New technologies in general aviation

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Abstract: *This research explored the technological needs of GA pilots at international levels. Overall, single pilot operators tend to value costs as the most important feature of any technology, followed by technology that helps with pre-flight tasks as well as during flight. Remote monitoring, post-flight analysis and 3-D displays are technological features of lesser importance.*

Introduction

In 2009, Perezgonzalez and Lee carried out a study on the informational needs of student pilots while flying. The students expressed their preferences for technological features among those provided by three different GPS-enhanced technologies. These technologies were an assisted-GPS mobile phone with an integrated programme for post-flight analysis, a real-time fleet tracking technology, and a flight management system program for Microsoft Windows-capable devices (including mobile phones). The student pilots in that study preferred or wished for electronic information for navigation charts, and technology that enhanced airspace awareness, helped with route planning and helped prevent mid-air collisions.

The research here presented is, thus, a spin-off from that pilot study. It explores the flight management informational needs of general aviation pilots in the role of single-pilot operators. The research also aimed for an international sample of general aviation pilots.

Methods

We adapted the questionnaire used in the pilot study to an online environment and uploaded it onto the website, SurveyMonkey.com for one-month. Following this, we emailed different flying clubs and schools internationally, using a list of New Zealand clubs compiled in-house, and the list of international clubs as listed in the "Thirty-thousand feet" website. Most general aviation clubs in both lists were contacted, although we excluded clubs which we believed the survey would not apply to directly, such as clubs dedicated exclusively to parachuting, hang-gliding, and paragliding, or pilots of vintage aircraft. In the email, sent to the president or the secretary of each club, we explained the objective of the survey and encouraged pilots to participate in the survey and to pass the email to other pilots.

After a few demographic variables (gender, type of licence, type of aircraft most often used, type of activity most often carried out, and country of residence), the participants were asked to assess the degree of importance they attached to 22 different technological features, such as the possibility of tracking flight parameters in flight, having technology that acted as TCAS, or the battery life of portable technology. These features were those compiled during the pilot study. The participants could range their response according to a 6-point Likert-scale ranging from "Not important" to "Very important". All responses were anonymous.

A total of 70 pilots participated in the survey: 16 pilots from the USA, 1 pilot from Australia and 53 pilots from New Zealand.

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PEREZGONZALEZ Jose D, Andrew GILBEY & Luis DIAZ VILELA (2010). *New technologies in general aviation*. Aviation Education and Research Proceedings, vol 2010, pp 55-59. ISSN:1176-0729.

Results

We performed a principal components analysis on the 22 technological variables in our research to ascertain whether they grouped themselves into distinctive components. Indeed, we obtained the following 5 components:

- “Flight support”, comprising most technological features with a role on the pre-flight phase as well as during the flight (e.g. calculation of weight and balance, airspace awareness, autopilot, etc).
- “Post-flight analysis”, comprising technological features allowing for post-flight analysis and for the visual feedback of a finished flight.
- “Costs”, comprising set-up and operating costs, as well as portability and battery life.
- “Remote monitoring”, comprising the third-party monitoring of both a particular flight and a fleet of aircraft.
- “3-D display”, comprising the display of flight information on 3-D.

We calculated the value of each component as the sum of those variables that loaded higher than 0.50 in the component. We also standardised each component to fit into a 6-anchor Likert-scale (with values “0, Not important”, “1, Very little importance”, “2, Little importance”, “3, Medium importance”, “4, Important”, and “5, Very important”). Consequently, we used these components as our research variables, instead of the original 22 variables.

The main results are summarised in the adjunct table. The table has been formatted to represent all decimal points between the values “0” to “5”, thus matching the 6-anchor Likert-scale used in the questionnaire. It also represents each demographic group according to their mean in each component, showing all groups at once. The reader needs to be aware that some groups are independent from related groups –e.g. participants can be either women or men, either gliders or helicopter pilots or airplane pilots, but not more than one in each category–, while the same groups are dependent among unrelated groups –e.g. men and women may be gliders, helicopter pilots and airplane pilots–, thus comparison among groups need to be made carefully: it can be done straightforwardly for independent groups but not so for dependent groups (related groups are separated by semicolons in the table). The table also represents with right braces those independent groups which showed significant means differences between them. Finally, the sample’s mean per component is also represented as a coloured box.

