Bridging the Gaps in Aviation Maintenance Education

Identifying Workforce Needs and Opportunities

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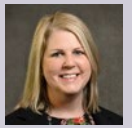

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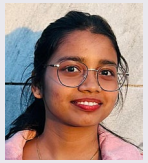

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Project Overview

- A big challenge facing aviation maintenance industry is keeping pace with current in-service aircraft technologies and future advanced technology aircraft (ATA)
- The competencies outlined in the Aviation Mechanic General, Airframe and Powerplant Airman Certification Standards (FAA-S-ACS-1)* do not fully align with the demands and needs of maintaining ATA, potentially affecting safety and limiting industry progress
- This study explored how well the current ACS standards prepare technicians to maintain both existing and ATA

*FAA-S-ACS will be referred to as ACS throughout this presentation

Objectives

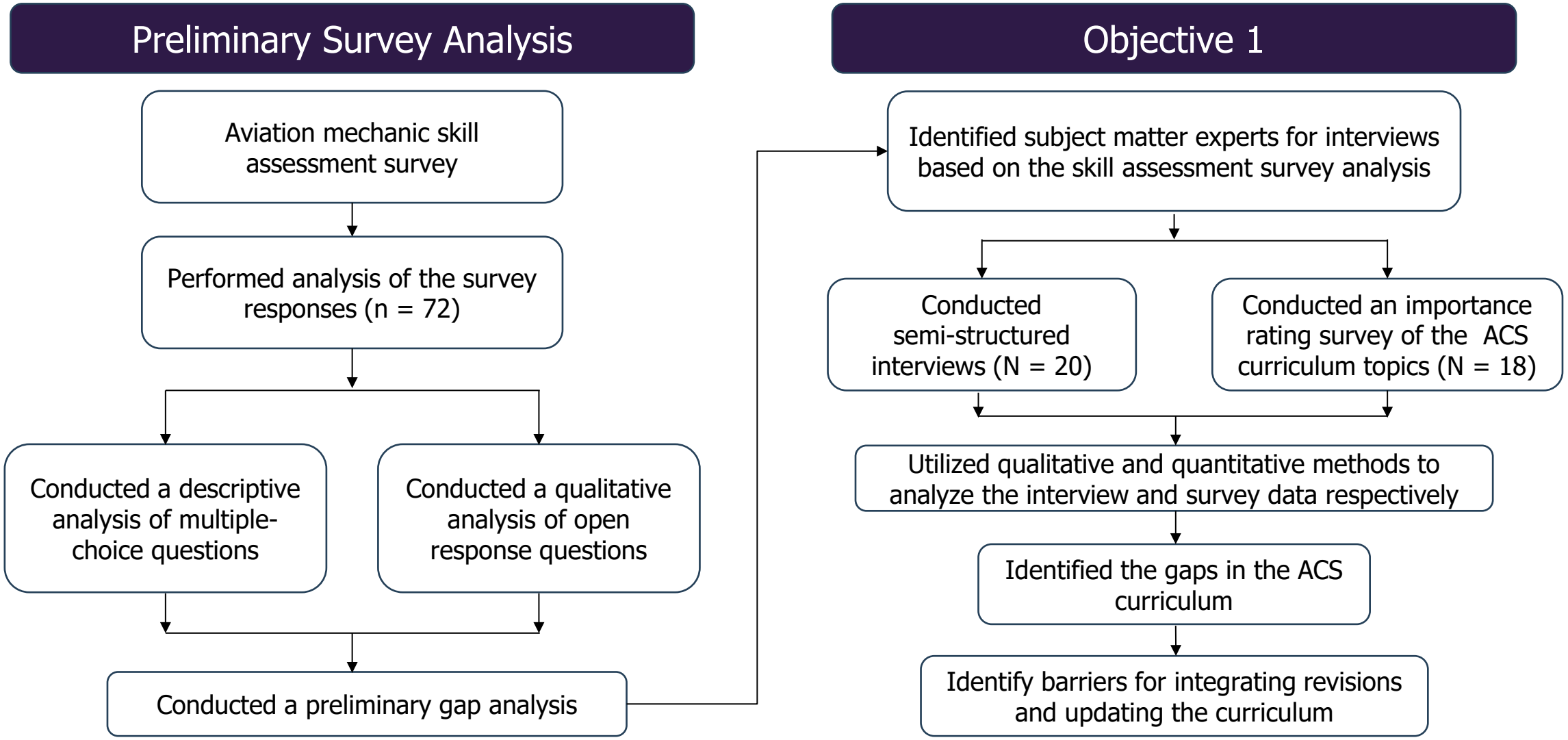
- **Objective 1:** Identify current state of curriculum and workforce requirements to conduct a gap analysis
  - Conduct a review of the aviation mechanic ACS to identify gaps between current standards and the required competencies for aviation maintenance professionals

