type of time to be considered to fulfill the requirement of work previously performed? If, however, the FAA were to count hours of instruction, the FAA would then be qualifying that a newly certificated A&P can instruct in a 14 CFR Part 147 as an AMT instructor and on all the ACS elements to a return-to-service standard. If a mechanic has never previously performed the work outside of a training environment, the mechanic is still not qualified and, by regulation, is not allowed to perform or supervise work performed, because the mechanic has not performed maintenance to a return-to-service standard, the individual does not know what a return-to-service standard looks like, and lacks the ability to assess the standard as such. The AMT instructor is appointed to deem competency of the AMT student, if the AMT instructor has never performed the task, how can they effectively and correctly deem competency of a student? Furthermore, this interpretation pertaining to the inexperience of the newly graduated AMT students is also validated by the I.A. renewal course (Gleam, 2025, Unit 17.1 Paragraph 4). The FAA I.A. renewal course is one of the ways an I.A. can obtain recurrent training to maintain currency for the I.A. endorsement. Additionally, all I.A. renewal courses are approved by the FAA, as such, this interpretation is clearly supported by the FAA as well.

Regardless of the interpretation, the issue warrants an FAA legal interpretation considering the 14 CFR Part 147 maintenance environment and AMT instructors. The specific question that needs to be asked is, can a certificated A&P train a certificated A&P or non-certificated individual (under supervision), which would then qualify as "direct supervision” and under “previous experience” under 65.81(a) on a task that they themselves have never returned to service on an airworthy aircraft? A scenario to illustrate this concept is if a student in a 14 CFR Part 147 maintenance school is trained on an Avotek retractable landing gear trainer, and after being trained on the Avotek trainer, the same individual obtains their A&P. Can this same individual perform a landing gear retraction test (which is part of a 100-hour inspection), as well as train a non-certificated individual (under supervision), with the supervised person then acquiring an A&P through experience, and moving on to perform the landing gear retraction test and approve the portion of the inspection for return to service? This same scenario can be applied to systems, such as cabin pressurization, instrument leak checks, removal and re-installation of control surfaces, and accompanying hardware, such as cables and pulleys, just to name a few. In this instance, the initial AMT’s training would qualify them for work previously performed concerning 14 CFR Part 65.81. Would the A&P need to have a training logbook where they recorded all of the individual maintenance performed, or would the completion certificate from the 14 CFR Part 147 maintenance school indicating that the minimum standard of 70% on all ACS elements be sufficient as a record of previously performed work?

The scenario only becomes further convoluted if this interpretation is applied as some of the ACS elements are incredibly vague; schools comply with meeting them in an individual manner, which is also unique to individual interpretation. This interpretation lacks consistent application and, thus, should never be misunderstood. The point remains that a clear need exists for an FAA legal interpretation. The only present quantifier for a return-to-service standard of work is noted in FAA order 8900.1: Flight Standards Information Management System, Volume 5, Chapter 5, Section 11, which contains criterion for the O&Ps examination, requiring the DME to evaluate the tasks of the applicant at a return-to-service standard (FAA, 2024).

The FAA order 8900.1: Flight Standards Information Management System, Volume 6, Chapter 10, Section 2, essentially allows for a newly certificated A&P, who graduated from a 14 CFR Part 147 maintenance school on a Friday, to turn around and teach the following Monday as an AMT instructor. Again, just because a regulation allows latitude for this unprincipled behavior, it is certainly not in the best interests of safety, the 14 CFR Part 147 community, and certainly not the safety of the aviation industry and the general public. Such a situation would allow a newly graduated AMT student to be immediately hired as an AMT instructor, who would then teach to the test, which would increase pass rates and could then afford the 14 CFR Part 147 maintenance school the opportunity to apply for testing authority. Once testing authority is obtained, the examiners would be appointed in a similar fashion; at this point, the experience requirements of the examiners are the only parameter of required experience that would remain, and now, a singular entity controls all of the factors concerning the various systems of checks and balances set in place by the FAA when the regulations were initially written with an intent to protect against such behavior. The pass rates would look good to the FAA on paper and also validated by the metrics set forth in FAA order 8900.1: Flight Standards Information Management System, Volume 6, Chapter 10, Section 1, but the fact of the matter is the newly graduated AMT student passed the exams, but in reality, enters the profession undertrained by their recently graduated peers. The newly certificated peers possess a narrow scope of aviation maintenance knowledge and an inadequate contextual understanding of overarching maintenance practices, gleaned solely from the backdrop of a 14 CFR Part 147 maintenance school training environment and content applicable to a specific school. The summation of which constitutes the entirety of their aviation maintenance knowledge.

