Electronic Flight Bag (EFB) Information Management and Training

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13. ABSTRACT (Maximum 200 words)

The purpose of this project is to support the Federal Aviation Administration (FAA) by gathering data to better understand how pilots access and manage information used for Electronic Flight Bag (EFB) functions. This document provides the results of a two-year effort to identify pilot perceptions of EFB use and training at their respective airlines. This report documents findings from three separate data collection efforts conducted with airline pilots from July 2016 to August 2018: individual interviews, group discussions, and lastly, data shared by the Air Line Pilots Association (ALPA). Findings from all three efforts identified strengths and weaknesses with EFB use and training at their airlines regarding the following eight topic areas: EFB setup; EFB training; reliability of the EFB; EFB settings; battery and power, electronic charts; electronic documents; and distractions, workload, and head-down time. Pilot comments across the three efforts provided insight into areas where pilots would like to see improvements. Tablet battery and power management issues were the most reported concerns. Other challenges include difficulty finding the information they need, in particular when searching electronic manuals and documents.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
oz	ounces	28.35	grams	g
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
mL	milliliters	0.034	fluid ounces	fl oz
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
g	grams	0.035	ounces	oz
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	Kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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The views expressed herein are those of the authors and do not necessarily reflect the views of the Volpe National Transportation Systems Center or the United States Department of Transportation.

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List of Acronyms

Acronym	Term
ALPA	Air Line Pilots Association
CA	Captain
EFB	Electronic Flight Bag
FAA	Federal Aviation Administration
FMS	Flight Management System
GPS	Global Positioning System
IT	Information Technology
PF	Pilot Flying
PM	Pilot Monitoring
QRH	Quick Reference Handbook
SA	Situation Awareness

Executive Summary

This document provides the results of a two-year effort to better understand pilot perceptions of managing information on devices used for EFB functions. The purpose of this project is to support the Federal Aviation Administration (FAA) by gathering data to better understand how pilots access and manage information used for Electronic Flight Bag (EFB) functions.

This report includes findings from three separate data collection efforts across a two-year time period from July 2016 to August 2018. First, we held individual interviews with nine pilots (July 11, 2016 and March 2, 2017). Then we conducted group discussions with nine airline pilots to build upon the opinions gathered from interviews (February 21-22, 2018). Lastly, we provided assistance to the Air Line Pilots Association (ALPA) to conduct a survey on the usability of EFBs (May-August 2018). In total, 1,047 pilots responded to this survey.

Overall findings are summarized below:

- Tablet battery and power issues were the most reported concerns across the three data collection efforts. Pilots reported that they do not have enough power to last a full day of flight and must carry backup batteries or connect to aircraft power. Pilots reported needing to turn off their device to save power or implement creative solutions on the flight deck to preserve battery life.
- The reliability of EFB hardware and software was not a cause of distraction for most pilots who responded to the survey. Common issues related to EFB reliability included auto-lock and sleep mode activation at inopportune times during flight resulting in the need to continually enter a password in order to sign back into the device each time, and EFB software freezing or slowing down, resulting in the need to restart the device.
- Pilots identified strengths and weaknesses with their electronic chart software and functionality. Zooming is perceived to be beneficial and necessary to view information on electronic charts, but it can be an issue when pilots are unaware that important information is off-screen and cannot easily interact with their charts to adjust the zoom level or make inputs while the autopilot is engaged. Pilots felt that chart interaction was more difficult while hand flying the aircraft.
- Pilots noted that it would be helpful for training to be developed around the operational tasks that require use of EFB information, rather than focused on details on all the capabilities available on their devices. Overall, pilots felt that classroom training is preferable to online or distance learning for EFB functions and devices so pilots have the opportunity to actively participate in the training using their devices and to ask questions.
- Pilots perceived their workload and head-down time to be improved in some areas and increased in others with EFB use compared to paper. Survey data show that two-thirds of pilots felt that managing EFB information decreased workload and head-down time when compared to using paper.

1. Introduction

The use of Portable Electronic Devices (PEDs), such as tablets, for Electronic Flight Bag (EFB) functions has largely replaced the use of paper products on the flight deck. Over time, pilots transitioning from paper to electronic formats are changing the way information is accessed for flight. For example, pilots use a search function or digital bookmarks to find frequently accessed information rather than flipping through books and binders. Pilots will need to continue to adapt as software and hardware evolve to make information available to pilots on the flight deck. It is important to understand how pilots manage information using EFBs in order to understand the impact of EFB on flight operations.

The purpose of this project is to support the Federal Aviation Administration (FAA) by gathering data to better understand how pilots access and manage information used for EFB functions. In particular, how do pilots perceive their interaction with their device and how has the training received during the transition from paper to tablet affected the way they manage information on their EFB? Pilot volunteers contributing to this project came from multiple airlines over a two-year period from July 2016 to August 2018. The information collected across the two-year time period is discussed collectively within eight main topics:

- EFB setup;
- EFB training;
- Reliability of the EFB;
- EFB settings;
- Battery and power
- Electronic charts;
- Electronic documents; and
- Distractions, workload, and head-down time.

2. Methods

This report includes findings from three separate data collection efforts with airline pilots. First, we held individual interviews with pilots, followed by group discussions with airline pilots to build upon the opinions gathered from interviews. Lastly, we incorporated our findings with online survey data shared by the Air Line Pilots Association (ALPA). Each data collection effort is described in more detail below.

2.1 Individual Interviews

From July 11, 2016 and March 2, 2017, we conducted individual phone interviews to better understand pilots' experiences transitioning from paper to an electronic device, and how pilots perceive interacting with EFB functions on the flight deck. Nine pilots from five airlines participated. These pilots possessed a variety of experience with devices used for EFB functions. All pilots had between one and five years' experience using portable tablets for EFB functions (7 captains, 1 check airman and 1 standards and training supervisor). Two pilots had experience with different types of PEDs and two other pilots had also used an installed EFB in addition to PEDs. All nine pilots frequently used a tablet for their personal use; two pilots also indicated that they used a portable Global Positioning System (GPS) device for EFB functions in their personal aircraft.