- **Objective 2:** Identify future aviation technical education needs and workforce requirements to identify areas for revision in the existing ACS curriculum
  - Analyze future workforce and technical education needs by examining emerging trends in aviation, focusing on new ATA maintenance requirements to provide recommendations for improvement to the ACS curriculum

Research Questions

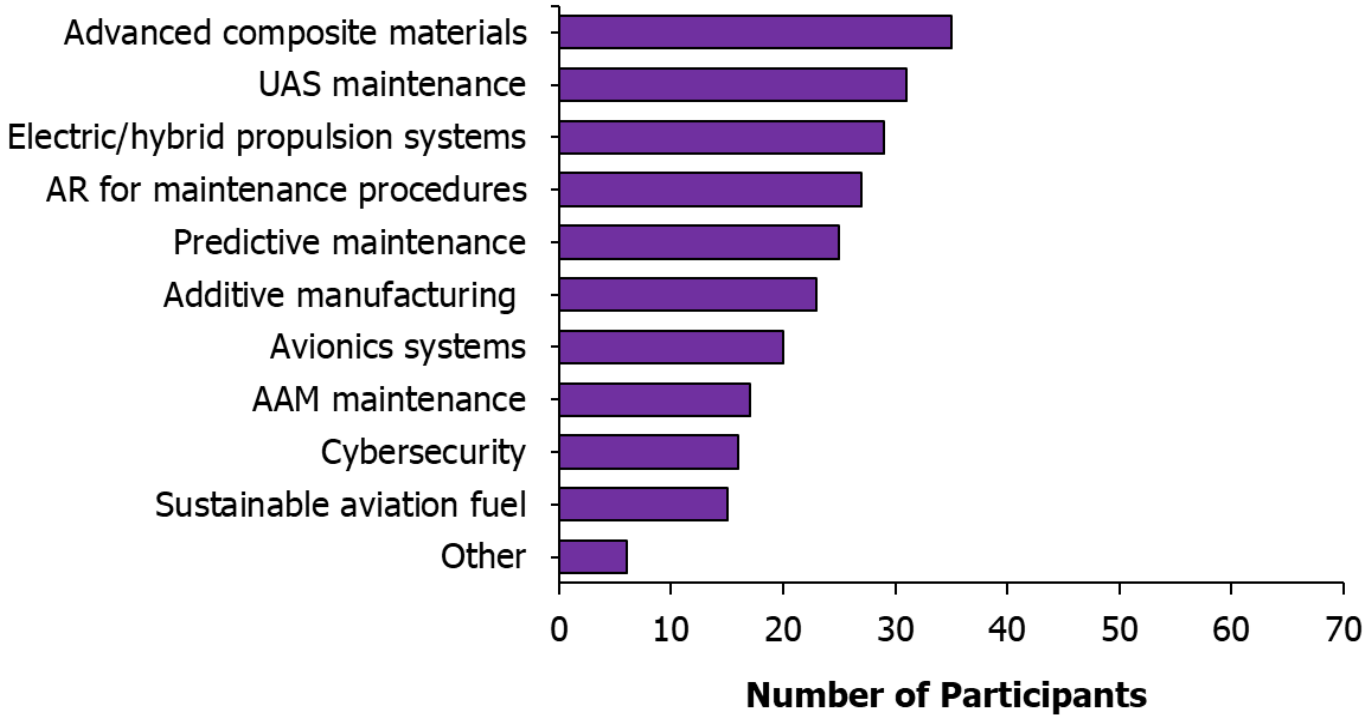
1. Which topics in the current ACS are outdated and should be revised?
2. Which topics need to be added to the ACS to align with the knowledge and skills needed for maintaining existing and future aircraft?
3. What competencies are required to maintain current in-service and emerging aircraft technologies that are not adequately addressed in the current ACS standards?
4. How can educational institutions currently adapt their curricula, instructional strategies, and training technologies to address gaps related to emerging aviation technologies?