Military Experience

The verbiage contained within § 66.77 demonstrates the potentially fatal flaw in comparing sub-paragraphs a and b as equivalents. For example, in the United States Air Force (USAF), an aircraft crew chief (USAF equivalent of a civilian A&P) attends two months of fundamentals training concerning tools, tech data interpretation, maintenance documentation, and inspection concepts tied to aircraft maintenance. The individual then undergoes several months of familiarity training; for the KC-10 airframe, three months at the Field Training Detachment (FTD) unit. In essence, the FTD unit is a familiarization course, similar to those that a civilian mechanic might attend when transitioning to work on a different Type Certificate

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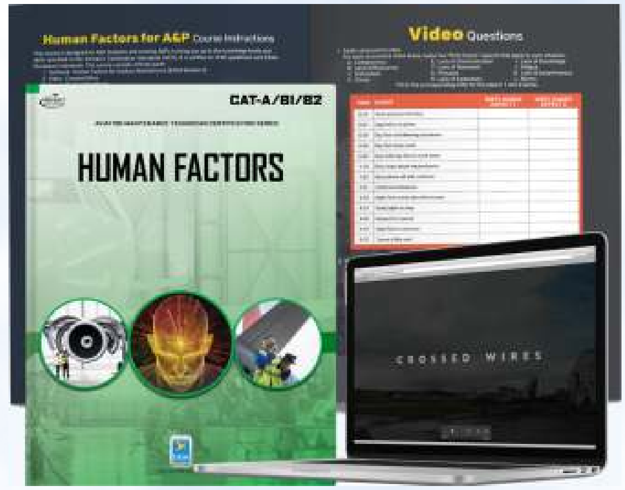

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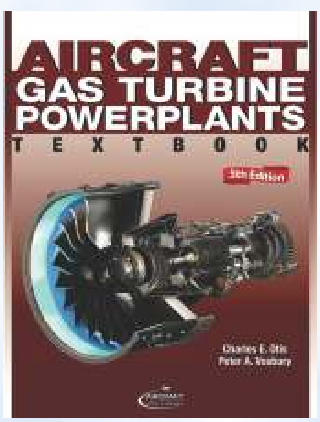

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According to Cheng (2018), individuals must be aware that differences exist among aircraft design, model numbers, and maintenance procedures on different aircraft; technicians must obtain training on different airframes. A civilian or military familiarization course exists to fulfill the transitional needs of technicians, while aiding their understanding of nuances between design series variants. Policy and procedural guidance are established using Air Force Instructions (AFI) and other required Air Force (AF) and Major Command (MAJCOM) guidelines. The personnel attend the Maintenance Qualification and Training Program (MQTP) following FTD Training. MQTP is a three-month iteration of the civilian 14 CFR Part 147 maintenance school curriculum. The MQTP meets the AFI 36-2201 requirements, Air Force Training Program, and AFI 36-2232, Maintenance Training. The Air Force Instructions are equivalent to the FAA policies and procedures for 14 CFR Part 147 A&P training.

The MQTP course is a "386-hour course meant to prepare maintenance personnel to effectively and safely perform 2A5X1 Core Tasks as established by AFI 36-2232" (Air Force Instruction 36-2232, 1999, p. 1). Furthermore, military personnel must obtain a passing rate of 80% instead of the 14 CFR Part 147 Maintenance School FAA standard of 70% (Summey et al., 2004). The curriculum is taught from the Career Field Education and Training Program (Department of the Air Force, 2020). However, unlike in civilian Title 14 CFR Part 147 Maintenance school, in MQTP, the AMT performs real-world maintenance and inspections on airworthy aircraft. The tailored content within the MQTP applies to the specific aircraft. For example, on the KC-10 Mission Design Series (MDS), the technicians are not exposed to propeller systems and theory, as the KC-10 has high bypass turbofan engines. In both 14 CFR Part 147 and the MQTP training programs, individuals in attendance are students in training status; the difference is the direct experiential learning in MQTP. Anecdotally, speaking from a professional standpoint, having taught in both the USAF Airframe, Powerplant, and General (APG) and 14 CFR Part 147 maintenance school domains, an ability is garnered to validate the comparison of the illustrated examples as like items. The USAF uses the content of FAA examination material in portions of the active-duty aircraft maintenance career field training and testing. Thus, the content presented compares similar frameworks, the only difference is the return to service level of completion required by the USAF. The USAF requires an airworthiness return to service level of completion, while the 14 CFR Part 147 environment is not completed to an airworthiness return to service level of completion.

After MQTP qualification, the technician is certified and can sign off on specific job tasks and inspections with their "Man Number," the military equivalent of an A&P certificate number. At this point, the technician could begin to obtain the allocated time required, as noted in subparagraph b, sections one and two of CFR § 65.77. Presented here is an easily identifiable similarity between the MQTP and the 14 CFR Part 147 maintenance schools regarding "training status" and both equivalent and non-equivalent variables. In both scenarios, once the AMT student is found eligible to begin signing off job tasks, either by the military MQTP or the civilian 14 CFR Part 147 maintenance school, students are technically "ready" after the student "graduates." Still, the military member must now accrue the time required to become eligible to test for their A&P certificate. Concerning application to paragraph b, at this point, the military member has real-world "experience," even if only the minimum time allocation is noted in section b.

In contrast, the freshly graduated 14 CFR Part 147 student lacks any real-world operational experience. Military students are in "training status" until graduation from MQTP. The students are then released to work on aircraft to "obtain" the 18 months of "experience" needed to comply with the regulations. The military member has several months of "time" as opposed to the 14 CFR Part 147 "student," who has yet to touch an airworthy aircraft or sign off a maintenance task or inspection.

