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Perceptions of the Inclusion of Electric Propulsion Curriculum in Collegiate Aviation Maintenance Programs by Faculty and Industry Professionals

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The aerospace industry is currently in a phase of rapid change with the development of new technologies such as electric and hydrogen propulsion, fully electric aircraft, artificial intelligence, and uncrewed flight. Educators in collegiate programs may face challenges incorporating new propulsion technologies into their classes. There are standards developed and issued by professional organizations such as IEEE and ASTM that may be used to facilitate the transition from petroleum-based aircraft propulsion to include electric propulsion in course materials. This paper seeks 1) to increase the understanding of the challenges that faculty and industry professionals face when they are seeking to incorporate electric propulsion into their courses and curricula, and 2) to increase the understanding of which standards faculty and industry professionals are aware of and how those standards are used in developing curricula. This exploratory study identifies the major challenges, the standards used, and the potential gaps in understanding the use of standards in learning materials.

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Introduction

The rapid development of new technologies in aerospace is driving rapid changes and challenges for aviation schools in providing relevant curricula. Many of these changes are driven by the growing push to develop alternative power systems to meet evolving environmental and sustainability needs, such as electric propulsion (Lisovin et al., 2023). In 2022, the aviation industry contributed 2% to global carbon monoxide emissions and could triple by 2050 (European Commission, n.d.). In 2021, the International Air Transport Association (IATA) committed to achieving net-zero aviation emissions by 2050 (International Air Transport Association, n.d.), in line with the International Civil Aviation Organization (ICAO) goals. This goal is consistent with the US Department of Energy's Sustainable Aviation Fuel Grand Challenge. IATA expects 13% of the emissions reduction to be obtained through new technologies, including electric and hydrogen power (International Air Transport Association, n.d.).

Hybrid electric power systems are one viable solution for more energy-efficient propulsion systems that exploit "the synergy with distributed propulsion configurations" (Sliwinsky et al., 2017, p. 1407). Hybrid propulsion systems offer reduced noise and emissions, with additional benefits including increased reliability, improved power distribution, and extended flight range (Rendon et al., 2021). A stable, comprehensive maintenance program, including new technologies, grounded in national qualifications and regulatory compliance, is critical to the needs of graduates (Gauthama, et al., 2025; Yother & Ha, 2024). Therefore, it is imperative that collegiate aviation education programs begin now to plan for and incorporate new propulsion systems technologies into classes and laboratories. This paper presents an exploratory study of collegiate faculty to better understand the primary challenges they face in incorporating electric propulsion into existing curricula, the industry standards they are aware of, and how these standards are used to develop curricula.

Literature Review

Electric Propulsion Uses in Aviation

There are multiple manufacturers developing electric or electric-hybrid aircraft such as the Extra 330EL, Airbus E-fan, Pipistrel Alpha Electro, Archer Midnight, and Joby Aviation (Archer, n.d.; Joby Aviation, n.d.; Peciak & Sharka, 2021). Each of these aircraft is on a different timeline for anticipated entry into the market. The Federal Aviation Administration (FAA) is developing new airworthiness certification requirements on a case-by-case basis. Joby Aviation completed stage three of the FAA type certification process and final airworthiness criteria in March 2024 (Federal Aviation Administration, 2024a; Joby Aviation, n.d.). The FAA issued the special airworthiness requirements for Joby in Docket No. FAA-2021-0638 pulling from multiple airworthiness standards, including normal category rotorcraft, transport category airplanes, normal category airplanes, propellers, engines, manned free balloons, and transport category rotorcraft (Federal Aviation Administration, 2024a). The Archer Midnight received its final FAA certification (Weitering, 2024). Both Joby Aviation and Archer hope to begin commercial operations by 2025 (Hirschberg, 2023; Treisman, 2023).