Methods


Preliminary Survey Analysis
Aviation mechanic skill assessment survey
Performed analysis of the survey responses (n = 72)
Conducted a descriptive analysis of multiple-choice questions
Conducted a qualitative analysis of open response questions
Conducted a preliminary gap analysis
Objective 1
Identified subject matter experts for interviews based on the skill assessment survey analysis
Conducted semi-structured interviews (N = 20)
Conducted an importance rating survey of the ACS curriculum topics (N = 18)
Utilized qualitative and quantitative methods to analyze the interview and survey data respectively
Identified the gaps in the ACS curriculum
Identify barriers for integrating revisions and updating the curriculum

Findings from Preliminary Survey

- The ACS curriculum needs an update to reflect the technologies technicians encounter, particularly in digital avionics, electric propulsion, composite materials
- There is a growing gap between industry skills needs and the current ACS standards, leading to misalignment in workforce readiness
- Key challenges include limited access to modern equipment and OEM manuals, high training costs, and the need for updated safety procedures for new technologies

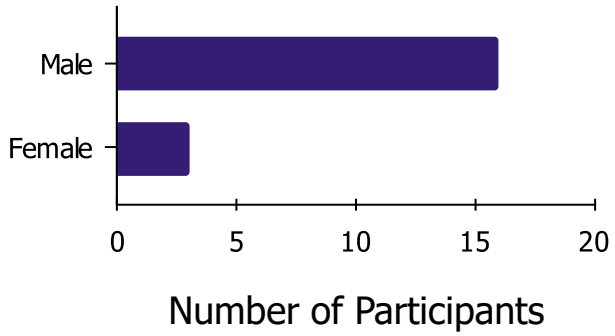


New technologies encountered not included in training

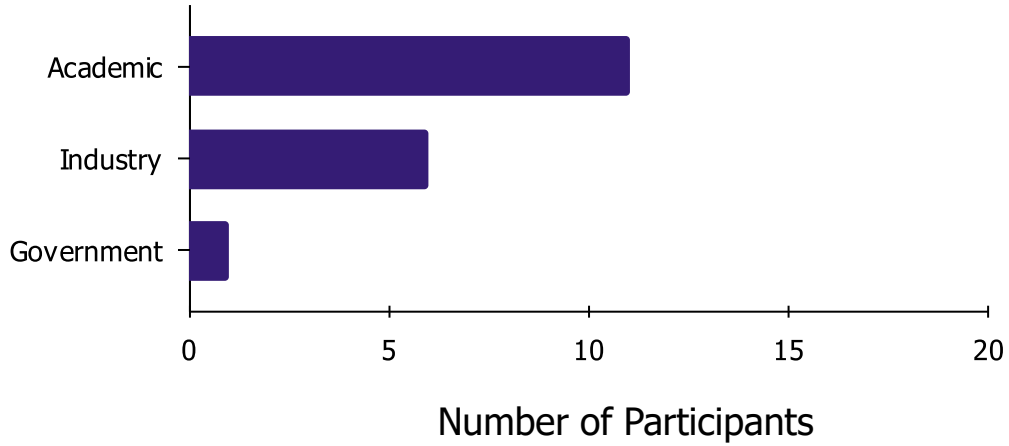
Analysis of the Preliminary Survey Responses (n = 72)