The moniker of "experience" to which 14 CFR Part 65 speaks is heavily convoluted, disconnected, and does not compare like requirements.

Civilian Experience

Similarly, an individual could be employed and work for an Maintenance Repair Operation (MRO; depending on the task) and obtain the same equivalent, likened to that of military experience. The major difference in this scenario is that the individual is signing work off and performing tasks under the FAA Certificate number of the MRO. An individual A&P certificate number is not included in this equation. Having been qualified to perform the specific tasks under the MRO, an individual could use the quantified time while working under the MRO to "sign off airworthy aircraft" as "experience." The individual is already qualified at this point and merely needs to demonstrate documentation of the tasks to the FAA to fulfill the requirements for subparagraph b, similar to the AMT military "experience." This specific example is not all-inclusive. For example, a Pratt and Whitney or General Electric (GE) turbine professional may show turbine documentation (similar to MRO experience) and also meet the requirements for subparagraph b. A technician may accrue appropriate experience toward the time requirement in several ways. However, while occupying the role of a student in training status at a 14 CFR Part 147 maintenance school is not a viable option for the time requirement fulfillment.

Advisory Circular (AC) 147-3C guidance on Title 14 CFR Part 147

The FAA provides direction to 14 CFR Part 147 maintenance schools in Advisory Circular (AC) 147-3C, which gives guidance for instructor requirements and qualifications. An additional issue lies in the regulations currently afforded to 14 CFR Part 147 maintenance schools; operational guidance is found in AC 147-3C Paragraph 2.9. As this advice demonstrated, there are no previous experience requirements necessary, other than holding an A&P certificate. Subparagraph (2) contains a "specifically qualified" note, which would typically be demonstrated through some sort of documentation, which quantifies "experience," noted in AC-147-3C paragraph 2.9.2.2 under Instructor Qualifications. However, this same experience requirement is not present for the individual holding an A&P. Moreover, additional guidance on "qualifications" is provided under the section "Instructor Qualifications."

Instructor Qualifications

Further guidance is given in AC-147-3C, which discusses 14 CFR Part 147 maintenance school instructor qualifications, section 2.9.2, paragraphs 2.9.2.1 through 2.9.2.3. As noted in paragraph 2.9.2.3, a determination should be made that instructors are competent to teach and instruct students in assigned areas of expertise. In paragraph 2.9.2.1 concerning the A&P, the only requirement is holding an A&P certificate; in contrast, in paragraph 2.9.2.2, the Specifically Qualified Instructor, must show documented evidence of both experience and training. No experience or training, which would aid the instructor in the ability to assess students, is required. An IA endorsement, however, requires demonstrated and documented experience, which must be presented to the FAA to obtain. Additionally, the IA gives the AMT authority to supervise other AMT personnel in work performed, which also implies the ability of the IA-rated technician to be both competent and skilled in assessing work completed.

Instructor Requirements

An illustration of specific instructor requirements is given in AC 147-3C. The AC-147-3C contains guidance for the necessary instructor requirements for Aviation Maintenance Technician School (AMTS), which is contained within each respective school's Operations Specification (OpSpecs). The instructor requirements, which are contained within § 147.19, include the areas discussed in paragraphs 2.9.1 through 2.9.3. This discussion demonstrates that documentation and evidence of performed maintenance tasks are required for specifically qualified instructors (instructors not holding an FAA mechanic certificate). Still, no evidence of this same type of maintenance or tasks performed by the AMT instructor holding the A&P certificate is required. Hence, no real-world experience is required by FAA policy.

Qualification Examples

A further example of qualification is demonstrated through various outside organizations specializing in specific training and certifications, qualifying individuals on tasks through familiarization courses and other training programs. FlightSafety International hosts several potential offerings, such as the Aerospatiale ATR 42-72 course. The Aerospatiale ATR 42-72 offering is a professional pilot and technician training program that qualifies pilots and technicians on a specific aircraft. Once personnel graduate from the course, pilot or technician, the individuals are then considered competent and "qualified" to fly or work on the specific aircraft. This example demonstrates a training program outside of a company that might be utilized to train and qualify personnel (Aerospatiale, 2024). Various companies and consulting firms also offer similar training courses. Outside entities offer companies programs to qualify personnel in their respective fields, such as aviation maintenance, HF, MRM, CRM, analysis of incidents, change equipment, and applying information technology to operational issues (Gramopadhye & Drury, 2000; Johnson, 1997).

Additionally, other maintenance-specific subsections contain qualification and experience requirements, such as 14 CFR Part 121 (airline carriers) and 14 CFR Part 135 (commercial on-demand operations). The 14 CFR Part 147 maintenance school section lacks a similar treatment. An example from 14 CFR Part 121 illustrates the differentiation of training when compared to qualification and requirements terminology. In this instance, the 14 CFR Part 121 demonstrates a "need" for a "training program" for inspection personnel. In contrast, regarding 14 CFR Part 147 instructor personnel, the regulations lack the same requirements concerning an appropriate instructor "certificate," training, qualification, or authorization to become a 14 CFR Part 147 instructor. Paragraph § 121.371 of The Title 14 CFR Part 121 section contains requirements for inspection personnel. There is a distinction in verbiage; "appropriated certificated, properly trained, qualified, and authorized" (14 CFR Part 121 Para. 371) have different meanings. An example of the clear distinction clarifies potential misinterpretation.

