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Challenges Faced by FAA CFR Part 147 Aviation Maintenance Instructors

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There is frequent discussion on the shortage of aviation maintenance technicians, but less frequent is the discussion on the instructors who will train these technicians. Most aviation maintenance technicians are trained at FAA-certified Part 147 Aviation Maintenance Technician Schools (AMTS) at the college or university level. What is less understood are the challenges faced by aviation technician instructors. What are some of the factors that make teaching difficult? How did those challenges change the instructor's approach to their career? The purpose of this study is to identify challenges faced by current aviation maintenance instructors and identify how those challenges affected the instructors' approach to their careers. This study surveyed instructors from FAA Part 147 AMTS on their background, the challenges they face, and their effect on the approach to their careers. The survey was sent to 172 programs with n = 44 respondents. Participants identified COVID, instructor shortage, incoming experience and knowledge of students, and lack of qualified instructors as common issues.

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Introduction

There is a shortage of aviation technicians. Boeing (2023) reports a demand for 690,000 technicians in commercial aviation alone over the next 20 years. While the entire reason for the shortage of aviation maintenance technicians is not completely understood, contributing factors point to an aging population, retirements, perceived benefits, and even qualified individuals who leave for other industries (Wyman, 2017).

A key component receiving less attention is a shortage of instructors needed to train that same workforce. As the population of students rises, so does the need for qualified instructors who also possess knowledge of the evolving industry, can effectively use physical lab spaces, can incorporate online learning environments, and are up-to-date on next-generation aircraft technologies to bring to the classroom. There is a growing and urgent need for qualified FAA Part 147 instructors who can teach the next generation of the aviation workforce. In addition to educational requirements, training aviation technicians at university or collegiate levels requires more than just a post-secondary degree. There are certification requirements and, frequently, industry experience requirements as well. Aviation maintenance technicians are trained under certification from the FAA under CFR Part 147 Aviation Maintenance Technician Schools (AMTS), requiring instructors to have their Airframe and Powerplant Certification. Additionally, if the program is at a college or university with research expectations, faculty may be in a tenure-track position. This means that they must also obtain a Ph.D. and pursue an academic career that includes research (Harl & Johnson, 2006). If research is not of interest to the instructor, this can become a significant barrier to entry. Some situations require instructors in a Part 147 maintenance program to have both a Ph.D. and an airframe and powerplant certificate. This combination of qualifications is not common. According to Motevalli et al. (2017), as of that year, only 490 people met that criterion.

The study data also indicated changes in technology tools being incorporated in maintenance tasks like Augmented and Virtual Reality (Borgen et al., 2021), data analysis from sensor-driven aircraft data systems (Boeing, 2023; Ropp et al., 2021) challenges instructors to stay current with new technologies. Even the expansion of online course delivery components was cited as a significant challenge. While the COVID pandemic that began in earnest in March of 2020 did not start the online education movement, it rapidly expanded its reach and pushed its limits. New technology can be difficult for some instructors to incorporate into classrooms. Before the COVID pandemic, the FAA did not generally allow for distance learning without a waiver, which is dependent on the local Flight Standards District Office (FSDO) to approve, and the FSDO did not always approve virtual instruction. During the pandemic, however, the FAA issued special waivers to allow for both synchronous and asynchronous learning. This forced many instructors to rapidly adapt their curriculum to an online format. For a program to switch from completely in-person to online was a seismic change and one that many instructors were not prepared to make. Questions on how to provide more online instruction in a program that

requires 1900 hours of seat time is one that many instructors are not ready to answer. Recent changes to regulations allowed for the removal of the 1900-hour requirement with a switch to competency-based assessment, but the program still required significant hands-on experience. While core content and skill changes to Part 147 required areas may evolve more slowly, education and training organizations for aviation maintenance must still take evolving teaching and learning tools and professional development needs into account in order to support and retain qualified instructors in the future. Professional development should also include how to integrate curriculum to online and virtual reality technologies in the classroom and assess student performance.

With all the challenges facing instructors in an aviation maintenance program, the purpose of this study was to identify challenges faced by current aviation maintenance instructors and identify how those challenges affected instructors' approach to their careers.