Demographics

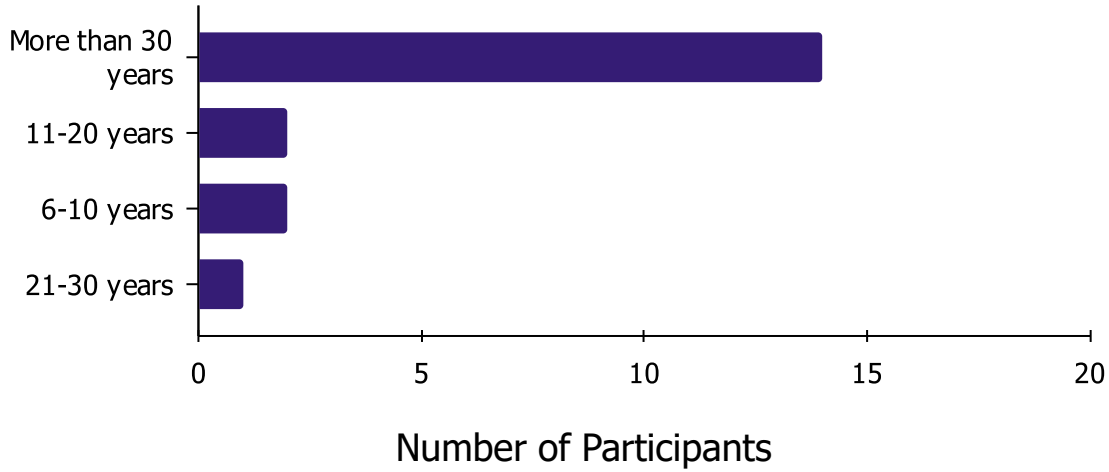
Gender Distribution



Professional Role



Years of Experience



Demographics of Objective 1 Interview Participants (N = 20)

RQ1: Are there any specific topics within the ACS curriculum (general, airframe, powerplant) that you find are no longer relevant for today's aviation maintenance technicians?

ACS Areas Considered Outdated for AMTs

Specific topics that were recommended for removal include:

- **Dope and Fabric (60%), and Wood Structures (50%):** The process of covering aircraft structures with fabric and protective coatings was cited as outdated most frequently, followed by the construction and repair of wood structures. Participants mentioned that the amount of curriculum time dedicated to these topics is excessive
- **Older Reciprocating and Radial Engines (40%):** While piston engines are still in use, participants noted an overemphasis on older engines. They suggest reducing the time spent on these engines to make room for newer turbine engines and other propulsion systems
- **Welding (25%):** Extensive training in welding is less relevant and necessary for the average entry-level technician compared to other modern skills
- **Purely Analog Systems (15%):** There is a strong industry focus on digital systems, hence topics focused on analog components, and their troubleshooting is becoming less relevant

ACS Curriculum Topics Receiving a Mode Score of 3 or lower*

Importance Rating Survey findings - General section topics:

- Electrical laws and theory - Faraday's Law (AM.I.A.K.7.d)
- Electrical laws and theory - Right-hand rule (AM.I.A.K.7.f)
- Resistor types and color coding (AM.I.A.K.20)
- Service an aircraft battery (AM.I.A.S.6)
- Fabricate a flexible hose (AM.I.D.S.7)
- Fabricate a flareless-fitting-tube connection (AM.I.D.S.8)
- Heat treatment and metal working processes (AM.I.E.K.2)
- Procedures for weld repairs (AM.I.E.K.14)
- Fabricate a cable assembly using a swaged-end fitting (AM.I.E.S.9)
- Areas of various geometrical shapes (AM.I.H.K.1)
- Definitions, descriptions and use of geometrical terms (AM.I.H.K.3)
- Scientific (exponential) notation, decimal notation, fractional notation (AM.I.H.K.8)
- Powers and special notations (AM.I.H.K.10)
- Compute the area of a wing (AM.I.H.S.3)
- Calculate the volume of a shape, such as a baggage compartment (AM.I.H.S.4)
- Compute compression ratio (AM.I.H.S.7)
- Determine density altitude (AM.I.J.S.2)
- Determine pressure altitude (AM.I.J.S.3)
- Design an inclined plane on paper, indicating the mechanical advantage (AM.I.J.S.6)

* Importance rating of 3 (the topic is nice to have but not necessary) or lower indicates topics were less important

ACS Curriculum Topics Receiving a Mode Score of 3 or lower*

Importance Rating Survey findings - Airframe section topics:

- Heat treatment processes for aluminum (AM.II.A.K.6)
- Flame welding gases (AM.II.A.K.10)
- Flame welding practices and techniques (AM.II.A.K.12)
- Inert-gas welding practices and techniques (AM.II.A.K.13)
- Wood structures, including inspection techniques, tools, and practices for wood structures (AM.II.B.K.1)
- Effects of moisture/humidity on wood and fabric coverings (AM.II.B.K.2)
- Types and general characteristics of wood used in aircraft structures (AM.II.B.K.3)
- Permissible substitutes and other materials used in the construction and repair of wood (AM.II.B.K.4)
- Acceptable and unacceptable wood defects (AM.II.B.K.5)
- Wood repair techniques and practices (AM.II.B.K.6)
- Factors used in determining the proper type covering material(AM.II.B.K.7)
- Types of approved aircraft covering material (AM.II.B.K.8)
- Seams commonly used with aircraft covering(AM.II.B.K.9)
- Covering textile terms (AM.II.B.K.10)
- Structure surface preparation (AM.II.B.K.11)
- Covering methods commonly used (AM.II.B.K.12)
- Covering means of attachment (AM.II.B.K.13)
- Aircraft covering preservation/restoration (AM.II.B.K.15)
- Covering repair techniques and practices (AM.II.B.K.17)
- Locate tire storage practices (AM.II.E.S.14)
- Install range marks on an instrument glass (AM.II.H.S.3)
- Determine barometric pressure using an altimeter (AM.II.H.S.4)
- Adjust gyro/instrument air pressure/vacuum (AM.II.H.S.11)
- Automatic direction finder (ADF) (AM.II.I.K.8)
- Distance measuring equipment (DME) theory, components, and operation (AM.II.I.K.10)