> 14 CFR Part 65 – Certification: Airmen other than Flight Crewmembers.
>
> To become a repairman, an individual must meet the requirements specified in §65.101, which includes the necessary training, exams, and qualifications as determined by the requesting organization and approved by the FAA Administrator. Specifically, this includes the processes and qualifications outlined under §65.101 and the corresponding qualification statements.
>
> 14 CFR Part 65, Subpart D – Repairman, §65.101 outlines the requirements for repairman, including the need for either 18 months of practical experience in the job or completion of an FAA-approved training course. (14 CFR Part 65)

Within the text, there is specific verbiage, which is lacking (Note: The experience requirement is lacking for the A&P personnel; the training course example is like that for the ATR 42 - 71 example).

> 14 CFR Part 65, Subpart E – Airframe and Powerplant (A&P) Mechanics.
>
> Details: §65.77 specifies the qualifications for obtaining an A&P rating. Mechanics must be at least 18 years old, be able to read, write, speak, and understand English, and have at least 30 months of practical experience.
>
> 14 CFR Part 43 – Maintenance, Preventive Maintenance, Rebuilding, and Alteration, §43.3 and §43.15 describe the requirements for being considered "actively engaged." To maintain authorization, individuals must perform at least one annual inspection and two major repairs or alterations every 90 days. (14 CFR Part 65 Subpart E).

The 14 CFR Part 65 describes how an applicant for a mechanic's certificate must demonstrate between 18 and 30 months of aircraft work experience as a mechanic before being considered as having enough experience to take the written examination (Summey et al., 2004). In contrast, concerning the 14 CFR Part 147 maintenance schools, AMT students, who complete the maintenance school curriculum, are then considered by the FAA to be qualified to take the written examinations for the mechanic certificate (Summey et al., 2004). The differentiation and distinction of a training program is also given in Paragraph § 121.377, entitled Maintenance and Preventive Maintenance Training Program.

The 14 CFR Part 121 illustrates the concept of a familiarization program, which trains personnel on specific aircraft and operational maintenance tasks and procedures applicable and appropriate to the specific company. The training program familiarizes individuals in efforts to prepare them to perform their duties; the individuals cannot perform job tasks until "training" is "complete."

A current example of a transitional, or training program aimed at qualifying instructors is the current ATEC Instructor Academy. The ATEC Instructor Academy focuses on the critical shortage of qualified aviation instructors, providing essential training for professionals transitioning from industry to the classroom. The program is designed to support new educators and seasoned professionals and equip instructors with the tools to thrive in aviation education (ATEC, 2023).

Competency-Based Training (CBT)

The best working definition of CBT is encapsulated by Kearns (2016); CBT is tailored to pre-identified competencies of each role and function that technical staff have been assigned, focusing on their ability to perform their job rather than the length or duration of their training (Kearns, 2016). For example, competencies are the reference point for measuring success across many activities and vocations. However, concise textualization of competence is not always possible (Hattingh et al., 2022; Hodge et al., 2020). Concerning HF, an instructor must have knowledge and experience that comes from extensive practice with a given subject area (Cheng, 2018; Johnson, 1997). Casanova et al. (2024) found a strong emphasis should be placed on intake and understanding of procedural information and processes to best perform maintenance tasks. The findings suggested training must place a further emphasis on procedural knowledge, processes, and planning for maintenance tasks for novice AMTs, who lack the experience level of seasoned AMTs (Casanova et al., 2024).

Such experience likely ensures the instructor understands the reality of the maintenance environment. For example, concerning risk management (RM), an instructor must be knowledgeable enough to identify inherent risks. However, maintenance experience alone should not be the sole criterion to qualify an individual; instead, experience should be combined with academic and industrial training (Johnson, 1997). These same concepts can also be applied within the specific realm of maintenance, as noted by Cheng (2018); by understanding the various interactions and how individual factors contribute to errors and accidents, AMTs can better learn to proactively prevent and manage components and factors. Contributing factors encompass poor judgment or reasoning and insufficient knowledge, leading to errors. All required maintenance must be performed to a specific standard using approved instructions. The instructions are based on knowledge gained from engineering and operation of aircraft equipment.

Furthermore, it has been suggested that CBT might disconnect learners from critical aspects of knowledge, theoretical understanding of systems, and underlying meanings (Hattingh et al., 2022; Wheelahan, 2019). A quality course must discuss the applied principle of machine systems and appropriate applied psychology when dealing with HF concerns and applied levels of AMT training. These various integrations of scenario-type CBT might help increase the ability to heighten Situational Awareness (SA) among individuals (Endsley, 1994; Johnson, 1997). SA represents a perception of elements within an environment in a given time and space, a comprehension and understanding of their meaning, and the projection of future outcomes. A lack of awareness or SA is a failure to recognize all potential consequences of an action, due to an omission of forethought (Cheng, 2018). The integration of CBT in a scenario-based framework, taught by individuals who are adept in the navigation of enigmatic environments, further improves the capabilities of participants to assess a situation accurately and make the most appropriate judgment to further a course of action.