The general steps for completing the FAA certification process are a review of the design, review of the results of ground and flight tests, review of maintenance and operational suitability, and collaboration with other civil authorities (Federal Aviation Administration, 2025b). However, since the FAA does not have certification authority for electric aircraft, it is currently using multiple sources to develop airworthiness standards for them. The FAA is working with the European Union Aviation Safety Agency (EASA) and has developed common criteria for eVTOL certification (Federal Aviation Administration, 2024b). In the fall of 2024, Advisory Circular, AC 21.17-4, Type Certification – Powered Lift, was still open for public comment, though the FAA is no longer accepting comments (Federal Aviation Administration, 2024c). The FAA previously accepted 30 published ASTM International standards as the means of compliance (MOC) for manufacturers to use to obtain certification for Part 23 small aircraft (AVweb, 2019).

Industry Standards for Electric Propulsion

The use of standards in any industry is vital to its success because they enable a common understanding of terminology and processes. The development and use of standards means, for instance, that when something is referenced as being "high voltage," there is agreement that high voltage is over 60VDC (International Electrotechnical Commission, 2005; SAE International, 2022).

There are industry-developed consensus standards that support electric propulsion in aviation and across the aerospace industry. A sample of those industry standards is listed in Table 1. This table is not an exhaustive list of all industry standards related to electric propulsion in aviation. Other standards not included are those that are not specific to electric propulsion but are generally applicable to aviation or propulsion, such as ASTM F3065 Specification for Aircraft Propeller System Installation or SAE AS7974 Cable Assemblies and Attachable Plugs, External Electrical Power, Aircraft, General Specification.

Table 1

Sample of Industry Standards in Aerospace

Standard Number	Standard Title
AIAA G-136-2022	Guide to Lithium Battery Safety for Space Applications
ANSI/AIAA G-095A-2017	Guide to Safety of Hydrogen and Hydrogen Systems
ASTM F2840	Standard Practice for Design and Manufacturer of Electric Propulsion Units for Light Sport Aircraft
ASTM F3239	Standard Specification for Aircraft Electric Propulsion Systems
ASTM F3316	Standard Specification for Electrical Systems for Aircraft with Electric or Hybrid-Electric Propulsion
ASTM F3338	Standard Specification for Design of Electric Propulsion Units for General Aviation Aircraft

Standard Number	Standard Title
ASTM F3547	Standard Specification for Fuel Cell Power Systems for Use in Small Unmanned Aircraft Systems (sUAS)
BS EN 16603-35-1	Space Engineering. Liquid and Electric Propulsion for Spacecraft
ECSS-E-ST-35-01C	Liquid and Electric Propulsion for Spacecraft
EASA SC-22.2014-01	Installation of Electric Propulsion Units in Powered Sailplanes
FAA AC 20-184	Guidance on Testing and Installation of Rechargeable Lithium Battery and Battery Systems on Aircraft
FAA-2023-1275	Integration of Powered-Lift: Pilot Certification and Operations (Notice of Proposed Rulemaking)
FAA-2024-1586 (AC 21.17-4)	Type Certification of Powered-lift (Draft Advisory Circular)
IEEE P1937.17	Standard Specification for Lithium Ion Cells and Batteries Used in Unmanned Aircraft Systems (UAS)
SAE AIR8678	Architecture Examples for Electrified Propulsion Aircraft (Information Report)
SAE ARP7131	Verification Process for Thermal Runaway Mitigation in Large Electrical Energy Storage Powertrain Systems in Normal Category Aircraft and Rotorcraft
SAE ARP8676	Nomenclature and Definitions for Electrified Propulsion Aircraft (Recommended Practice)
SAE J1715	Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology
SAE J3235	Best Practices for Storage of Lithium-Ion Batteries

Research Questions

The purpose of this study is to investigate the presence of electric propulsion and industry standards in aviation programs. The two research questions (RQ) of this study are:

RQ1: What are the primary challenges faculty face in incorporating electric propulsion in the existing curriculum?

RQ2: What industry standards are respondents aware of?

Methodology

Background and Method

This study surveyed the population of people in academia, industry, or government with experience in electric propulsion in aviation. Research on human subjects was approved on September 22, 2023, IRB protocol number IRB-2023-180.

The survey included eleven questions developed by the co-principal investigators. The electronic survey included logic based on participants' responses to the first survey question. Participants were not asked to answer all eleven questions. Participants who indicated they were from academic programs answered six questions. Participants who answered that they were from the industry answered five questions.