Methodology

This study surveyed instructors of FAA CFR Part 147 programs, asking for their perspectives on the challenges of teaching in an aviation maintenance program. Participants were identified through a download of the Aircraft Maintenance Technician Schools (AMTS) listed on the FAA website (Federal Aviation Administration, 2021). In September 2021, the total number of schools listed was 185. The list included their designator, name, address, and phone number. The list was re-formatted to include only the name to help simplify the spreadsheet list. It was then used to review the web pages of the schools to identify a point of contact.

The contact information was normally from the school's webpage. Once a point of contact or multiple points of contact for an AMTS were found, they were added to the spreadsheet list. From this process, 184 school email addresses were collected. Some schools had multiple points of contact on the list based on the type of contact information listed. Nine AMTS were eliminated because they were high schools or contact information could not be located. The remaining 172 schools were contacted to participate in the survey.

An identical message was sent individually to each contact with a survey link and a brief message describing the survey and its goal. Due to each email being sent individually, the process was done in three batches in November of 2021.

There were 44 responses (n = 44) received between November 2021 and January 2022. Multiple types of data are reported, including demographics, descriptive statistics for Likert data, and qualitative thematic coding for open-text responses.

5P Thematic Framework Assessment

As this was not a typical interview process with the expected narrative response, but instead were short, focused responses, a typical qualitative coding analysis was not appropriate for this study. The responses were categorized according to the 5P framework for further exploration. The 5Ps are a piece of the Six Sigma quality process. The 5Ps are a framework that allows organizations to assess their culture and capacity.

There is inconsistency in the assignment of the different Ps. ISIXSIGMA defines the 5 Ps as purpose, participants, preparation, process, and progress (ISIXSIGMA, 2022). The 5 Ps are also identified as purpose, process, people, platform (tools and technology), and performance (Lewis, n.d.; Rousseau, 2018). Similar 5P models have been used in organizations where Quality Management Systems (QMS), Safety Risk Management, and Safety Management Systems (SMS) components are part of a systematic regulatory requirement of daily tasks, including aviation (U.S. DOT – FAA, 2012) and specifically used as part of education and training aeronautical and piloting risk management tools (FlightStudy, 2021). Other 5P assessment framework methodologies have been validated in organizational Six Sigma applications in manufacturing and the medical industry (Huber, 2006).

For this study, the 5P model used was:

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.
Processes	The sequence of tasks required to perform the duties of the instructor.
Placement	Geographical or physically within a learning organization's campus.
Performance	How well the program or course meets its objectives.

To assess the survey with open-ended/open-answer responses (survey items 13 – 16) with more precision, two researchers independently reviewed the textual responses and analyzed them using the 5P framework. This analysis was completed using one of the built-in tools in Qualtrics, Text iQ. The first researcher reviewed all the responses and reviewed them for alignment with the 5Ps. For instance, one of the questions was, "Please briefly describe a problem or challenge you faced in your career in the last three years." The response was, "Teaching in the last three years has become more demanding and time-consuming. The amount of work required is becoming so great I am concerned future educators will be hard to find. Personal time vs. professional time is way out of balance." This response was coded "People" for alignment with the 5P framework. A second researcher then performed a second review for alignment with the first researcher. Any conflicts were resolved through discussion between the two researchers. This study examines only two of the questions from the instrument beyond demographic information: 1) Describe a problem or challenge you faced in your career in the last three years, and 2) How did that problem or challenge change how you approached your career?