Recent research has demonstrated the challenges of dealing with assumptions of CBT for educators within the vocational and education training sectors (Kearns et al., 2016). Similar hurdles also apply to assessing the environment and ambiguous situations, such as those concerning troubleshooting and malfunctions or errors. Difficulties existed when traversing some of the CBT-related issues, and navigational concerns were true for even experienced educators and those with relevant industry-required training and assessment qualifications (Kearns et al., 2016; Lowrie et al., 1999; Smith, 2010). The advancements in automation and technologies further compound the gaps in the experience and competency requirements of AMTs. For example, concerning automation, Bainbridge (1983) found that although automation reduces human activity during standard operations, in unexpected incidents, such as troubleshooting, automation increases the demand for competency and reasoning ability of the individual. Additionally, individuals must have greater skill, expertise, and theoretical knowledge of systems and operations when interfacing with such machines and systems. Automation that overruns the operator or instructor in "normal" operational and hazardous situations requires greater knowledge, expertise, and competence (Bainbridge, 1983).

A lack of industry experience further compounds these factors; as the number of variables increases within the operation of a system or subsystem, the number of potential errors also increases. The chain of events further demonstrates a greater need for fuller understanding and knowledge. A generally accepted definition of human error refers to an action or action(s), series of actions, or mental activities that fail to meet an intended outcome (Cacciabue & Cassani, 2011). Examples of error types that might lead to an unwanted outcome might correlate to effective or ineffective training, in addition to the experience or inexperience of an individual, the omission of a task, erroneous operations, and misinterpretation of information.

More specifically, in contextualized scenarios, a high level of experience helps navigate unclear circumstances, such as scenario-based training and troubleshooting. The Australian Government (2014) selected a single-engine abnormal scenario due to the commonality, practicality, and complexity of interpreting information and its practical application. The understanding of the scenario-based information presented to participants was not based on sound explicative processes but was influenced by selective and biased factors. There were several potential reasons for the biased interpretation of readings, including the type of workplace environment and resource availability, the amount of professional development afforded within the workplace, and previous industry or operational experiences (Hattingh et al., 2022; Johnson, 2024).

Additionally, the aviation environment represents a very limited category of people: individuals with a high level of detailed and specific training and knowledge (Cacciabue & Cassani, 2011). The supply of qualified AMTs is insufficient for the ever-increasing demand for qualified technicians within the operational aviation environment (Gunes et al., 2020). Similarly, by implementing realistic scenarios, educators and instructors better ensure that students learn at their best by implementing skills-based training, including RA and HF training in a CBT framework; this approach might aid the AMT in better learning outcomes (Johnson, 2023). Implementing RA and HF training helps students assess safety risks properly, which ties to real-world situations. This concept is similar to the employment of CRM in practice (Olaganathan, 2024).

From a professional standpoint, a seasoned mechanic might have a "positive bias" in terms of navigating situations and executing appropriate responses. The effectiveness of CBT also relies on sound theoretical understanding, real-world experience of the instructor. The ability of the instructor to effectively teach further compounds the complex environment of CBT and scenario-based training. Concerning theoretical understanding, real-world experience, and the ability to teach, all might play key roles in student success. These contributing factors are also gleaned from contextual understanding, not a mere recitation of information at a surface level of understanding. The purposeful facilitation of practical scenarios leads to authentic and realistic workplace scenarios, which helps the student transition to the operational environment (Hattingh et al., 2022; Johnson, 2023). Baghdasarin (2020) defined applied knowledge as being acquired through "practical experience" with either power plants, airframes, or both. Pragmatic expertise is gleaned from appropriate tasks conducted within the field of aviation maintenance, e.g., returning an aircraft to airworthy status, but not directly through maintenance tasks performed within a 14 CFR Part 147 training environment as a student. The training environment aims to equip AMT students, and they are often guided in the maintenance actions, which differs greatly from when the AMT must navigate, interpret, and execute maintenance actions independently, under their own certificate number, without the aid of an instructor.

Olaganathan (2024) found that among the twelve most common errors in the judgment skills of maintenance personnel were lack of knowledge and lack of SA. To this end, a more seasoned instructor might be best positioned to further identify SA factors and impart this knowledge to future students. An area of future training might focus on the enhancement of skills needed to improve SA, helping aviation personnel obtain superior capabilities in achieving this crucial construct for all aviation professionals, professional pilots, maintenance personnel, or otherwise (Endsley, 1994). SA skills can be taught and enhanced, trained and honed; for the aviation professional, the ability to accurately assess a situation could mean the difference between safe operations and an accident or even a potential loss of life.