Survey questions were evaluated using two methods, depending on the question type. Questions with answers provided were evaluated using descriptive statistics only. Questions with short, open answers were analyzed using qualitative coding (SQ4, SQ5, SQ10, SQ11). The researchers used a 5Ps framework to code participants' responses. The 5Ps the researchers used are purpose, people, parts, processes, and performance as a technique inspired by another 5P framework (SAE International, 2022).

Participants and Sample Size

Participants of this study are faculty members and industry professionals in aviation who responded to recruitment emails from members of aviation conferences and organizations. The total number of respondents for this study is n = 35. This respondent size is not surprising, as the results show that few programs sought to incorporate electric propulsion at the time. Qualitative studies typically have smaller sample sizes than their quantitative counterparts. Adequate sample sizes for qualitative studies are determined when the data reaches informational redundancy or saturation. Saturation, originally developed by Glaser and Strauss (1967) is the point at which there is enough data to reach an "in-depth understanding" (Creswell & Plano Clark, 2018, p. 176), or "the point at which gathering more data about a theoretical construct reveals no new properties, nor yields any further theoretical insights." (Charmaz & Bryant, 2010, p. 611). There is no minimum sample size, and saturation can be reached with as few as six participants (Guest et al., 2006). The researchers believe that, after reviewing the data from their sample of 35, they have reached data saturation for the current study. As technology becomes more widely used in industry, researchers anticipate that greater adoption may increase awareness of standards and their use by faculty and industry professionals.

Instrument Development and Data Collection

The survey was developed using the industry and academic experience of the co-principal investigators. The instrument included eleven survey questions (SQ) and was administered through QualtricsXM®.

No participant was asked to answer all eleven questions. Depending on the respondent's answer to SQ1, "What is your current position?", the survey's logic would skip certain questions. Participants could choose a response for SQ1 from academia, industry, or government.

Participants who answered "academia" to SQ1 would only answer questions SQ2, SQ3, SQ4, SQ5, SQ6, and SQ7.

SQ2 What kind of program?
SQ3 Are you currently developing a curriculum for electric propulsion?

SQ4 What are the challenges you are facing?
SQ5 What have you learned that you would like to share?
SQ6 Are there other technologies that you are planning on incorporating into your program?
SQ7 Which standards, if any, are you aware of?

Participants who answered "industry" or "government" to SQ1 would only answer questions SQ7, SQ8, SQ9, SQ10, and SQ11. For all respondents, the last question asked was SQ7. Only SQ7 included responses from both academia and industry.

SQ8 Which sector of the industry or government do you work?
SQ9 How soon do you think it will be important to have aviation technicians with knowledge of electric propulsion?
SQ10 What do you think are the greatest challenge(s) for training for electric propulsion technicians?
SQ11 How do you think industry or government could help in electric propulsion technicians?
SQ7 Which standards, if any, are you aware of?

Analysis

The analysis for this study uses both quantitative and qualitative methods. Quantitative methods are suitable for questions such as where they teach or their awareness of industry standards. For other questions with short, focused responses, a qualitative method is more appropriate.

Where a qualitative method is indicated (SQ4, SQ5, SQ10, SQ11), responses were coded and categorized using a Six Sigma quality process as the framework, the 5Ps (SAE International, 2022). The assignment of the 5Ps is inconsistent in the literature. This study does not intend to review all uses and configurations of the 5Ps, but rather to highlight some of the more common assignments of the 5Ps.

The 5Ps, according to ISIXSIGMA, a Six Sigma quality resource, in some management situations are purpose, participants, preparation, process, and progress (Feldman, 2024). Other management applications use purpose, principles, processes, people, and performance (Pryor et al., 2020). In manufacturing applications, common uses are purpose, process, people, platform (tools and technology), and performance (Lewis, n.d.; Rousseau, 2018). Other industries, such as healthcare, have adopted similar frameworks. One study assigns the 5Ps as purpose, patients, professionals, processes, and patterns (Huber, 2006). The 5Ps were applied in the aerospace industry across both industry and academic settings. Pilots used a variation of the 5Ps as part of their single-pilot resource management (SRM) process, where the 5Ps were plane, plan, pilot, passengers, and programming (Federal Aviation Administration, 2023). The 5Ps were used as a framework in aviation maintenance faculty research (Yother & Ropp, 2023). Table 2 summarizes the types of 5Ps found in this study.

