Chapter 6
Electric Aircraft: Motivations and Barriers to Fly

Paul Parker and Chelsea-Anne Edwards

6.1 Introduction

Electric planes became a certified aviation option in 2020 when the European Aviation Safety Agency, EASA, certified an electric two-seat aeroplane designed primarily for flight training. The new technology offers several potential benefits that motivate adoption, including reduced greenhouse gas (GHG) emissions, reduced lead emissions, reduced noise and reduced operating costs. However, barriers such as uncertainty or lack of trust in the technology, limited battery capacity, limited battery life and costs associated with battery replacement may limit its appeal. The rate of adoption of this new technology will depend on perceptions regarding how important these benefits and barriers are among key stakeholders. This study provides insights from surveys of four groups: student pilots, instructors, managers/owners and others. The results will identify similarities and differences in the perceptions of these stakeholders influencing e-plane adoption at flight schools.

Flight schools are identified as an important first market for e-planes because their high usage rate (annual hours flown per aeroplane) and they are an important source of skills to enable change in the aviation industry. The introduction of new technology early in training will give students the skills in managing electric battery systems as a foundation for them to take to the aviation industry. E-planes may also reduce the cost of training thus reducing the financial barrier to entry into the pilot profession. This paper will set the context by starting with the global challenge to reduce GHG emissions from aviation and the entry of electric technology as a viable flight propulsion system. The literature on the expected benefits and barriers is reviewed and then the methods and research questions presented.

P. Parker (✉) · C.-A. Edwards
Faculty of Environment, University of Waterloo, Waterloo, ON, Canada
e-mail: pparker@uwaterloo.ca; ce2edwards@uwaterloo.ca

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6.1.1 Context and Literature

The impacts of climate change and the urgent need for action to reduce GHG emissions is well documented (IPCC 2021). The use of electric aircraft (e-planes) in place of conventional fossil-fuel powered aircraft allows for the elimination of in-flight emissions, providing deep reductions in GHGs (Borer et al. 2016; Moua et al. 2020; Thapa et al. 2021). Although this technology is not at the commercial airliner scale, integrating e-planes into small scale operations such as flight schools provides an opportunity for the technology to be tested, proven and further developed. An example is the Pipistrel Velis Electro, a two-seat electric aircraft, officially certified by EASA in 2020 (Pipistrel 2020). This certification made the Velis Electro the first fully electric aircraft in the world to be type certified (EASA 2020). In addition to the deep emissions savings from using electric aircraft such as the Velis Electro for flight training, costs to student pilots can also be dramatically cut (Moua et al. 2020). However, before assuming the success of electric aircraft in flight training, it is important to understand the perceptions of key stakeholders.

A global study completed by Ansys (2020) of 16,037 participants from 10 different countries (U.K, U.S, Austria, Germany, Switzerland, France, Sweden, Japan, Chile, India) found that 63% of those surveyed, think about the emissions they create from personal or work air travel. The findings from the Ansys global study also showed that 89% of participants reported a willingness to pay for greener air travel, with 60% of participants considering e-planes because of the benefits to the environment. In terms of what would prevent the participants from wanting to travel on an electric aircraft, the most popular reason, at 49% of respondents, was that the technology is not yet proven. The other top reasons included the plane running out of battery, the battery technology failing or exploding, and expensive ticket prices. Pilot training was also addressed, with 17% concerned about additional pilot training needed (Ansys 2020). Only 14% of participants reported that they have no concerns.

In Canada, half of the population agrees that now is the best time for Canada to be ambitious in addressing climate change (Nanos Research 2021). In terms of aviation emissions, Canada successfully set a world record in 2019 by operating the world’s first fully electric commercial aircraft (Guardian News and Media 2019). Harbour Air completed this flight in a retrofitted 1950’s DHC de Havilland Beaver seaplane and has announced ambitions to retrofit all of their aircraft to become fully electric and free of in-flight emissions. Canadian flight schools also have aging fleets with 60% of the singe engine flight training fleet built before 1980. If these aircraft were replaced by e-planes, flight training emissions would be sharply reduced.