An often-overlooked method of immersive learning is that of scenario-based training. Scenario-based training is used

heavily in the pilot domain to great effect, and this same approach might yield positive benefits within the 14 CFR Part 147 environment (Johnson, 2024). Likewise, aspiring remote pilots and sensor operators have employed an immersive environment with high realism to achieve resounding success in training (Macchiarella & Mirot, 2018). Hattingh et al. (2022) focused on flight instructor perceptions of CBT, and results indicated that many instructors, irrespective of experience, may have difficulty interpreting and implementing competency text requirements. These concerns are related to incorrect interpretation and implementation of competency requirements. An individual must fully understand the context to which a competency applies, including the potential risks (Hattingh et al., 2022). An appropriate consideration is understanding the role experience, practical exposure, and training may have on competencies, which might mitigate or hinder future findings. This framework is also cemented in the future success or hindrance of students.

Aviation Instructors: Maintenance

The relationship between the qualifications of aviation instructors as pilots and performance has been surveyed in previous studies, but only some are focused on AMTs (Haines, 2008). Various factors contribute to the lack of qualified AMTs and, more specifically, the AMTs operating as instructors within 14 CFR Part 147 maintenance schools. The 14 CFR Part 147 maintenance training can be likened to pilot training, because in flight training, a pilot is trained on one type of aircraft at a time; this is the exact same concept of training as an AMT is in a single "curriculum" at a time, this is why the ratings are separated and allow the AMT student to test in general, airframe, and powerplant separately. From a DME standpoint, during the certification process, the outcome of the test is identified on three separate forms, testing planning sheets, and then uploaded to the PSI website, as standalone tests, general, airframe, and powerplant, to be calculated as a pass or fail and the percentage of the outcome for both oral and practical exams separately. To this end, ATEC and various 14 CFR Part 147 maintenance schools have pursued efforts for the FAA to allow for testing of O&Ps for general once the knowledge exam is passed at 70% or higher. However, one of the reasons this has not been implemented yet is because general alone is not a certificate, and testing can only occur when an application for a rating is made.

Once an AMT is qualified and experienced, they are expected to be an expert in multiple systems simultaneously, but not while in training. Training is meant to equip the student to prepare them to operate in the eventual capacity in which they will one day operate, similar to the fully trained solo pilot. Concerning the pilot realm of training, a CFI has to obtain between 190 hours for 14 CFR Part 141 and 250 hours in an airworthy aircraft and have made the appropriate logbook entries in the respective flight logbook. The entirety of the pilot training cannot be completed within a simulator. This concept is equivalent to the 14 CFR Part 147 maintenance school; projects are simulated and do not require a logbook entry or a return to service, and work performed is certainly not on an airworthy aircraft.

Since the FAA has changed from the Practical Test Standards (PTS) to the Airman Certification Standards (ACS) for AMT training, the FAA now allows the educational institutions approved as 14 CFR Part 147 maintenance schools to determine the curriculum (H.R.133/Public Law 116-260, sec. 135). The FAA provides ACS elements that must be met, but how elements are integrated, taught, and assessed depends upon the individual institutions. A mere FAA-level exam pass rate may not be the best indication of the quality of instruction nor the best predictor of future student success. Summey et al. (2004) might have made a valuable initial contribution to the current framework by comparing school pass rates of four- and two-year programs. Replicating that study now would allow a comparison between the PTS and the ACS change.

Currently, only flight instructors are required to teach from the Aviation Instructor's Handbook. However, the assumption that all instructors (flight and maintenance) will teach from the handbook, the assumption is given further validity with a small note, which applies to maintenance instructors: "one of the best actions a flight or maintenance instructor can take to enhance aviation safety is to emphasize safety by example" (FAA, 2020, p. 8-6). The deficiency between regulatory requirements and the lack of instructor requirements poses a significant risk to aviation safety (Larson, 2011). Though various job postings "require" experience, in many cases, this "requirement" seems to be more of a "paper" check-the-box requirement. In contrast, Portland Community College has steadily increased the years of experience required to be an AMT instructor (PCC personnel requirements, 2024). Some 14 CFR Part 147 maintenance schools recognize the importance of experience by self-imposing mandatory years of experience; however, these criteria for hiring are not consistent between schools.

The AMT profession is a hands-on trade, learned and garnered through years of experience to hone skills and expertise. Likewise, an educational framework emphasizing real-world performance must be cultivated. Known as competency-based training (CBT), it best meets the AMT students in a growing and evolving aviation environment (Kearns et al., 2016). Evidence supports the assumption that most AMTs learn at the applied level of education. Practical experiences lead to applied knowledge for individuals (Baghdasarin, 2020). AMT students can struggle in the traditional classroom setting but most often thrive in the hands-on shop environment.

Knowledge about the latest pedagogical techniques and technological changes and having a high level of interest and enthusiasm for instruction are vital for high-quality education and educational excellence (Hirshberg, 1992), and traditional and non-traditional methodologies may need to be employed (Johnson, 1996). Adapting to different learning styles is a skill present within adult education programs. To meet the growing demand for future AMTs, matching the training with students' learning styles is paramount (Boeing 2010, September 15, para. 1; Johnson, 2024). The student's success largely depends upon the instructor's knowledge, expertise, and adaptability to adjust the teaching approach to best meet the student's learning style.