The interview questions were intended to gain insight into how pilots perceive their use of EFB functions, how pilots are trained to use these functions, and the pilots' perceptions of the EFB's usefulness during operations. See Appendix A for the complete list of interview questions. The phone discussions lasted approximately 60-90 minutes, and were semi-structured in nature so pilots could skip any questions they did not feel comfortable answering. Pilots were given the choice of being audio recorded or having an additional note taker on the line so that the interviews could be later transcribed. The interviewers told the pilots that their identity and company affiliation would not be disclosed and that responses would not be identified. Each discussion was scheduled at the convenience of the pilot. All but one interview took place entirely via phone, with one interview taking place via phone and continuing in person.

2.2 Group Discussions

In order to expand upon the information gathered from the individual interviews, two 90-minute group discussions focusing on pilots' opinions were held in coordination with the 2018 annual Air Line Pilots Association (ALPA) meeting on February 21-22. A set of core questions was designed to gain high-level feedback, followed by more specific questions based on pilot responses (see Appendix B for the list of questions). Additional time was allotted for unplanned questions or follow-on responses from the core questions. The interviews were audio recorded with pilots' permission.

Six captains and three first officers from five different airlines participated in the interviews. The pilots

ranged in age from 30-59 years. We interviewed the pilots in two groups (three pilots in the first group, and six pilots in the second). Their flight hours in their current position ranged from 150 to 12,000 with an average of 4,466 hours. Flight hours in the last 30 days ranged from 0 (pilot on extended vacation) to 240 hours with an average of 65 hours. All pilots had experience with EFBs. One pilot used an installed and permanently mounted EFB; two pilots used an installed EFB and a tablet; two pilots used a permanently mounted EFB and a tablet; two pilots used an installed EFB and a tablet; and four pilots only used a tablet. Two of the pilots also mentioned that their airline was just starting their validation period during their transition from installed EFBs to tablets.

2.3 Online Survey

In May 2018, ALPA conducted an online survey to collect information from airline pilots about their experience with EFB functions on the flight deck. Refer to Appendix C for the complete list of survey questions. From May-August 2018, 1,047 pilots responded. Whenever a pilot did not respond to a particular survey question, they were excluded from the response total for that question. Therefore the number of pilots responding for each question may differ.

Pilot respondents included captains (56%), first officers (42%) and one line-check airman. Most captains were 50-59 years old (46%) while first officers tended to be a little younger, between 40-49 years (32%). Four captains (19%) were between 60-69 years while only 16 first officers fell into that age range (4%). See Figure 1 for distribution of position by age of pilot.

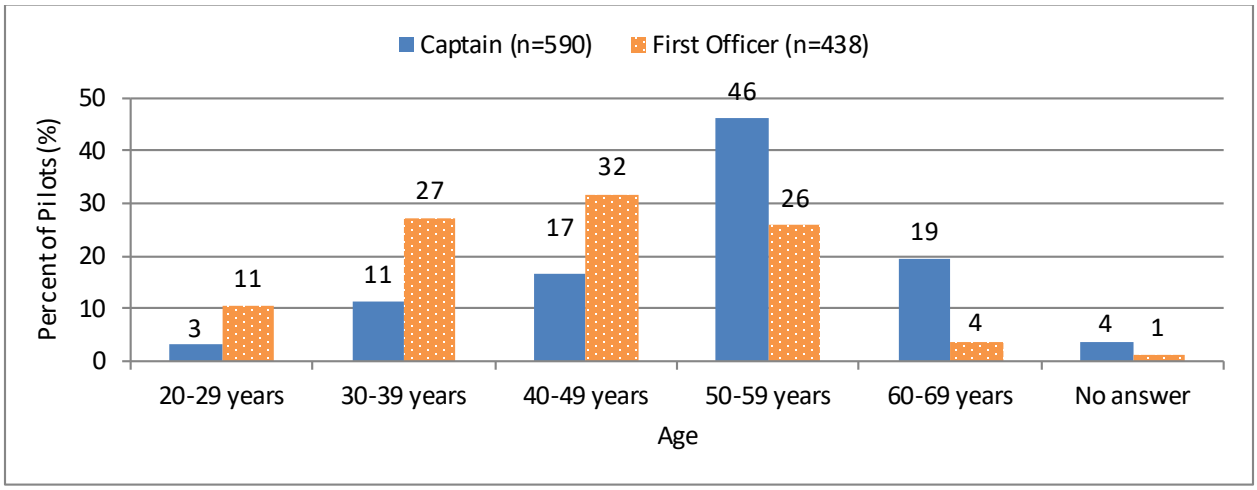


Figure 1. Percent of Pilots by Age and Position

3. Results

This section presents the combined results from all three data collection efforts: individual interviews, group discussions, and the ALPA EFB User Survey. Findings from all three efforts identified strengths and weaknesses with EFB use and training at their airlines. The survey questions allowed pilots to clarify any negative responses in order to better understand what the issues are from the pilots' point of view, therefore few positive comments are available in the survey data. A chi square (χ^2) goodness of fit test was calculated for all survey questions excluding pilot background (see Appendix D for survey data tables). Findings for all survey questions presented in the results section are statistically significant unless otherwise noted.

3.1 EFB Setup

Across all data collection efforts, when pilots received their EFBs from the airline company, they were responsible for setting it up.

Survey results showed that 27% of pilots took 60+ minutes for set-up, 37% took 30-60 minutes, and 36% took 1-30 minutes for set-up. Of those who took 60+ minutes, many felt that they were not compensated for their personal time and effort during the set-up process (39%), while additional pilots said they were not compensated at all (16%). One pilot stated that, "it definitely takes longer than the hours paid," while another pilot had to "set-up with no initial training, everything on my unpaid time."