* Importance rating of 3 (the topic is nice to have but not necessary) or lower indicates topics were less important

ACS Curriculum Topics Receiving a Mode Score of 3 or lower*

Importance Rating Survey findings - Powerplant section topics:

- Radial engine construction and internal components (AM.III.A.K.5)
- Storage and preservation (AM.III.B.K.9)
- The purpose and procedure for paralleling a dual-generator electrical system (AM.III.F.K.8)
- Fabricate a bonding jumper (AM.III.F.S.13)
- Perform oil pressure adjustment (AM.III.G.S.7)
- Remove and install a carburetor main metering jet (AM.III.I.S.5)
- Chemicals used in liquid cooling systems (AM.III.J.R.4)

* Importance rating of 3 (the topic is nice to have but not necessary) or lower indicates topics were less important

RQ2: Which topics need to be added to the ACS to align with the knowledge and skills needed for maintaining existing and future aircraft?

Topics That Need to be Added to The ACS Curriculum

- **Specific topics that were recommended for addition to the ACS include:**
  - **Digital Avionics & Electrical Systems (80%):** Foundational knowledge of modern digital systems, cockpit avionics, fly-by-wire controls, and advanced electronics principles
  - **Electric Propulsion (60%):** Electric and hybrid-electric propulsion technologies
  - **Unmanned Aerial Systems (UAS) (60%):** Unmanned Aircraft Systems (UAS) and autonomous flight topics
  - **Modern Structures & Materials (50%):** Advanced composite materials and additive manufacturing techniques
  - **Human Factors and Safety Management Systems (50%):** Human Factors, risk assessment, procedural compliance, and the principles of a safety management system
  - **IT, Software, & Data Systems (50%):** IT fundamentals, diagnostics software, the use of Artificial Intelligence (AI) for diagnostics, and modern electronic record-keeping procedures
  - **Modern Aircraft Systems (25%):** Systems of Large Transport-Category Aircraft, modern jet engines, advanced safety systems, and modern inspection programs

RQ3: What competencies are required to maintain current in-service and emerging aircraft technologies that are not adequately addressed in the current FAA ACS standards?

Competencies Required to Maintain Current and Newer Aircraft

	Required Competency
Digital Avionics	Ability to troubleshoot integrated digital and electronic systems
	Ability to perform software-based diagnostics and fault diagnostics
	Ability to read sensor and telemetry data to facilitate data communication
	Ability to perform firmware updates and verification
Electric Propulsion	Ability to perform inspection and repair of electric propulsion components
	Ability to perform maintenance and diagnostics of electric motors, batteries, and high-voltage systems
	Ability to integrate electric/hybrid propulsion systems with other aircraft components
	Ability to troubleshoot and repair aircraft control systems
Human Factors	Ability to perform on-the-job risk assessments and make decisions
	Ability to follow procedural compliance requirements
	Ability to operate within the recommended limits of a Safety Management System (SMS)

Competencies Required to Maintain Current and Newer Aircraft

	Required Competency
Modern Structures & Materials	Ability to perform aircraft structural inspections, and perform non-destructive testing (e.g., tap testing)
	Ability to perform structural repair of advanced composite structures
	Ability to maintain and troubleshoot systems specific to large transport-category aircraft

RQ4: How can educational institutions currently adapt their curricula, instructional strategies, and training technologies to address gaps related to emerging aviation technologies and industry needs?