Students further excel once they see the correlation between what they have learned and how the concepts apply to their career field. A heightened sense of learning and cognitive growth occurs, and a positive correlation to course grades is achieved (Niemczyk & Ulrich, 2009). A traditional lecture instruction format for college classes is not always effective; this approach may be further compounded when speaking of students within the aviation disciplines (Brady et al., 2001). Through self-examination, students can improve their study habits, assessment scores, and knowledge retention. Individuals learn how to apply these skills in a given learning or applied context (Niemczyk & Ulrich, 2009). The ability to articulate and explain subject material well is also tied to student success and the perception of teacher effectiveness. Teachers must be familiar with the content and the concepts and principles underlying the topic of study, which better equips the instructor to answer potential questions from students more accurately.

The instructor is more prepared to explain the various levels of importance concerning the given topic and how the material can be applied to the student in a real-world context (Pass & Switzer, 2004). However, concerning teaching effectiveness specifically, Marsh (2007) found little evidence that it either improved or declined with additional teaching experience. The ability to teach effectively should not be confused with the experience and level of understanding of the material, which increases with years of experience on the application side. Students taught by teachers with more teaching experience scored higher than those taught by teachers with less experience, but the findings were not vastly different between the groups. Part of the additional findings noted that the experienced instructors supplemented the course material significantly due to their experience within the respective field and years of teaching (Pass & Switzer, 2004). Admittedly, teaching effectiveness has been noted to decline with age and years of teaching (Marsh, 2007). Findings noted that the years of teaching an instructor processed was a poor indicator of student success. However, rather than assessing an instructor's teaching experience concerning student success, a better relationship was identified between the specific courses taught and instructor familiarity with content and student success.

Interestingly, the students' evaluation of teaching effectiveness (SETs) was found to be a more effective measure of the teacher than the course that was taught (Marsh, 1981). In a recent study that measured student success and random effects in university instructors, Vazquez and Wilson (2020) found a high level of variability among majors and instructors. A student's academic success was found to be more accurately assessable given the classes taken and the specific individual teaching the subject area (Arreola & Wilson, 2020). An instructor with experience in the respective field should conduct only hands-on AMT proficiency level assessments. A proactive mindset toward hazard abatement and safety compliance within an environment fosters a strong safety-minded culture, which must have full support from the upper echelons of any operating entity to be most effective (Adjekum, 2017; Baghdasarin, 2020; FAA, 2015). Adjekum (2021) suggested that effective policies sometimes do not translate into an effective Safety Management Systems (SMS). Although effective enforcement of safety protocols is largely contingent upon leadership involvement, a successful SMS program also involves many components, which rely on individual instructors, reporting officials, and other FAA regulatory compliance. Much of the onus and success of the program relies on individual compliance, reporting, cataloguing, and handling of findings and reports. Many primary concerns involve individual personnel, reporting, and the effective management of the overall SMS.

Companies implementing Maintenance Resource Management (MRM) (Olaganathan, 2024; Patankar & Taylor, 2000) have achieved some HF mitigation success. Similar positive results for pilots and the successful implementation of Crew Resource Management (CRM) might also be found in the integration of MRM. For example, some airlines have reported reduced safety issues, personal injuries, and aircraft damage (Taylor & Christensen, 1998, Chapters 9 & 10). Most aviation maintenance personnel within the industry know HF issues; however, supervisors and managers continue to be challenged to make a case for HF programs, despite the evidence that MRM can mitigate HF errors.

Although there has been a significant focus on safety and experience for pilots, this has yet to translate into aviation maintenance (Preudhomm et al., 2012). With 12 to 18% of all global commercial aviation accident triggers attributed to maintenance errors (Marx & Graeber, 1994; Olaganathan, 2024; Patankar & Taylor, 2000), a focus on aviation maintenance HF could be a potential answer and should be a risk reduction emphasis. According to Rashid et al. (2014), maintenance events contributed to almost 20% of all global accidents in the year of 2007. Findings suggest that with more experience, an overall heightened sense of safety might be achieved, even more so in the training arena, where initial impressions hold substantial weight.

Within some teaching frameworks, instructor experience correlated to teaching effectiveness (Carrell & West, 2009; Education Commission of the States, 2005; Hoffman & Oreopoulos, 2009; Marsh, 2007; Pass & Switzer, 2004). Hoffman and Oreopoulos (2009) noted that instructors, who were observed to have a positive correlation to student success from the perspective of the student, had a perceived level of effectiveness with the handling of the related subject matter and material by the instructors, a subjective measurement of quality by the students. Olaganathan (2024) observed that HF training for aviation maintenance personnel had been a mandatory requirement in Europe since 1999, which resulted in a reduction of 11% of incidents related to maintenance errors. Conversely, the FAA has not adopted the same mandatory approach to HF training for AMTs, which has since been correlated to an increase in maintenance and inspection-related errors (Olaganathan, 2024; Reynolds et al., 2010). Thus, the case for training correctly the first time by a qualified and experienced instructor is paramount in elevating safety and the standards of practice.