Regarding the results for the overall sample, they show that the pilots in our sample considered costs (mean=3.4, std=1.0) and flight support (mean=2.8, std=1.1) to be components of medium importance. On the other hand, remote monitoring (mean=2.4, std=1.5), post-flight analysis (mean=2.0, std=1.2), and 3-D displays (mean=1.9, std=1.4) were valued as of little importance. Given the disparity in participant numbers per group, the current results may be more representative of male, airplane pilots residing in New Zealand. Yet, some of the group proportions may actually reflect population proportions (e.g. between male and female pilots) and, thus, deserving of some attention. Most demographic groups tend to concentrate around the sample’s mean per component, except in regards to their attitudes to monitoring, which appears more spread out. Therefore, only a few means differences between groups appear in our analysis, showing some discretionary significant results rather than general patterns.

Regarding the component “Flight support”, most groups valued these technologies as being of medium importance to their flying. However, women (mean=2.0) and recreational pilots (mean=2.2) valued them lesser than any other group, while pilots holding an air transport licence (mean=3.4) valued them more than any other group.

Notwithstanding this, significant differences appeared only between pilots without a licence and pilots holding a private licence, and between pilots using aircraft for training and recreational pilots. Pilots without a licence (mean=3.1) valued flight support technologies more than pilots holding a private licence (mean=2.6, $t=-2.09_{(df\ 33)}$, $p<.05$). And pilots in training (mean=3.0) valued them more than recreational pilots (mean=2.2, $t=-2.14_{(df\ 32)}$, $p<.05$).

Regarding the component "Post-flight analysis", most groups valued these technologies as of little importance. However, commercial (a.k.a, business) pilots (mean=1.5) valued them lesser than any other group, while pilots in training (mean=2.5), pilots without a licence (mean=2.6) and, especially, glider pilots (mean=4.5) valued them the most. Notwithstanding this, significant differences appeared between glider pilots and both airline and helicopter pilots, between pilots in training and business pilots, and between pilots without a licence and pilots holding a private licence. Glider pilots valued post-flight technologies more than airplane pilots (mean=2.0, $t=-3.08_{(df\ 62)}$, $p<.05$) and helicopter pilots (mean=1.6, $t=-4.72_{(df\ 5)}$, $p<.05$). Pilots in training (mean=2.5) valued them more than business pilots (mean=1.5; $t=-2.78_{(df\ 36)}$, $p<.05$). And pilots without a licence (mean=2.6) valued them more than pilots holding a private licence (mean=1.7, $t=-2.22_{(df\ 33)}$, $p<.05$).

Regarding the component "(lower) Costs", most groups valued these features as of medium importance. However, women (mean=2.7) and business pilots (mean=2.8) valued them lesser than any other group, while glider pilots (mean=4.0) valued them the most. Notwithstanding this, significant differences appeared only between instructors and business pilots. Instructors (mean=3.7) valued low costs more than business pilots did (mean=2.8, $t=-2.35_{(df\ 18)}$, $p<.05$).

Regarding the component "Monitoring", most groups valued these technologies as of little importance. However, recreational pilots (mean=1.1), American pilots (mean=1.5), women (mean=1.6) and pilots holding a private licence (mean=1.6) valued them lesser than any other group, while pilots holding no licence (mean=3.2) or a commercial licence (mean=3.1), instructors (mean=3.4) and helicopter pilots (mean=3.5) valued them the most. Notwithstanding this, significant differences appeared only between recreational pilots and both instructors and pilots in training, between pilots holding a private licence and both pilots with no licence or with a commercial licence, and between American and New Zealand pilots. Recreational pilots (mean=1.1) valued monitoring technologies lesser than instructors (mean=3.4, $t=4.92_{(df\ 15)}$, $p<.05$) and pilots in training (mean=2.8, $t=3.84_{(df\ 33)}$, $p<.05$). Pilots holding a private licence (mean=1.6) valued them lesser than pilots holding either no licence (mean=3.2, $t=3.52_{(df\ 34)}$, $p<.05$) or a commercial licence (mean=3.1, $t=4.01_{(df\ 45)}$, $p<.05$). And American pilots (mean=1.5) valued them lesser than New Zealand pilots (mean=2.6, $t=-2.92_{(df\ 68)}$, $p<.05$).