After initial setup, 55% of pilots felt comfortable using their EFB in operations within the first month. Figure 2 presents pilots' level of comfort using the EFB during line operations by position.

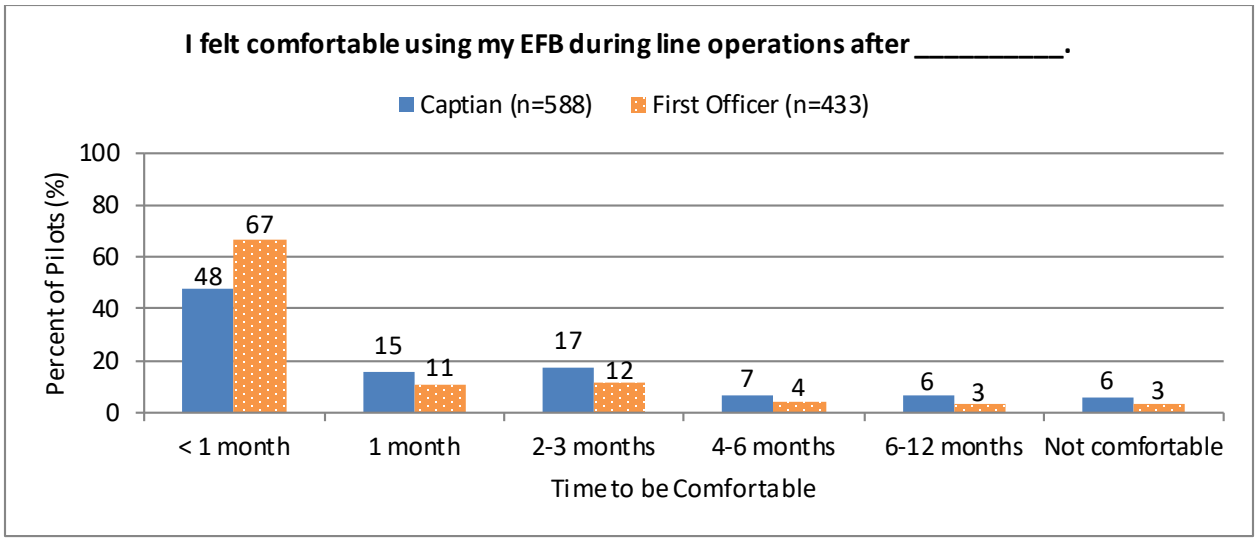


Figure 2. Percent of Pilots by Time to Achieve Comfort Using EFB for Operations and Position

3.2 EFB Training

Three themes emerged from pilot responses about EFB training:

- EFB formats and satisfaction
- EFB training topics
- Improvements to EFB training

3.2.1 EFB Training Formats and Satisfaction

Survey data show that 66-80% of pilots were satisfied or very satisfied with the EFB training they received for initial EFB rollout, new-hire, and recurrent training. Figure 3 shows pilot satisfaction for initial rollout, new-hire and recurrent training.

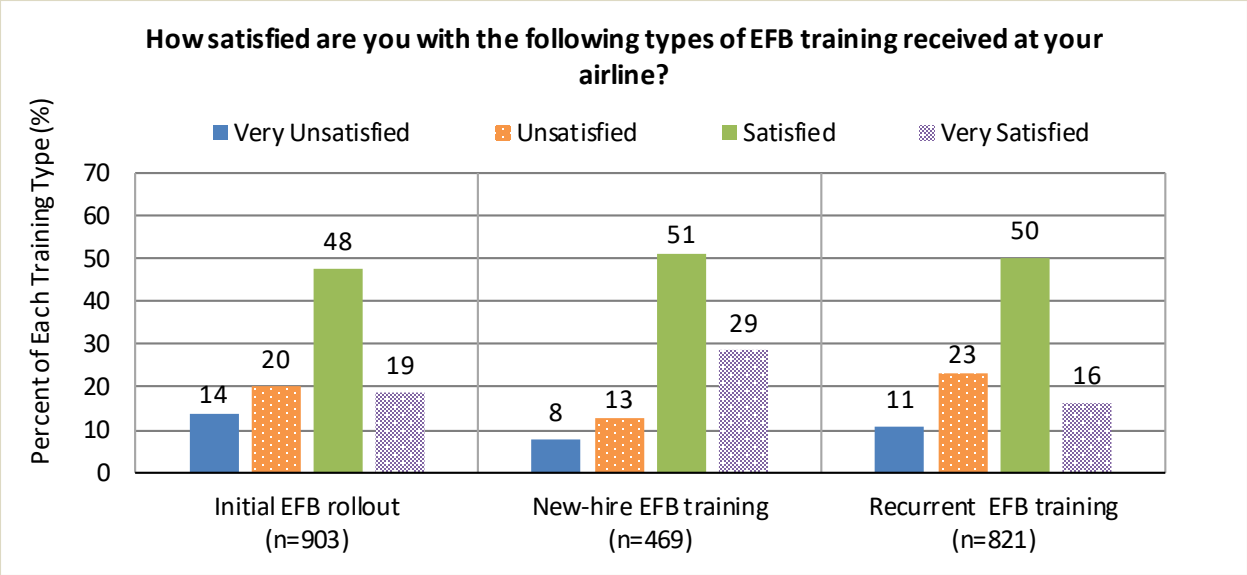


Figure 3. Pilot Satisfaction with EFB Training: Initial EFB Rollout, New-Hire, Recurrent

Of the 34% (n = 307) of pilots who were not satisfied with their airlines initial training, a few provided statements expressing concerns.

- "Rolling out this technology without adequate training leads to poor performance and safety issues on the line."
- "My airline conducted very little training on EFB use in initial training. We were handed EFBs, were given a lesson to read, and that was about it. No practical and dedicated training was conducted during ground school."