Instrument

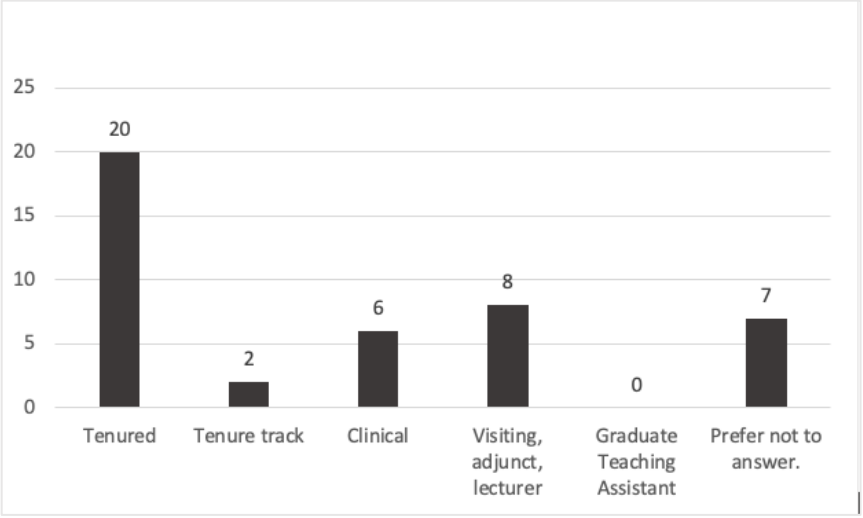
The survey was built and distributed through Qualtrics, see Appendix A. There were three major sections, consisting of 16 questions, to the survey: 1) questions related to the individual and the institution (6 questions), 2) questions related to their interaction with the aviation industry (6 questions), 3) and finally, questions about a recent challenge or problem they have faced in their career (4 questions). In the first two sections, all questions were answered except for a question where the participants were asked to describe their position, which was open text. The final section, questions on a recent problem or challenge, were all open-text responses.

Analysis

Participants

In the first section of the survey, the researchers collected data on the participants and their institutions. Most participants were in tenured positions and had taught for over fifteen years, $n = 20$. See Figure 1 for a breakdown of the positions held. Of the 43 participants who answered, 20 were tenured professors. 41 had an airframe and powerplant certificate, one had a powerplant-only certificate, and the remaining participants preferred not to answer. Forty participants were male. Two participants preferred not to say, and the remaining one did not answer the question.

Figure 1
Position Held by FAA Part 147 Faculty



Thirty-two of the participants had more than 15 years of industry experience, see Figure 2. When it came to the program where they were teaching, most of them were in a two-year program as part of an associate's degree, see Figure 3. Two respondents identified themselves as teaching at a high school program. One clarified in the question of roles that they were an adjunct at a university, but their responsibilities were to teach high school students. The second appears to be an instructor at a high school. Even though high schools were not intended to be part of this study, their responses were kept in the data. Most participants had some background working in the aerospace industry, and most of their backgrounds were in aircraft maintenance or maintenance, repair, and overhaul (MRO).

Figure 2
Teaching and Industry Experience of FAA Part 147 Faculty

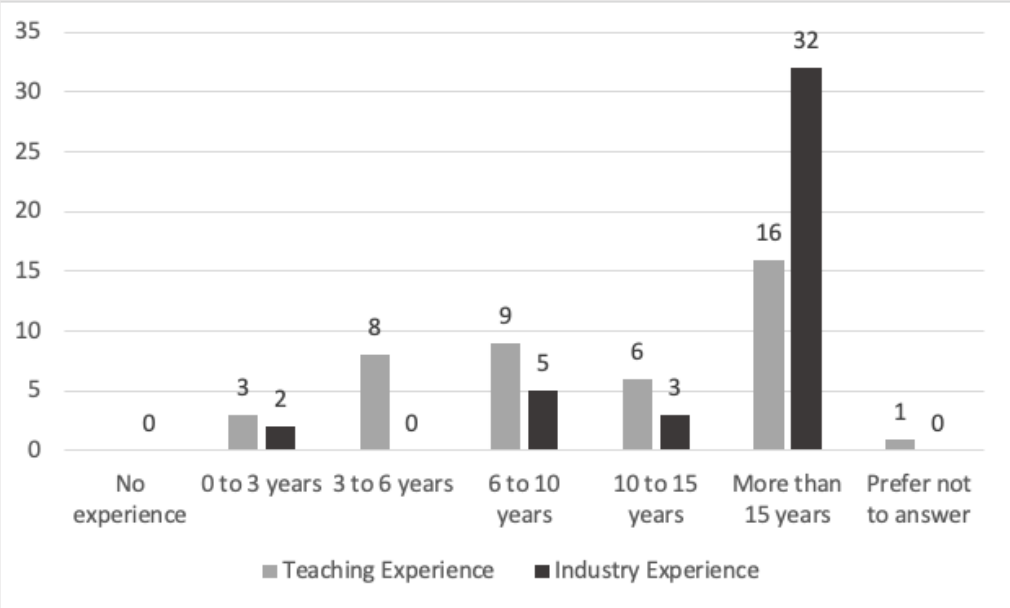
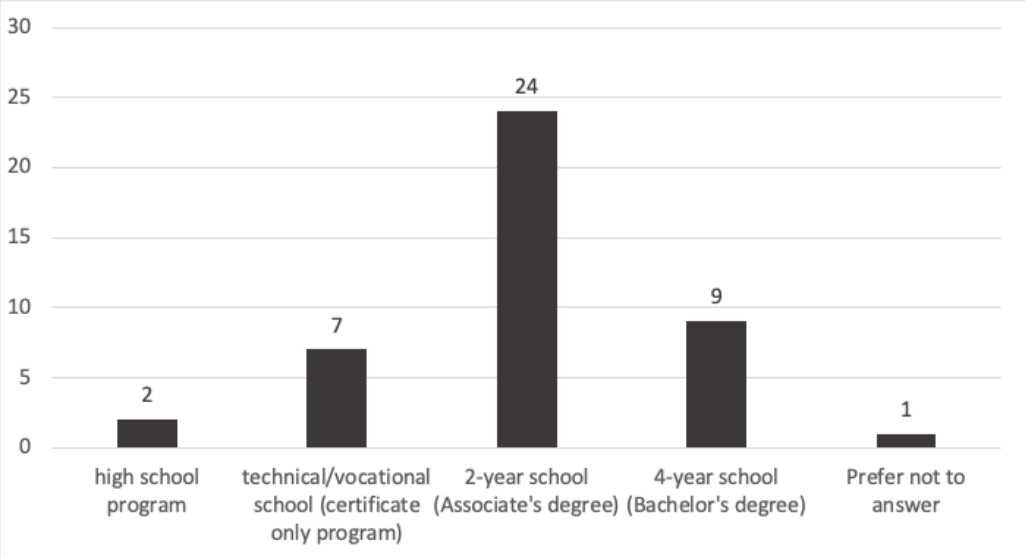