Strategies for Aligning Curriculum with Industry Needs and Technological Advancements

- **Following are the strategies mentioned by participants:**
  - Partner with industries to ensure students get access to latest equipment and knowledge of industry procedures
  - Introduce micro-credentials, specialized certifications and add-on certifications to enable students to gain expertise in modern ATA technologies and procedures
  - Collaborate with other technical departments within the institute to promote knowledge acquisition of other domains (e.g. electrical engineering, information technology)
  - Overcome intellectual property and data access barriers by partnering with aircraft manufacturers
  - Prioritize development of soft skills and human factors skills to ensure students are ready to work in the industry
  - Standardize instructor training and development to ensure similar training procedures are followed and available to the students

Key Takeaways

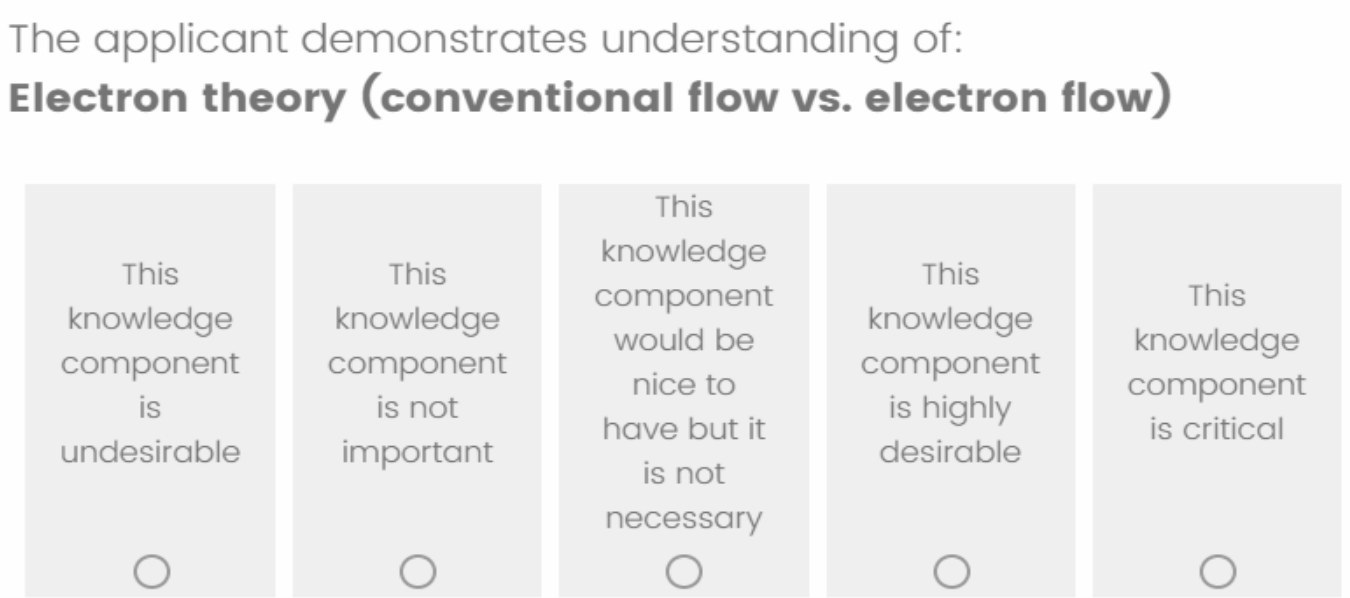
- **Curriculum Gaps:** The curriculum gaps identified in this study need to be bridged to ensure AMTs graduating from part 147 schools are equipped to maintain ATA on the job
- **Outdated Topics:** Outdated topics identified in the ACS need to be removed or updated to ensure students are learning advanced maintenance procedures required to maintain aircraft used in the industry
- **New Topics for Addition:** Recommended additions shows that the curriculum must be modernized to align training with the technologies currently used in the industry
- **Missing Key Competencies:** The absence of the identified competencies especially in Digital Avionics, Electric Propulsion, and Safety Management Systems creates a training gap, limiting the development of well-rounded technicians
- **Adaptation Strategies:** To maintain a relevant, up-to-date curriculum, adaptive strategies must be implemented to ensure that the workforce is well-trained


Questions

Appendix A

- The Importance Rating Survey of the Airman Certification Standards (ACS) was organized into three main sections: General, Airframe, and Powerplant. Each section was further divided into specific subjects based on the ACS curriculum. All participants were required to complete all three surveys; however, they could choose which subjects to rate based on their area of expertise and knowledge

The scale for the rating was a below:
1- The component is undesirable
2- The component is not important
3- The component would be nice to have but it is not necessary
4- The component is highly desirable
5- The component is critical



Thank You