Pilots who felt that their airlines did not provide adequate recurrent training (34%) described a general lack of EFB-related topics. Pilots noted the following:

- Even though they bring their tablets with them to training, "we don't spend any time going over new features… or other issues which may be relevant."
- "In recurrent training, the instructors would try and teach you how to interface with the EFB, but not how to use it during flight or how to use the EFB to improve our job performance during line operations. The instructors and check airman got an 8-hour course on how to use the iPad. The 7,000 line pilots got zero training before [they were] required to use them on the line."

Overall, pilots who received documentation during EFB rollout, new-hire and recurrent training were satisfied with the information they received. Approximately 70-80% of pilots agreed or strongly agreed that the information and guidance were adequate for EFB operational use during each type of training. Figure 4 shows pilots' perceived adequacy of documentation for initial rollout, new-hire and recurrent training.

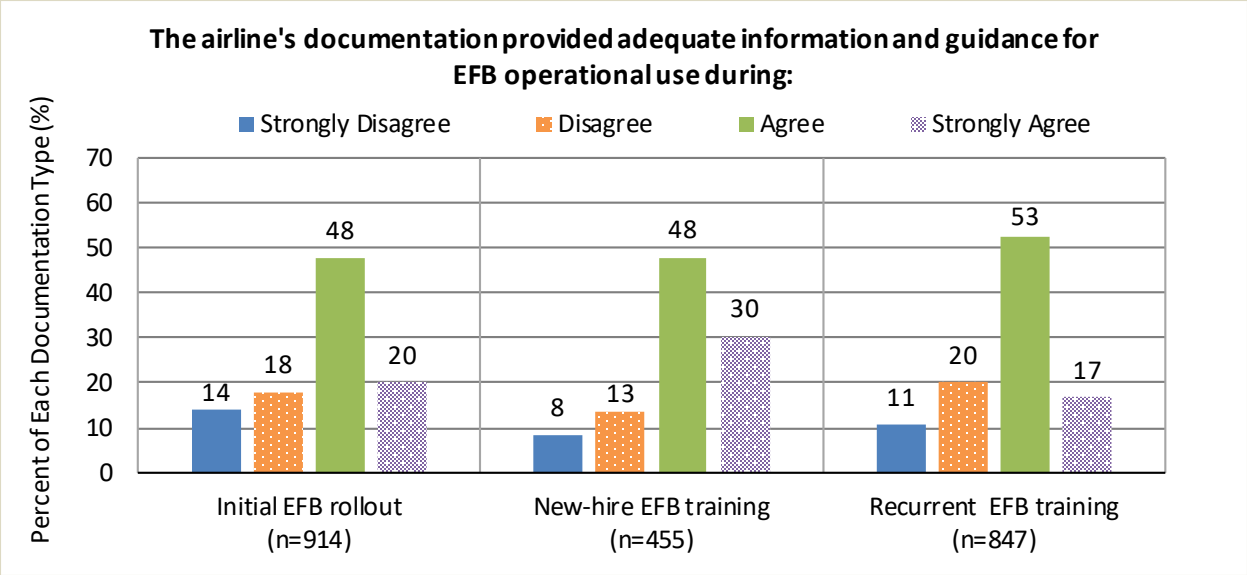


Figure 4. EFB Documentation: Initial EFB Rollout, New-Hire, Recurrent

Pilot comments from the interviews and group discussions (18 pilots combined) revealed that pilots received a range of different training formats when EFBs were initially rolled out. Pilots with portable tablets reported a range of formats across airlines. Six pilots received only documentation without formal training, while 12 pilots participated in classroom training or completed online training modules.

- One pilot noted that they were only provided with voluntary training using videos at their airline.
- Another pilot stated that even though he felt that there was little training, it was appropriate for EFB introduction because "training was for the basics, how to operate it, how to make use of it." This pilot appreciated that "I didn't have to sit in a classroom," and "enjoyed doing training on my own at my own pace."
- On the other hand, another pilot who also experienced very little EFB introduction training and received only basic instructions through email, did not find this format very helpful.

Training that pilots received electronically through online distance learning was seen as beneficial:

- One pilot mentioned that the benefit of this type of format for initial EFB training is that the pilots are able to learn at their convenience and at their own pace.

Classroom training was also seen as beneficial by pilots in the interviews and group discussions:

- Three pilots from the same airline noted that permanently mounted EFBs were made available to them in a common area so that pilots could access them and ask for demonstrations as needed. One pilot felt that this format fit moderately well, as they continued to learn how to use these devices through hands-on experience during operational use over time.

- Two pilots who used installed or permanently mounted EFBs received recurrent training in a classroom setting, which included details on where and how to find information for flight, and how to utilize highlighting and bookmarks. Instructors incorporated EFB use into training by asking questions that required pilots to find specific information using their EFBs. The airline also held training events for pilots that included practice flight scenarios that required the pilots to use their tablets. These sessions included information on how to prioritize, plan and use the tools available during flight.
- Five pilots stated that during their recurrent classroom training, the instructor took time to help pilots practice where and how to access information.
- Two pilots from different airlines mentioned that during recurrent training, instructors would ask the pilots questions that required them to practice finding information for their flight using their EFBs. One pilot also stated that they found recurrent EFB training to be more helpful that their initial training because it included information on updating the EFB applications and reinforced how to search for and access information.

3.2.2 EFB Training Topics

The online survey asked pilots about several different training topics across three different training formats: documentation, classroom or distance learning, and simulator training. Overall, pilots agreed that the documentation and classroom or distance learning were adequate for most topics. Approximately half of pilots (48-51%) agreed or strongly agreed that the documentation and classroom or distance learning they received were adequate for all topics, except for using the EFB while hand flying where only 33% of pilots felt that the documentation was adequate. The topic areas found by pilots to have adequate documentation are those related to basic EFB use, including EFB buttons and switches (63-73%), EFB use when there is a departure, arrival, or runway change (58-68%), EFB power management (59-67%), and touch screen gestures (57-65%). Figure 5 shows a comparison of pilot responses for the adequacy of the documentation they received on each EFB topic listed, and Figure 6 provides this comparison for classroom and distance learning.