Figure 3
Program Type of the Participants



After the preliminary questions on the participants and their institutions, the survey questioned them on the challenges they faced and how their administration responded. Responses were coded using the 5P model of people, parts, process, placement, and performance using the TextiQ tool in Qualtrics.

Describe a Problem or Challenge You Faced in Your Career in the Last Three Years

Once the responses from the participants were coded using the 5Ps, the data showed that people were the key finding for most of the responses. Figure 4 is an illustration from TextiQ of the 5Ps, how common the responses are, and the tone of the responses, positive or negative. Since the question is asking about a problem or challenge, it is not surprising that the responses were negative overall.

Figure 4
Challenge Responses

The breakdown of responses is detailed in Table 1. There were 34 respondents who answered this question. Each response could be included in more than one category.

Table 1
Challenges responses for each category

Category	Number of Responses
Parts	7
People	24
Performance	14
Placement	5
Processes	13

Respondents identified three major areas as challenges faced in the last three years. Those are the following:

- COVID-19/Online instruction (Process)
- Qualified instructors (People, Performance)
- Student preparedness (People, Performance)

Due to the timeframe of when participants responded, in November 2021, COVID-19 was a common response for a recent challenge they faced. One participant replied that they quit teaching full-time after the spring of 2020: “Teaching A&P online during the initial stage of the pandemic. Retired from full-time instruction prior to the following (Fall) term. Would avoid repeating that experience. Feel terrible for current faculty that have to function in the current COVID environment.” Another participant also discussed their challenging experience with the pandemic.

> Transitioning from lecture/lab-based program delivery to a synchronous online lecture-only course delivery in response to COVID. I only had a few weeks to prepare and had to transition class presentations, tests, and projects to remote delivery. I then had to develop a plan in which the hands-on projects could be done in a compressed format upon returning to in-person classes.

Another issue cited was instructor shortages to meet the needs of the program. Many participants had comments on the ability to find and hire qualified instructors. Multiple respondents specifically mentioned instructor staffing as a challenge.

> "Finding instructors to fill positions when they become vacant. Current teacher pay isn't exactly strong compared to what we can make working in the aviation industry."
> "Short on teachers, having to fill in when necessary."
> “Adequate faculty staffing.”
> “The biggest challenge of the last few years has been finding qualified faculty.”
> “…limited number of availability [*sic*] of qualified AMT professors.”
> “Also, extremely difficult to hire and keep qualified instructional staff.”