Furthermore, individuals are the focus of aviation safety; the quality, attitude, perception of safety, understanding, and training of personnel are important. An organizational culture, climate, management model, decision-making patterns, and the aviation safety climate will also affect an individual (Chang & Wang, 2009). With more significant experience in a respective field, instructors are in the best place to accurately mitigate hazards and navigate complex maintenance issues and tasks. The critical first step in risk management is the ability to identify the applicable risks (Chang & Wang, 2009). With experience comes the knowledge required for staff positions that require proficiency in their respective fields, such as the AMT instructor role.

Larson (2011) focused on a global survey of the education and experience of AMT instructors and noted the lack of standardization and qualifications:

> There are no regulatory or industry standards for civilian aviation maintenance instructors. The global aviation industry is unique in its technology, regulations, and operations. Several respondents indicated receiving educational training as an aviation instructor in the U.S. Air Force. The qualifications for military instructors could be modified for civilian use to elevate and standardize the educational effectiveness of aviation maintenance instructors. (Larson, 2011, p. 96)

The lack of standardization within the civilian aviation environment could be mitigated by potentially adopting a framework similar to that employed by the military.

Title 14 CFR Part 147 School Pass Rates

Summey et al. (2004) focused on the differences between two-year colleges and four-year universities that offered an FAA-approved 14 CFR Part 147 maintenance school curriculum, and the student pass rates on FAA exams. Results indicated that very few schools had below a 100% first-time pass rate, and all three sections of analysis were found not to be statistically significant (Summey et al., 2004). A possible explanation for the results could be the oversight of the FAA. The FAA previously regulated the methods of instruction and approved curriculum for 14 CFR Part 147 maintenance schools; the standards of instruction being uniform, it could have been expected that graduating students would be equally prepared regardless of if graduating from a two-year college or four-year university (Summey et al., 2004). Furthermore, as schools are graded on the first-time pass rates by the FAA, many schools conduct an internal iteration of the examination; a pretest, to ensure the student is ready. In flight training, CFIs may hold students back until they are ready to progress, particularly during the mock-check ride lesson. This principle is unknown in the AMT environment as the training infrastructure is unique to each 14 CFR Part 147 entity.

However, this same standard of instruction with FAA curriculum oversight is no longer present since the 14 CFR Part 147 rule change (H.R.133/Public Law 116-260, sec. 135). Uniformity of minimum instructor experience and qualifications might be vital at this juncture to establish some baseline of standardization. While the demand for AMTs continues to grow (Boeing, 2024), 14 CFR Part 147 maintenance schools decreased from 220 schools in 1993 to 185 in 1999 (McGrath & Waguespack, 1999). Presently, 168 14 CFR Part 147 maintenance schools are registered as ATEC members; however, the total number of 14 CFR Part 147 maintenance schools is currently unknown. However, the need for qualified and experienced AMT instructors remains. Summey et al. (2004) is the only formal assessment of AMT "instruction" to date; there is a lack of research concerning the AMT and 14 CFR Part 147 training. This represents a base-level knowledge of the school pass rates, but a much further refined and finite approach is needed to truly examine the variables that impact student success, particularly those related to AMT instructors.

Recommendations for Increased AMT Instructor Experience

On the maintenance side of aviation, there is a lack of research and understanding concerning AMT training, qualifications, and operational environment. Challenges from FAA regulations for instructor experience and a lack of standards make the 14 CFR Part 147 environment incongruent, enigmatic, and difficult to navigate. The situation is made more amorphous due to a lack of literature concerning 14 CFR Part 147 schools and AMT instructors. Research supports the claim for a correlation between instructor experience and student success; these constructs have been studied and well documented in the flight training domain. Furthermore, FAA policy interpretation and verbiage illustrate the lack of AMT instructor experience and qualifications, demonstrating the need to standardize 14 CFR Part 147 AMT instructor requirements. To improve student outcomes, implementing standardization of instructor experience is critical. One potential option to promote instructor experience is an endorsement similar to the CFI's. The CFI endorsement has been studied in-depth, and its ties to student success have been documented (Polstra, 2012). Within this framework, the need exists to assess AMT instructors' frameworks. An implementation to mandate an Inspection Authorization (IA) endorsement to fulfill the role of an AMT instructor could alleviate the experience need as the IA is one of the only maintenance endorsements that currently requires industry experience to receive. Alternatively, creating an AMT instructor endorsement similar to the CFI would enhance AMT training. Benchmark standards, such as experience and flight hours, are well documented (e.g., Endsley, 1994; Polstra, 2012) and illustrate a standardization of instructor ranking. AMTs do not have tiered endorsements and lack the same standardization, benchmark training, and experience requirements. The mandate for the IA or the creation of the AMT instructor endorsement would enhance training in the 14 CFR Part 147 domain to better the 14 CFR Part 147 community and the future of aviation maintenance personnel. With the critical shortage of AMT personnel within the aviation industry, technically efficient, experienced, and qualified AMT technicians must teach the next generation, the future of AMT professionals; the future success of the aviation industry hinges on how well training is conducted and received.

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