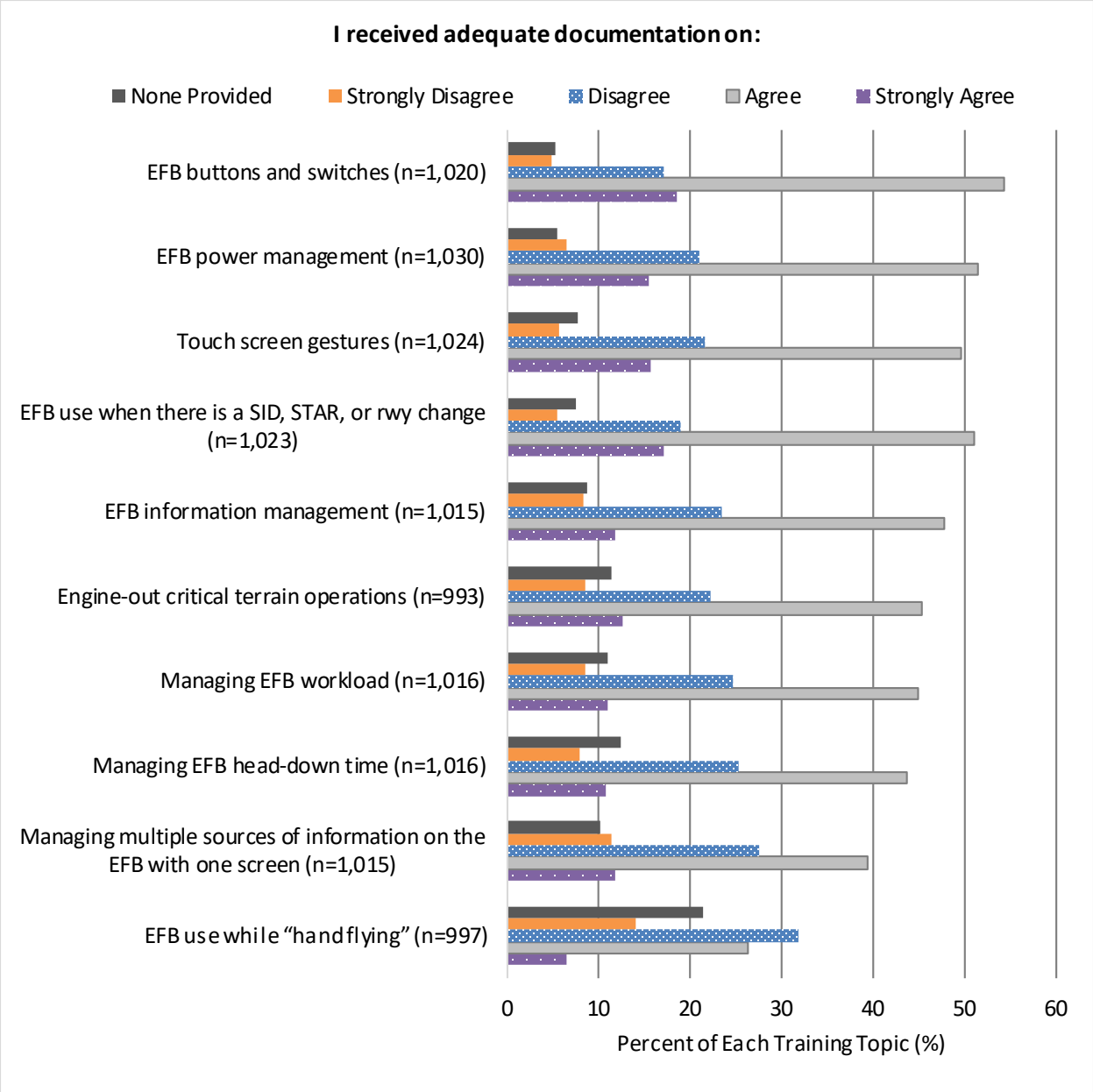

I received adequate documentation on:
None Provided
Strongly Disagree
Disagree
Agree
Strongly Agree
EFB buttons and switches (n=1,020)
EFB power management (n=1,030)
Touch screen gestures (n=1,024)
EFB use when there is a SID, STAR, or rwy change (n=1,023)
EFB information management (n=1,015)
Engine-out critical terrain operations (n=993)
Managing EFB workload (n=1,016)
Managing EFB head-down time (n=1,016)
Managing multiple sources of information on the EFB with one screen (n=1,015)
EFB use while "handflying" (n=997)
0
10
20
30
40
50
60
Percent of Each Training Topic (%)