Table 2

Frequency of 5P Assignment Types across Eight Papers using 5P

	K. Feldman (2024)	M. G. Pryor, et. al. (2007)	M. Shil, et. al. (n.d.)	J. Lewis (2020)	S. Rousseau (2018)	T. P. Huber (2006)	FAA (2023)	T. Yother & T. Ropp (2023)	Total
Purpose	x	x	x	x	x	x			6
Participants/ People/ Patients/ Passengers	x	x	x	x	x	x	x	x	8
Preparation/ Plan	x						x		2
Process/ Programming	x	x	x	x	x	x	x	x	8
Progress/ Performance	x	x	x	x	x			x	6
Platform/ Tools/ Technology/ Plane/ Parts				x	x		x	x	4
Professionals/ Pilots						x	x		2
Patterns						x			1
Principles		x	x						2
Placement								x	1

For this study, the 5P model used includes the most common instances of different Ps. The 5Ps used for this study are:

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. This also includes funding.
Processes The sequence of tasks required to perform the duties of the instructor. This also includes curriculum.
Performance How well the program or course meets its objectives.

The analysis for each question included developing a subset of codes under each of the main codes. These subcategory codes were derived directly from the participants' responses. For instance, under "parts," there could be several subcategories, including industry sharing, mature technology, and funding. The subcategories are discussed in detail for each survey question. This model was not shown to the study participants. This model was used by researchers to categorize responses to short-answer questions.

Qualitative analysis of this study was accomplished using the built-in tools in QualtricsXM®, specifically Text iQ (QualtricsXM, 2024). The first researcher reviewed all short-answer responses and evaluated them for alignment with the 5Ps. A second researcher then conducted a review to align with the first researcher. Any conflicts were resolved through discussion between the two researchers. Responses could have been given multiple codes. For example, one response to the question, what are the challenges you are facing, was "We are just beginning the process of adding electric propulsion to our program. We are still searching for the most optimal places to introduce it. Additionally, all of our current faculty have zero experience with electric propulsion." This response was coded with both people and processes.

Text iQ assigned each comment a positivity rating. The six possible ratings were either very negative, negative, mixed, positive, very positive, or neutral. Given the nature of the questions and the purpose of this study, this information was excluded from the analysis.

Survey Results

Three survey questions helped identify participants' backgrounds. The questions were tailored to each participant based on their response to SQ1.

SQ1 What is your current position?

Survey question one asked participants to identify their current position and choose a response from academia, industry, or government. There are n = 35 responses to this question. Six participants were identified in the aerospace industry, and the remaining 29 were from academia. Depending on the answer, the participants were asked to further identify their respective program type or industry sector.

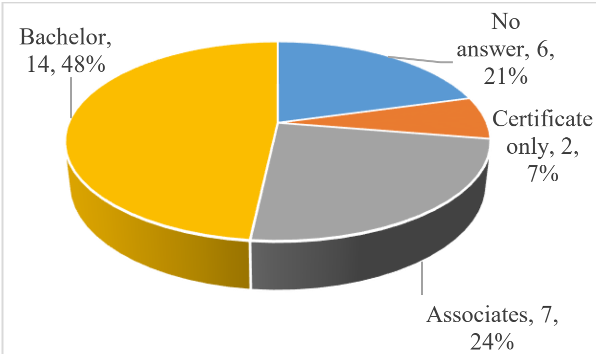
Responses from academia

SQ2 What kind of program?

Survey question two asked the academic participants about their program type. There were 23 responses (n = 23) to this question. Of the 36 participants, 29 identified themselves as coming from an academic program; therefore, only 29 were asked to answer this question, leaving six who did not respond. See Figure 1.

Figure 1

Distribution of Faculty Program Type



SQ3 Are you currently developing curriculum for electric propulsion?

There were 24 participants who answered the question about whether they are developing a curriculum for electric propulsion. Of those, only eight responded yes. The remaining 16 responded no.