Other concerns focused on the preparedness of the students with regard to both expectations and skills. Some students do not realize the composition of the program.

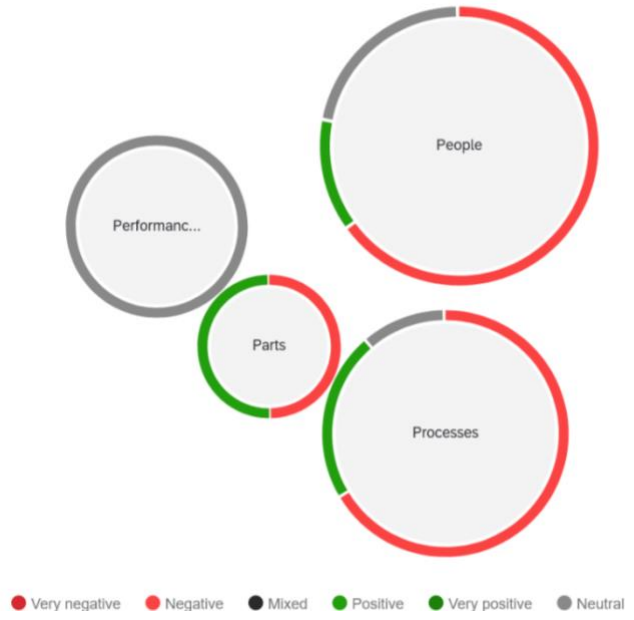
> They come to class understanding that as an A&P, they will make big money from day one. They either are not told or do not understand that they will need to read and take quizzes/tests. They think they will spend their time working on aircraft. I must try to help them learn to study and understand that to be an A&P, they will be reading tech manuals and filling out paperwork.

Students may not have the education strength they need for a collegiate level program, “Mainly incoming students not being properly prepared for higher education. Lack of sufficient math and English skills.” Or they are missing mechanical skills, “Students are less mechanically prepared than in the past (but more electrically capable).” With the increase in international students, communication becomes a greater concern, “The problem that we run into the most is the foreign students that English is their second language. It's very difficult for them, especially in a technical field.”

How Did That Problem or Challenge Change How You Approached Your Career?

This question is a follow-up to the previous question about a challenge the participants faced. After coding responses against the 5Ps, the responses were primarily people and processes. The results of the coding are found in Figure 5. While the responses to the challenge were universally negative, the responses to this question were still primarily negative, but in this case, they included positive responses.

Figure 5
Changes in Career Approach Due to Recent Challenges



The breakdown of responses is detailed in Table 2. There were 33 respondents who answered this question. Each response could be included in more than one category.

Table 2
Response to challenges breakdown by category

Category	Number of Responses
Parts	2
People	23
Performance	8
Placement	0
Processes	18

Overall, respondents focused on two major areas that changed their approach to their careers. Those are the following:

- Incorporation of distance learning (Processes)
- Leave teaching or retire (People)

Considering when this survey was sent to participants, it was not a surprise that many focused on the challenges and recovery from the COVID pandemic. Many instructors found a positive response to the review and adaption of the curriculum. A common response was around the use of technology in the delivery of material. One respondent said, "… their *[sic]* are different opportunities to use technology in the classroom…." Another said, "The curriculum that I taught had to be converted to something appropriate for Canvas and distance learning." "… how curriculum can be presented in multiple formats. I have developed contingency plans for my class if instruction is disrupted again."

Others responded that the changes forced them to adapt or modify outcomes. "As a program, we have learned to adapt *[sic]* and supply needed supplies and equipment…." "It stretches all of our faculty and makes us look for other options to keep classes running." "Have to spend more time teaching basic mechanical skills instead of teaching aircraft-specific skills."

> I decided that instead of constantly fighting with the college over when we would enter grades, I would try to change the program to fit their requirements while still meeting the Part 147 rules. Looked over a sequence of units and determined that I could reorder them to get the desired results of everything fitting into the semester guidelines.

Not all responses were positive. Many found that either they or other instructors in their program left their positions. "Encourages me to retire" was one response. "This problem was significant and nearly caused all the tenured staff to leave the program" was another. "It actually has me looking to retire at the end of this year." Another said, "I questioned my decision to accept this position and questioned my broader career choice."