Figure 5. Documentation by Training Topic

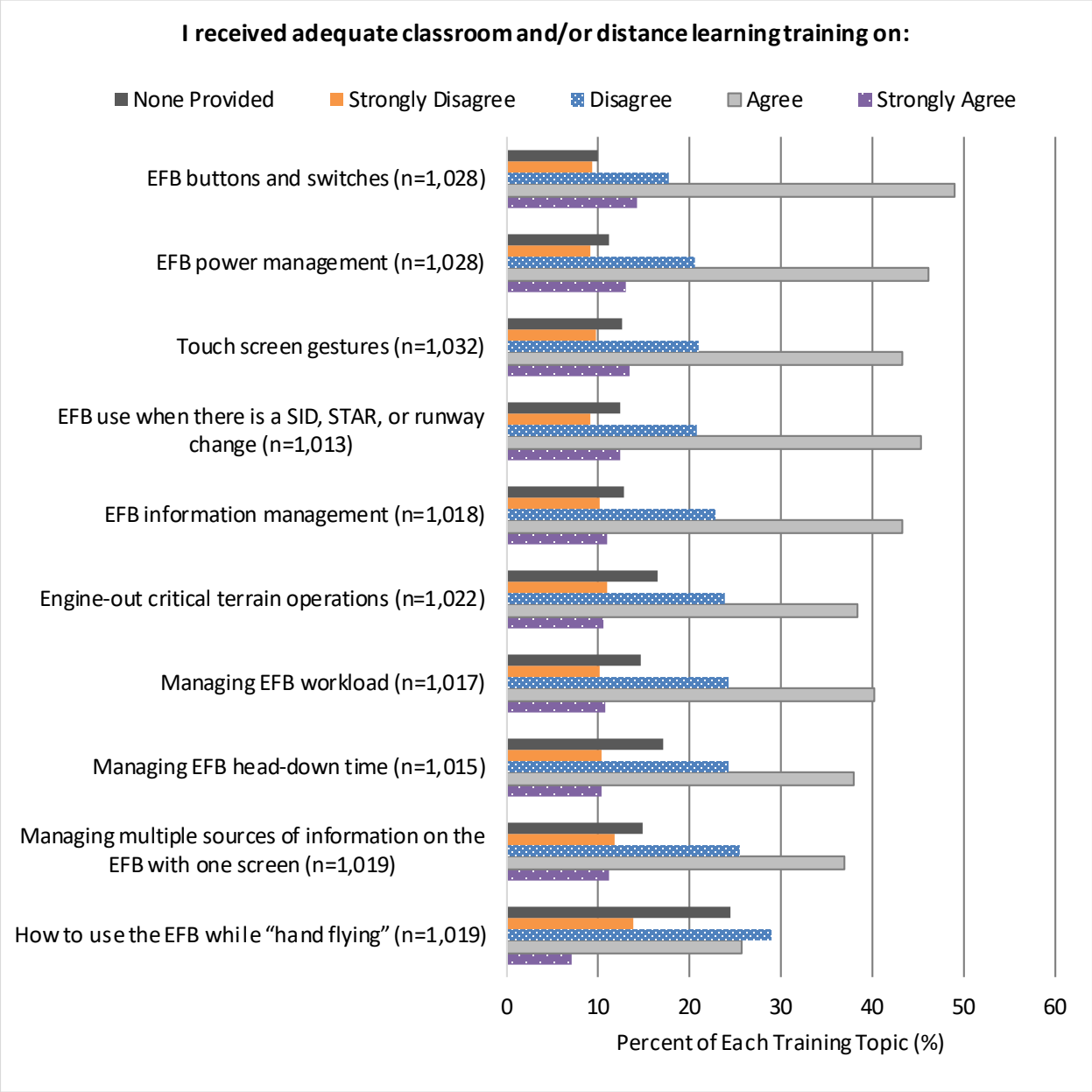


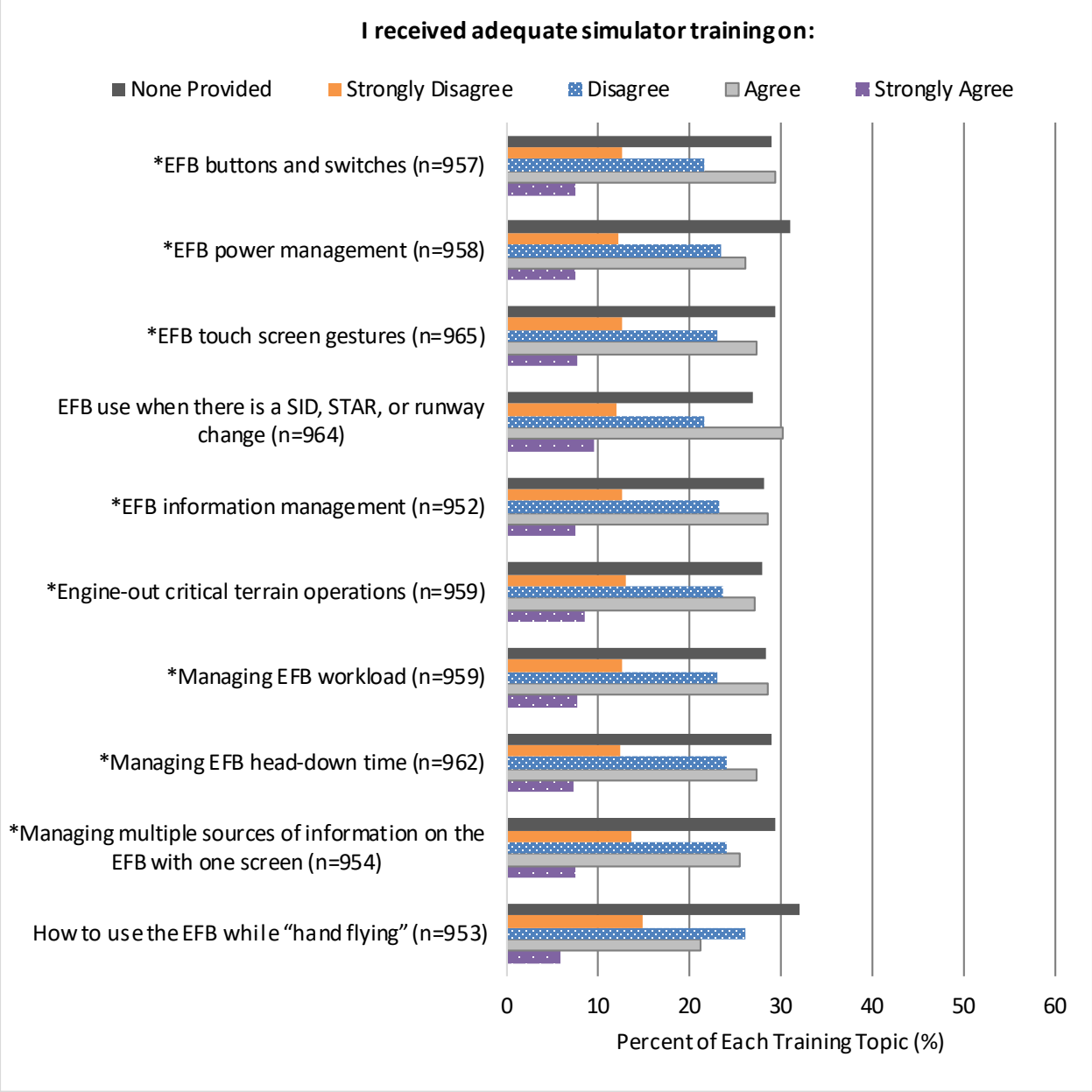
Figure 6. Classroom or Distance Learning by Training Topic