6.2 Method

Given that no e-planes are currently certified or used for training in Canada, this study examines self-reported perceptions to gauge the importance of motivations and barriers to stakeholder groups (student pilots, instructors, flight school managers). We particularly wanted to answer the following questions:

1. How much do respondents know about e-planes?
2. What factors motivate respondents to want to fly e-planes?
3. What factors or barriers reduce respondent's desire to fly e-planes?

To answer these questions, the authors sent email invitations to 10 flight school managers in Canada and one in India (who had recently moved from Canada) to inform them about the study. When they agreed to participate, they were provided with an electronic survey link to forward to the students, instructors and staff at their flight school. In total, 186 responses were collected: 117 student pilots, 35 flight instructors, 15 managers/owners, and 19 others. Participation by gender was 28 females (15%), 155 males (83%), and 3 who preferred to not indicate gender (2%). Distribution by country: 158 Canada (85%), 24 India (13%), 4 other countries (2%).

The research instrument was created using Qualtrics and approved by the Office of Research Ethics (ORE# 43089). Information and recruitment letters preceded the 34-item survey. Most questions were answered on graphic scale: 0 represents "not an important reason to me" and 10 represents an "extremely important reason to me". A limitation was that the scale was automatically set at 0, so for questions where 0 was likely (low average), more respondents did not interact with the scale.

6.3 Results and Discussion

6.3.1 Knowledge and Desire to Fly an E-plane

Knowledge about a new technology is essential to support its adoption. Participants were asked about their knowledge of e-planes. Generally, knowledge was limited (mean value of 3.7 on a 10-point scale). Students reported the lowest level of knowledge (3.3), then instructors (4.0), and then managers (4.7). Finally, the group who classified themselves as "other" reported the highest level of knowledge, although it was still limited (5.0). This may indicate a higher level of knowledge and higher interest in e-planes and thus their willingness to participate in the survey (Table 6.1).

The second knowledge question asked participants to rate their knowledge of e-planes for flight training. As expected, the knowledge about this specialized type of e-plane (3.1) was lower than that for e-planes in general (3.7). All four cohorts followed this trend of less knowledge about e-planes for training. Again, students indicated the lowest level of knowledge (2.7) while managers reported the highest (4.1).

Table 6.1 How much do you know about e-planes?, mean value by cohort (0 = none at all, 10 = complete knowledge)

	All	Student	Instructor	Manager	Other
E-planes – mean	3.7	3.3	4.0	4.7	5.0
n=	179	112	34	14	19
E-planes for training – mean	3.1	2.7	3.6	4.1	3.7
n=	117	67	27	12	11

Table 6.2 Would you like to learn to fly an e-plane? (0 = not at all, 10 = definitely)

	All	Student	Instructor	Manager	Other
Type certified – mean	8.9	9.0	8.7	9.5	8.7
n=	180	113	34	15	18
Experimental – mean	8.0	8.3	7.5	7.7	7.9
n=	177	113	33	15	16

When asked if they would like to learn to fly an e-plane, all cohorts gave their most positive responses out of all the questions in the survey. When asked if they would like to learn to fly an e-plane that had been officially certified, all four stakeholder groups gave extremely strong positive responses. The average response from students was 9 out of 10. Managers provided an even higher average rating of 9.5. The instructors and other cohort gave a slightly lower average rating (8.7). Even learning to fly an experimental e-plane was rated very highly with students giving the highest rating (8.3) and instructors the lowest (7.5) (Table 6.2).

6.3.2 *Motivations and Barriers*

Questions regarding the importance of reasons to want to fly an e-plane identified different priorities among the stakeholder cohorts. The strongest reason among any cohort was manager's rating of the potential to cut costs (mean = 8.5). The managers rated the potential for quieter flights as their second reason (7.9), cutting emissions was third (7.5) and increased safety fourth (7.4). Instructors followed the managers' pattern of rating cost reduction the highest (8.0), but their second strongest reason was that e-planes were a technology of the future (7.7). Student motivation was different with cutting emissions rated most important (8.2). The next reasons for students were cutting costs (7.3) and flying a technology of the future (7.3) (Table 6.3).