SQ4 What are the challenges you are facing?

Nineteen participants (n = 19) answered this question. The responses included four different codes: parts, people, performance, and processes. This resulted in 34 codes and subcategory codes across all responses; refer to Table 3. SQ4 is directly related to RQ1 and provides a faculty perspective.

Table 3

SQ4 Category and Subcategory Code Occurrences of Challenges Faced

Code	Subcategory	Occurrences
Purpose		0
People		
	Faculty training	6
Parts		
	Mature technology	5
	Industry sharing	7
	Funding	2
	Program equipment	3
Processes		
	Curriculum	5
	Federal regulations	4
	Business considerations	1
Performance		
	Certification	1

The technical data and curriculum needs were common responses from the participants. Aviation maintenance schools must follow FAA FAR Title 14, Chapter 1, Subchapter H, Part

147 Aviation Maintenance Technician Schools regulations (Federal Aviation Administration, 2025a). This regulation identifies curriculum, equipment, and faculty requirements for training FAA-certified Airframe & Powerplant mechanics. Specific topics are published as the Airmen Certification Standards (ACS) by the FAA (Federal Aviation Administration, 2021).

The ability to develop curriculum depends on the industry acting as a partner by providing the necessary technical data and equipment. Participants' responses indicated that this need is not currently being met. Examples are “Uncertain technologies and FAA requirements”, “1. Obsolete regulations. 2. Electric propulsion uncertainties. 3. Insufficient knowledge of the infrastructure needs”, “Lack of equipment and lack of OEM data (manuals, instructions for continued airworthiness”, and “Industry willingness to share technology with us”. Even when the participants indicated that they had reached out directly to the industry, they reported not receiving assistance: “I have contacted numerous OEMs (Siemens, Joby, Eviation, etc.) [sic] have not received any responses”.

Several participants expressed concern that the technology is not yet mature enough to incorporate into their curriculum. Participants said “Lack of charging infrastructure. Lack of electric training aircraft range and endurance”, “…duration of battery packs (especially in cold weather)”, and “Operational endurance of current technology and downtime when batteries are being charged.”

When it came to funding, participants identified institutional funding (such as “university funding”) and industry funding (such as “grant funding to research new technologies”) as challenges.

For the people code, all six responses concerned faculty training. Responses include “all of our current faculty have zero experience with electric propulsion”, “Finding qualified candidates as AMT Instructors. As you know, just because they were a good mechanic, that does not mean they will be a good Instructor. Finding the balance between the two is challenging”, and “broad-based knowledge on special considerations regarding energy storage and distribution for aviation-based systems.”

Concerns raised by the participants may be related to the school’s ability to support an electric propulsion program. Without support from industry (parts), there is no technical data to build a curriculum (processes). Faculty also need the technical data so they can learn the equipment (people) before training students. Programs need equipment (parts) to train students.

SQ5 What have you learned that you would like to share?

Fourteen (n = 14) participants responded to this question. Responses were distributed across parts, processes, people, and performance, resulting in 12 codes and subcategory codes; see Table 4. Three participants responded N/A or “Nothing at this time…”. Of the twelve codes and subcodes generated, five participants reflected on technology maturity or lack thereof. Three examples from participants discussed the limitations of flight time. “The duration of each flight is substantially lower than current trainers and the recharge time is much higher than refueling an ICE AC”, “It is a great local or pattern option. The batteries in cold weather would be very poor", and "Across multiple platforms (Beta technologies, Joby, Archer, Eviation, etc.) the recurring theme I've observed is payload capacity and range. These are affected by the powerplant's inability [sic] create enough thrust or sustain operations long enough to go further or increase thrust due to the lack of energy available in the batteries".

Table 4

SQ5 Category and Subcategory Code Occurrences of Shared Information

Code	Subcategory	Occurrences
Purpose		0
People		
	Faculty training	1
	Knowledge	1
Parts		
	Mature technology	5
Processes		
	Curriculum	4
Performance		
	Certification	1

The second most common response concerned the lack of curriculum. Participants found that it was difficult to develop new curriculum due to the rapidly changing environment, "Developing a curriculum for electric propulsion in aviation presents challenges due to the rapidly evolving technology and the need for specialized knowledge in electric systems". Others were currently in the planning or developing phases: "We haven't incorporated electric propulsion yet; perhaps a few years off for us", "We are still developing our 14 CFR 147 curriculum per ACS. We want to add electric propulsion in it", and "That Part 147 schools are behind the curve".