Pilot responses from the interviews and group discussions varied when asked about the type of information provided for EFB training. However, most pilots noted that they would like EFB training to provide only the basic information needed for operations, as captured by the following statements:

- "Give me everything I need, maybe not the deluxe tricks, but give me all the basics I'm going to need in explicit format. I don't care whether video, memo, step by step process or an hour of instruction in the simulator [which is not going to happen with 12 thousand pilots and training pay]. Just give me what I need up front."

- "I don't want to know the user's guide, I want to know how do I not get in trouble and in what ways I can use this tool I've been provided and be able to really capitalize on what it brings to the environment."

Survey responses indicated that EFB topics are not always covered in simulator training, similar to findings from our discussions with pilots. Approximately 28-31% of pilots noted that simulator training was not provided on all training topics listed in Figure 7 below.



*. Comparison of disagree/strongly disagree and agree/strongly agree groups (χ^2) is not statistically significant; however the overall χ^2 test is statistically significant.

Figure 7. Simulator Training by Topic

Pilots from the interviews and group discussions provided additional insight into simulator training. EFB use in simulators often occurs as part of larger tasks that pilots are required to complete during training.

- "My airline did not provide simulator training for our EFBs, however, our simulator instructors are free to provide technique, tips and tricks, or other suggestions regarding EFB usage when observing us perform during other simulator events."
- "Sim training included some sims where we had to use the aircraft-mounted EFB, some where we had to use the iPad, and some where we could use either/both as we desired. This was good, as it forced us to become proficient with both."
- "We need to demand that pilots use the iPads during simulator emergency training to gain experience during high stress."

Pilots were asked if they were satisfied with the EFB training they received at their airline when changes to EFB software or hardware occur, for example, with new applications or modifications to EFBs. Most pilots (65%) are satisfied or very satisfied with this type of additional training, however, we identified 151 survey comments from pilots whose airlines do not provide this type of training:

- One pilot stated that there has been "no recurrent EFB training and yet numerous new APPs have been added."
- "With the constant changes to app operation, it would be nice for some time to be devoted during recurrent to EFB operational changes and tips on how to get [the] most out of the EFB."
- "We are told when various updates are required but not much in the way of what updates are being made. It is frustrating when the updates change the way various functions are performed or change the location where the user accesses those functions. You have to relearn - on your own - how to do what you previously knew how to do. Usually these "changes" are discovered while flying the line."

Comments from the interviews and group discussions also indicate that pilots do not always receive training for hardware and software changes. One pilot recalled receiving an email notification for a new electronic document application but received no instruction on how to use it. The pilot noted that training would have been beneficial to help him understand how to effectively use the new application for flight.

3.2.3 Improvements to EFB Training

Pilots pointed out in the survey and in our discussions that using a tablet at home is very different from using a tablet to complete specific tasks during flight operations:

- "I'm an iOS guy, but half the time I'm trying to figure out where I can go to dim the screen or make it brighter. I mean it's that bad. Opening apps, being able to transition software, so being able to update the apps… how do you check that your manuals are up-to-date, that your apps are up-to-date?"

- "For older pilots who use computers for word processing and emails and are unfamiliar with iPads this is and was a difficult transition. Comments from IT [Information Technology] advisors like, 'it is the same icon like in the game xxx.' I do not play video games."
- "In new hire training it was assumed that everyone either owned or had owned an iPad. I had no experience with an iPad. I felt behind as a result. My sim partner was most helpful. But I should not have needed to rely on him."

Classroom training for EFB-related topics is particularly useful for pilots because it gave them the opportunity to ask questions, and to see how an instructor or other pilots may approach retrieving certain information. Hands-on operational experience was most important for gaining proficiency with EFB functions, although pilots did not necessarily feel simulator training was the only way to get this type of experience. One pilot felt that simulator time should be reserved for practicing maneuvers and procedures rather than dedicated time to learning EFB functions. Other pilots felt that a lower-cost method would be helpful for gaining hands-on experience outside of actual flight operations:

- "I think you could really improve the tabletop training with this. You don't necessarily need the simulator. I think some of this training could just be done two pilots sitting next to each other in a scenario. You don't need a simulator to do this."
- "It doesn't have to be a full motion device with sound and everything. Put them in an FTD [flight training device], let them play - a runway change on takeoff, or departure change or on arrival an approach change, that type of thing."

Several pilots during interviews and group discussions agreed that gaining real-world experience during operations is more helpful than time in the simulator for gaining proficiency with EFB use, as illustrated by the following quotes:

- "Really the training was on-the-job. Pushing buttons and finding out what works for you is probably one of the best training parts of it - working with it."
- "If you look at the 223 slides on this electronic flight bag [online] lesson, it's probably more about how do I enter airport identification, when am I complete, how do I navigate throughout the options. But as far as how to manage the EFB, we don't have a formal training program. That's more word of mouth and interaction. If you and I fly and I see you did something unique and I'll go holy smoke that's a great idea, I'll put that in my bag of tricks."

3.3 Reliability of the EFB

Overall, pilots viewed an EFB's reliability as generally good. Pilots (75%) responded that they agreed/strongly agreed that the EFB is reliable and requires little, if any, pilot interaction for reboots during normal line operations. Of the 25% of pilots who disagreed gave comments (36) summarizing the situations they encountered on the flight deck. A few examples are listed below:

- One pilot summarized the sentiment by stating, "You are constantly waiting for the slow (tablet) to catch up with you; then when it crashes you have to start again."