Finally, regarding the variable "3-D display", most groups valued it as of little importance. Yet, recreational pilots (mean=1.3) and helicopter pilots (mean=1.4) valued them lesser than any other group, while pilots with commercial licenses (mean=2.4) and, especially, instructors (mean=3.6) valued them the most. Notwithstanding this, significant differences appeared only between instructors and pilots in training, business pilots and recreational pilots. Instructors (mean=3.6) valued 3-D displays more than training pilots (mean=2.0, $t=-2.46_{(df\ 26)}$, $p<.05$), business pilots (mean=1.6, $t=-3.35_{(df\ 18)}$, $p<.05$), and recreational pilots (mean=1.3, $t=-5.05_{(df\ 15)}$, $p<.05$).

Conclusions

The overall picture from this research is that single pilot operators tend to value low costs as the most important features of flight technologies. However, they also value technology that helps with the pre-flight tasks as well as during the flight phase. In contrast to this, remote monitoring and post-flight analysis are technological features of slightly lesser importance, followed by 3-D displays. These results, however, represent the male, airline pilot resident in New Zealand, above any other groups.

Yet, per demographic groups, there are some interesting results, as well. Instructors and pilots in training tend to value technologies above average, while commercial (business) pilots and recreational pilots tend to value technologies below average. More specifically, instructors, perhaps because of their role in training and their duty of care for students, valued 3-D displays as important -together with costs-, followed by the remote monitoring of a flight. Business pilots give less importance to post-flight analysis and costs, and recreational pilots, perhaps because they fly for the pleasure of it, seldom value any technology, although they are still concerned about costs.

Also interesting is that women tend to place less value than men on technology – even its cost. Although conclusions in regards to gender are risky, as only 4 women replied to our questionnaire, these results suggest a need for further study in regards to pilots' gender differences.

Glider pilots appear to value post-flight analysis technologies, perhaps as a visual manner of either obtaining feedback about their flying or showing off their flight progress to friends afterwards. Costs are also an important factor for glider pilots. Actually, because gliders would have less probability of purchasing technology together with their aircraft, any enhancement in this regards will typically be as a third-party component perceived as an extra (albeit optional) cost. Helicopter pilots, on the other hand, value technologies below average, except for monitoring technologies, which they value most than any other group. Again, these interpretations may be off hand, as only 2 gliders and 5 helicopter pilots replied to our questionnaire. But the results, nonetheless, are suggestive for future studies.

Also interesting is that pilots holding a commercial licence tend to value technologies above average while pilots holding a private licence tend to value technologies below average.

References

PEREZGONZALEZ Jose D & LEE Seung Y (2009). *New technologies for the student pilot*. Aviation Education and Research Conference Proceedings, Blenheim (New Zealand), July 2009, pp.10-11. ISSN 1176 0729.

	Flight support	Post-flight analysis	Costs	Monitoring	3-D display
5.0					
~					
4.5		**G**			
4.4					
4.3					
4.2					
4.1					
4.0			G		
3.9					
3.8					
3.7			**I**		
3.6					**I**
3.5			M, T, R, US	H	
3.4	AL		A, NZ, NL, PL, CL	**I**	
3.3					
3.2	I		AL	**NL**	
3.1	US, CL, **NL**			**CL**	
3.0	**T**		H		
2.9	M, A				
2.8	NZ		**B**	**T**	
2.7			W		
2.6	**PL**	**NL**		**NZ**	
2.5	H, G, B	**T**			
2.4				M	CL
2.3		I		A	
2.2	**R**				
2.1		W, NZ, AL		B	US
2.0	W	M, CL, **A**		G, AL	G, AL, **T**
1.9		R			M, A
1.8					NZ, PL
1.7		**PL**			NL
1.6		US, **H**		W, **PL**	**B**
1.5		**B**		**US**	W
1.4					H
1.3					**R**
1.2					
1.1				**R**	
1.0					
~					
0.0					

M=men (n=66), W=women (n=4); A=airplane pilot (n=63), H=helicopter pilot (n=5); G=glider (n=2); T=training (n=22), I=instructing (n=5), B=business (n=15), R=recreation (n=12); NZ=New Zealand (n=54), US=USA (n=16); NL=no licence (n=11), PL=private licence (n=24), CL=commercial licence (n=22), AL=air transport licence (n=6). Braces indicate significant means differences between the connecting pairs. Coloured boxes represent each component's mean.