The final three subcategory codes referred to the lack of general knowledge and faculty training under the people code and certification under the performance code. Responses included "…the need for specialized knowledge in electric systems" and "Talk to as many people as you can". When it came to performance, one participant discussed the lack of certification: "This will introduce hurdles to overcome if electric aircraft are solely used for training, including not being certified for spin training as required in Canada."

SQ6 Are there other technologies that you are planning on incorporating into your program?

No participants responded to this question. While the researchers have no way of understanding why the participants did not answer this question, the researchers believe the answer is that participants are either not currently involved in this type of curriculum or are not planning to incorporate any other technologies into their program at this time. Many faculty in these technical programs may not have the funding, technical data, or release time to incorporate technologies that are not in common use or incorporated into existing standards.

Responses from industry

SQ8 Which sector of the industry or government do you work?

Participants who answered "industry" to SQ1, are asked to identify the sector of the aerospace industry where they work. Only 3 of the 6 industry participants answered this question, and all 3 indicated that they work in the aerospace industry. The remaining three industry participants did not answer. The other options that were not selected by any participant were electric ground vehicle, electric aircraft, standards organization, and other.

SQ9 How soon do you think it will be important to have aviation technicians with knowledge of electric propulsion?

Three industry participants answered the question of how soon aviation technicians with knowledge of electric propulsion are needed, see Table 5.

Table 5

SQ9 When are Knowledgeable Technicians Needed

Years	Responses
0 to 3 years	1
4 to 7 years	1
Beyond 8 years	1

SQ10 What do you think are the greatest challenge(s) for training for electric propulsion technicians?

There were two responses from the six industry participants to this question: "Approved and reliable electric propulsion systems and components" and "It would require making an investment in technology that is very new and evolving". Both responses were coded under parts with the subcategory of mature technology, see Table 6. One response mentioned the need for approved systems, so that response was coded with Federal regulations under processes. SQ10 ties directly to RQ1.

Table 6

SQ10 Category and Subcategory Code Occurrences of Training Challenges

Code	Subcategory	Occurrences
Purpose		0
People		0
Parts		
	Mature technology	2
Processes		
	Federal regulations	1
Performance		0

SQ11 How do you think industry or government could help electric propulsion technicians?

Two of the six industry participants answered this question: "Concentrate exclusively on the home bult [sic] and experimental side of aviation. After systems are proven at the Oshkosh airshow for several years, general acceptance of the technology will naturally come" and "Sharing what will be the big universal items/ systems". Both responses are coded as purpose with the subcategory code industry sector. The second response was also coded as parts with the subcategory industry sharing, see Table 7.

Table 7

SQ11 Category and Subcategory Code Occurrences of Industry or Government Assistance

Code	Subcategory	Occurrences
Purpose		0
	Industry sector	2
People		0
Parts		
	Industry sharing	1
Processes		0
Performance		0

Responses from both academia and industry

SQ7 Which standards, if any, are you aware of?

Of the 35 participants who responded to the question, only four responded with anything other than no, not yet, or N/A. One participant discussed how Transport Canada is taking an interest and is developing new standards. Another participant discussed how the FAA's federal regulation of airmen certification standards could apply. The other two respondents identified that ASTM has standards. Notably, other standard bodies, such as IEEE, SAE, and ISO, were not mentioned, as were many others applicable to various types of aircraft. SQ7 ties directly to RQ2. What industry standards are faculty aware of, and how are they being used to develop curriculum?

Research Question Results

Based on the data collected during this exploratory study, the results for RQ1 and RQ2 are discussed.

RQ1: What are the primary challenges faculty face in incorporating electric propulsion in existing curriculum?