Discussion

Evolving Challenges in Aviation Education

Educators at the collegiate level face increasing challenges to remaining current and relevant in a changing consumer-focused learning landscape and changing learner needs that follow industry hiring and training practices (Bok, 2020; Crow & Dabars, 2020). Additionally, the aviation industry itself continues to evolve tremendously in technology, as well as demands for a more agile, cross-trained workforce (Garret, 2017; Hedden, 2020). Changes in technologies and processes outpace many traditional educational institutions. While experienced instructors have the competencies, data in this study suggests perhaps there is associated frustration at a perceived lack of being trained and upskilled in new technologies. This frustration could arise in the delivery of instructional material, such as teaching out of online learning management systems. As well as introducing students to new technology, such as electric propulsion. Typically, investment into these areas is required at School/Departmental levels and competes with other capital needs expenditures such as upgrading older facilities or hiring to fill instructor shortages.

Instructor Education Pathway

Instructor shortage is an issue many of the respondents identified, but it is not an easy task to hire more. Aviation maintenance instructors must meet many requirements before they can teach. Because the requirements to be an instructor are so unique and varied, many of the instructors in aviation maintenance programs come from the programs themselves. This means that in addition to training future aviation technicians, which is a challenging process, these programs also have a secondary purpose: to train the next generation of instructors. Johnson (1999) surveyed faculty members of the University Aviation Association (UAA) about their perspective on their program's ability to prepare the next generation of faculty members. While the responses could range from "poor" to "excellent," no respondent ranked their program as excellent. Sixteen percent responded that their program was doing a good job in training the next generation of faculty members. 39% of the respondents said their program was doing average in faculty training. 28% responded with below average 28%. 16% responded poor.

There are multiple challenges in developing aviation maintenance instructors, including professional development, changing technology, and evolving curricula. The need for professional development is not unique to instructors in aviation maintenance training or even all instructors but includes all workers. Professional development could include multiple avenues, including a) maintaining currency in the field, b) faculty renewal, and c) improving instructional techniques (Johnson, 1996).

Future Work

Future work building Part 147 education and training systems that support development and instructor retention can go in many directions. Critical areas would include evaluating advances in:

- Innovation in online course delivery
- Programmatic and instructional delivery methods and professional development of instructors
- Curriculum content

A conversion to online education did not start in the spring of 2020, but it did accelerate it. Aviation maintenance programs have a significant amount of hands-on education that is difficult to convert. In the future, studies could explore the ways activities that have been traditionally seen as restricted to in-person instruction could be modified, possibly to virtual or augmented reality. Rapid changes in technologies both in the aerospace industry and teaching methodologies are challenges for existing instructors.

Additional professional improvement could include online teaching techniques. Knowing that many future instructors are initially trained in a technician program with minimal or no instruction in teaching skills, the curriculum could be revised to include student outcomes focused on teaching and training to better prepare them for a day when they might find themselves in front of a classroom. This extra instruction would need to be in addition to the FAA ACS requirements. The inclusion of teaching techniques could be challenging for programs without much additional space in the curriculum for additional material.

Future work could also include how new teaching techniques could be used to increase flexibility in programs. Can instructors be virtual, with some instructors teaching at multiple locations? Can the sections that must be hands-on be covered by a reduced number of instructors?

Conclusion

With the shortage of aviation technicians, there is a need to increase the number of technicians trained. A consequence of this gap is the need to develop additional instructors to train the new technicians. The purpose of this study is to identify challenges faced by current aviation maintenance instructors, identify ways to improve the academic environment in the future, and encourage new people to become instructors. The instructors surveyed identified multiple major challenges, which include COVID, instructor shortage, incoming experience and knowledge of students, and lack of qualified instructors. Recommendations to address these concerns include further training and professional development for instructors. Training for future instructors could begin during maintenance technician training if schools or programs have the space in their curriculum to include basic instructor knowledge. Additional courses or seminars focused on building a common and higher experience level for incoming students will help bridge the gap between what students know and what they are expected to know.

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Appendix A

A&P Faculty Challenges Survey

Researchers at XXX invite you to participate in this research study.

The title of this study is Assessment of Challenges in Teaching for Instructors/Faculty in Part 147 Airframe and Powerplant education programs. The purpose of this study is to gather your perspectives and challenges teaching in an FAA Part 147 program and other experiences you have had with or in the industry.