The barriers or reasons for not wanting to fly an e-plane saw much stronger consistency across cohorts. Students, instructors, and managers each rated limited battery endurance as their strongest reason to not fly an e-plane. Students and managers both rated the likelihood that oil-based technologies would continue to dominate the

Table 6.3 Reasons to fly an e-plane, (0 = not important, 10 = extremely important)

	All	Student	Instructor	Manager	Other
Cut emissions	7.9	8.2	7.2	7.5	7.1
Reduce cost	7.5	7.3	8.0	8.5	6.9
Future tech	7.3	7.3	7.7	7.0	6.9
Quieter	6.9	6.8	6.7	7.9	6.9
Safer	6.0	5.8	6.0	7.4	6.1
Growing share	5.6	5.7	5.7	5.6	4.5

Table 6.4 Reasons not to fly an e-plane, (0 = not important, 10 = extremely important)

	All	Student	Instructor	Manager	Other
Battery endurance	5.8	5.6	6.7	6.3	5.1
Oil tech continues	5.5	5.6	4.9	6.2	5.1
Battery safety	4.8	4.5	5.3	4.8	5.6
Increase cost	4.6	4.7	3.5	4.9	4.9
Increase accident risk	4.2	4.2	4.1	3.7	4.5
Not trust electric tech	3.7	3.4	4.1	4.3	4.5
Increase training time	3.6	3.4	3.2	4.0	4.9

industry for their career as the second strongest reason and a possible increase in costs as the third. In contrast, instructors rated battery safety as their second strongest reason and the continued dominance of oil-based technologies as third. The concern about battery safety was rated as the strongest reason to not fly e-planes by the "other" cohort. The clear conclusion is that this study supports findings of earlier studies (Han et al. 2019) that batteries are the biggest perceived barrier and that students, instructors and flight school managers share this assessment (Table 6.4).

Having identified the top motivations and barriers to the adoption of e-planes, their relative strength can be considered. The top motivation among all participants was cutting emissions rated an importance of 7.9 while the strongest barrier was battery endurance rated at 5.8. This indicates a much stronger perception of the top motivation than the top barrier. This overall result is strongly influenced by the student perceptions because of the large number of student respondents. An examination of each stakeholder cohort reaches the same conclusion. The student rating of cutting emissions (8.2) is much higher than their rating of battery endurance and the continued use of oil-based technologies (5.6). Similarly, the instructor and manager ratings of reducing costs (8.0 and 8.5, respectively) is much higher than battery endurance (6.7 and 6.3, respectively). The other cohort repeated the pattern with cutting emissions (7.1) rated more highly than battery safety (5.6).

6.4 Recommendations and Conclusions

The survey findings lead to the following recommendations:

- Address limited e-plane knowledge with knowledge dissemination
  - Media, social media, demonstrations, air shows, etc.
- Reinforce motivations with information
  - Share cost information

    Top priority for manager/owner, instructor cohorts
    Important for other cohorts

  - Share emission performance information

    Top priority for student pilots
    Important for other cohorts

- Address barriers with research and knowledge dissemination
  - Document and share improved battery performance
  - Make direct comparisons in the flight school environment

Overall, participants in the survey demonstrated that different stakeholder cohorts place different levels of importance on reasons to fly an e-plane. The most important reason among student pilots was to reduce emissions while the most important reason among instructors and managers was to reduce costs. These differences should be recognized when prioritizing information to be shared with each cohort. Secondary reasons were also rated as important so information on noise reduction, improved safety and developing skills for technologies of the future should also be developed. The perceptions of barriers or reasons not to want to fly e-planes were consistent across cohorts with the limited endurance of batteries being the most important. Improvements in battery performance need to be shared.

Providing performance results across multiple sustainability criteria (emissions, cost, noise, appeal to diverse cohorts, safety, endurance, etc.) will help overcome the limited knowledge currently available regarding electric aviation. Improved knowledge dissemination will help create a market for the new technology and attract a new generation of talent to the industry.

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