For SQ3, 8 of 24 faculty respondents indicated they were looking to incorporate electric propulsion into their existing programs. Of the 24 respondents to SQ4, 19 replied with challenges facing the incorporation of electric propulsion. From a faculty perspective, 9 areas of challenge were identified. The challenges are summarized as faculty training, mature technology, industry sharing, funding, program equipment, curriculum availability or development, Federal regulations, business considerations, and certifications.

From an industry perspective, two of the six respondents provided data in SQ10. The responses identified mature technology and Federal regulations as the primary challenges for faculty incorporating electric propulsion in the curriculum.

RQ2: What industry standards are respondents aware of?

For RQ2, this study revealed in SQ7 that in this sample of industry and faculty, only 4 out of the 35 respondents were aware of any standards that are being developed or may be applicable. These standards were identified only in general terms, e.g., existing FAA airmen certification standards, existing ASTM standards, or Transport Canada standards under development. No specific standard was identified by standard body, name, or number. However, a response of size four is too small to make generalizations. Therefore, this should be studied further.

Discussion on Curriculum Development

In ABET-accredited programs under the Engineering Accreditation Council (EAC) (ABET, 2024a) or under the Engineering Technology Accreditation Council (ETAC) (ABET, 2024b), each has criteria that address Program Educational Objectives, Student Outcomes, Continuous Improvement, and Curriculum, among other criteria. EAC includes Student Outcomes such as the ability to gain and apply new knowledge (ABET, 2024a). Student outcomes must directly relate to the needs of the program's constituencies and be traceable to specific parts of the curriculum (ABET, 2024a).

While ABET does not prescribe specific technologies that must be incorporated into programs, the accrediting body does require the involvement of program constituents in determining Program Educational Objectives (PEOs). These PEOs flow down through the student outcomes, and ultimately to curriculum and course outcomes, and the identification of any needed equipment and facilities to support the PEOs.

In non-ABET programs, there may be advisory committees comprised of program constituents. Through interactions with the advisory committees, both ABET and non-ABET programs may seek advice on incorporating new knowledge, skills, abilities, and equipment needs.

Limitations, Future Work, and Implications

This exploratory study sought to shed light on the incorporation of electric propulsion into aviation programs in the USA. In addition, the study sought to determine which standards, if any, the participants were aware of. While the study included responses from 35 participants, the value is that the responses provide insights into the current state of aviation maintenance programs with respect to electric propulsion.

More awareness of electric and other types of aircraft propulsion is needed in programs so that graduating students better understand the very real and practical applications of life-long learning in a field where technologies and techniques change many times throughout a 30 to 45-year career. The limitations of this study may be related to the brevity of the survey and to the sample size's ability to be representative of industry and academia. The brevity was designed to encourage inputs from already very busy people. With a short response, the likelihood of responses was felt to be higher than in surveys with more and/or longer questions. Another possibility may be that electric propulsion is not the most pressing problem today and is not on the front burner of problems under consideration. To develop and equip education programs at any point in the future, faculty and industry need to plan for a multi-year development, installation, and operational window. Given the current state of technology, the focus does not appear to be on electric propulsion curriculum development.

Academic respondents to the question, "What are the challenges you are facing?" were categorized into the 5Ps. In the Process category were curriculum and Federal Regulations, along with industry sharing (in Parts) and faculty (in People). These results may lead to future research questions and studies. Future exploration of effective curriculum development models and assessment methods, industry and academic cooperation, and faculty training methods may lead to more rapid and cost-effective incorporation of new technologies in academic programs.

Future work needs to include a larger respondent pool and the manufacturers of electric propulsion, and to gather their views on the content and timing of incorporation into programs, which can serve as a basis for future curriculum development. As other technologies, such as hydrogen propulsion or advancements in avionics, become available, they may be incorporated into future programs. This study identified a gap but does not attempt to explore why it exists, how to resolve it, or even whether it is an issue that needs to be resolved.

Conclusion

This study sought to understand the primary challenges faculty face in incorporating electric propulsion into their existing aviation maintenance programs, and to assess their awareness of industry standards and their use. Common challenges included both people and parts; specifically, a lack of qualified faculty, technical data, and equipment. Industry respondents cited industry immaturity as a barrier. All participants lacked awareness of existing industry standards. One question for future studies is when and how new technologies should be included in the curriculum.

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