Your participation in this study will involve taking an online survey through Qualtrics. First, we'll ask you a few questions about yourself, your certifications, the areas you teach in, your professional background, and the area in which you teach. You will then be asked to complete a 12-question survey about your experiences teaching within your program. The estimated time to take the survey is approximately 20 minutes.

The risks to you as a participant are minimal. This survey is designed to be anonymous, but there is a slight risk of loss of anonymity. This risk is minimized by designing the survey in a way in which no identifiable information will be collected. The researchers have taken additional data security measures, minimizing the chance of personally identifiable information being disclosed. This includes ensuring the online survey has been developed to make responses anonymous and password protection to the survey results available only to the researcher.

The results of this study may be published in scientific research journals or presented at professional conferences. However, your name and identity will not be revealed, and your record will remain anonymous.

Participation in this study may help develop and improve approaches to preparing and mentoring existing aviation educators. Additional benefits may come from the assistance in equipping and hiring future educators as well.

You can choose not to participate. If you decide not to participate, there will not be a penalty to you or loss of any benefits to which you are otherwise entitled. You may withdraw from this study at any time.

If you have questions or wish to withdraw from this study, call XXXXX.

Reference IRB-2021-1320.

These questions are related to you and your institution**.**

1. What is your current rank?
   - ○ Tenured
   - ○ Tenure track
   - ○ Clinical
   - ○ Visiting, adjunct, lecturer
   - ○ Graduate Teaching Assistant
   - ○ Prefer not to answer.
2. How long have you been teaching in a Part 147 A&P program?
   - ○ 0 to 3 years.
   - ○ 3 to 6 years.
   - ○ 6 to 10 years.
   - ○ 10 to 15 years.
   - ○ More than 15 years.
   - ○ Prefer not to answer.
3. Which certification do you have?
   - ○ Airframe only.
   - ○ Powerplant only.
   - ○ Airframe and Powerplant.
   - ○ Neither.
   - ○ Prefer not to answer.
4. Please describe your position, including the most important characteristics of your job.
5. What is your gender identity?
   - ○ Male
   - ○ Female

- ○ Non-binary/third gender
- ○ Prefer not to say

6. Is your Part 147 program part of a:
   - ○ High school program.
   - ○ Technical/vocational school (certificate only program).
   - ○ 2-year school (Associate's degree).
   - ○ 4-year school (Bachelor's degree).
   - ○ Prefer not to answer.

The following questions are related to your interaction with the aviation industry.

7. How many years of industry experience do you have?
   - ○ No industry experience.
   - ○ 0 to 3 years.
   - ○ 3 to 6 years.
   - ○ 6 to 10 years.
   - ○ 10 to 15 years.
   - ○ More than 15 years.
   - ○ Prefer not to answer.

8. If you have industry experience, which best describes your primary prior area of professional experience?
   - ○ Aircraft maintenance/MRO
   - ○ Pilot (Airline, Corporate)
   - ○ Airline Operations (Revenue management, planning, etc.)
   - ○ Commercial Manufacturing
   - ○ Military Manufacturing
   - ○ Aircraft finance/leasing/acquisition
   - ○ Government/Regulatory

- ○ Air Traffic Control
- ○ Training
- ○ Airport Operations
- ○ Commercial Space
- ○ NASA
- ○ Military
- ○ Other _____
- ○ Prefer not to answer.

9. Do you currently connect with the industry as part of your class? Examples could be coordinating student projects, company site visits/tours, special speakers in class, or internships.

- ○ Yes
- ○ No
- ○ Prefer not to answer.

10. Do you concurrently connect with the industry doing consulting, technical assistance, or research?

- ○ Yes
- ○ No
- ○ Prefer not to answer.

11. Please indicate your level of agreement to the following statement.

The institution in which I teach, I am encouraged to stay updated on current industry advances and trends.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

12. Please indicate your level of agreement to the following statement.

At the institution in which I teach, I am provided time and funding for continuing education and learning.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Prefer not to answer.

Please answer the following questions about a recent experience you have faced in your career.

13. Please briefly describe a problem or challenge you faced in your career in the last three years.

14. How did that problem or challenge change how you approached your career?

15. What did your administration do that was helpful / not helpful in this situation?

16. What would have made this problem easier for you to manage?