- Slowdowns with the software loading or freezing due to the age of and amount of use as the device gets older (14).

- Some airlines have a procedure to give pilots new devices every four years but after two to three years' slowdowns can start to occur (6).

Pilots during the interviews also mentioned the need to sporadically reboot their device during operations, mostly due to freezing or updates. For some a reboot occurred at least weekly for unknown reasons (9). Several pilots thought this could be because of recent updates to the system.

3.4 EFB Settings

Pilots were asked if power settings (e.g., screen going to sleep, screen lock, settings, etc.) and password changes distracted them during flight operations. Only 35 percent of pilots agreed or strongly agreed with the survey statement. For those who did report having issues with EFB settings, the issues were related to the sleep mode, passwords and brightness settings. These comments were similar to those made during the interviews.

Pilot comments from the interviews also stated that tablets can lock or go into sleep mode too fast. After a few minutes without pilot interaction, the auto-lock feature activates. Pilots have no way to lengthen this setting.

- One pilot stated, "If you are not actively touching the device then it will lock-up where a password must be entered. In an emergency this could cause some delay if you enter your password incorrectly and then need to keep trying." Although only one pilot mentioned this occurring at a critical time, other pilots (11) agreed that this is possibly more than just a nuisance and makes the device "less than reliable."

- "Precious seconds are lost just getting the EFB to wake up from sleep mode."

- Other plots found the sleep setting helpful when their battery was running low because saving battery life was of critical importance.

When pilots from the survey commented on password issues, they focused on needing to change their password often (23) during flight, as shown by the following quotes:

- "Entering multiple passwords in multiple apps increase workload. If a company has you unlock your device to access it shouldn't be done with entering multiple passwords to access information."

- "You could sort of justify it for company info but that bag of paper charts next to my seat isn't locked so why do I have to deal with passwords to get to my approach charts. My solution is to

always carry my personal [tablet]… to show NexRad [Next Generation Weather Radar] weather."

- "My iPad is usually OK, but occasionally quirky. I've had it blink and present the passcode to unlock the screen in the middle of a flight twice recently. Then I have to re-enter the approach charts - not comforting."

- Pilots reported concern with the number of passwords they needed to remember for the device and different applications (10), while others commented about when they are prompted to update their passwords (6).

One additional pilot from the interviews described a case that can result in a loss of charts and manuals during flight due to password changes:

- "The password specific for the device that we use is connected with our email account. The problem is that we have to update that email account password every 90 days. The only way you can properly update the password is if you do it online, not through the EFB, but you have to do it online on a computer. Once you update your password on the computer, the only way you can update the password on this device is if you're at work on a company server. Then you can update the password. Otherwise, what ends up happening is if you don't update the password on the EFB it will continue to open, but you're not able to update your manuals or the apps because of the security feature."

In terms of brightness settings, the majority of pilots responding to the survey (86%) agreed/strongly agreed that EFB brightness adjustments are easily made with few steps, and that the brightness levels are adequate for day and night operations (83% and 89%, respectively). However, in the interviews, pilots commented that there can be issues with brightness setting and night mode.

- Three pilots agreed that the night mode setting is very distracting until the brightness can be corrected to its normal level.

- "If the [tablet] goes to sleep, it reawakens in a brighter mode than it was set to at the time it went to sleep, requiring another adjustment." The pilot added that this affects pilots' night vision and creates a distraction when flying a potentially complex approach.

- "The electronic chart application has its own brightness setting in addition to the device itself," and, the brightness level for electronic charts always returns to high after the device wakes from sleep or lock mode, regardless of the settings initially entered.

- Even after pilots find their preferred brightness setting, default settings are restored without warning after updating the operating system or an application, and after resetting the hardware.

3.5 Battery and Power Supply

Running out of power for portable tablets was one of the most common concerns pilots expressed in

the group discussions and the survey comments. Over half of pilots (58%) who responded to the survey felt that tablet batteries did not have sufficient power to support operations during a normal flying day and that they need a spare battery or to recharge using an airplane electrical source. Most pilots found the spare battery or airplane electrical source easy to use (83%).

Pilot comments (67) from the survey revealed issues with battery life on the flight deck.

- "Biggest problem for me as a B737 captain is managing battery life for a long multiple leg day. I have to constantly turn the EFB off to conserve battery life."
- "Battery life is not what is claimed by company. Every pilot carries an extra battery at their own expense and different brands and sizes. While the EFB was tested for many months the extra batteries were not tested and mine overheats sometimes when charging [the tablet]."
- "Pilots are encouraged to leave their tablets dark as much as possible to ensure battery power throughout a 12 plus hour duty day. This 'policy' indirectly causes many pilots to avoid using the enroute charts and looking up minor technical questions in order to preserve battery life."

Airlines may provide different guidelines for charging of devices and use of batteries depending on the configuration of their aircraft fleets. In the group discussions, pilots felt that many of these guidelines do not address pilots' concerns, especially during long-haul flights. They provided insight into these guidelines at their respective airlines:

- Five of the pilots did not have the ability to charge their EFBs during flight, either because there is not a dedicated power source in the aircraft, or because its use is restricted.
- One airline allows pilots to charge their EFBs any time except during takeoff and landing.
- Three pilots said they can charge their EFB only at the gate, but they indicated that there is not always enough time at the gate to sufficiently charge their EFBs.
- One pilot recalled a situation where a colleague needed to take extra time at the gate to ensure that the tablet was adequately charged, resulting in a 20-minute flight delay.

In order to avoid delays but find safe work-around for charging a depleted battery during flight, pilots sometimes use their own techniques to extend the life of their tablets. These techniques include using back-up batteries or portable chargers that may or may not have been approved by the airlines.

Pilots responding in the survey provided the following examples of battery life concerns and work-arounds:

- "They don't provide us with a battery backup, and prohibit us from using one, so we are only allowed to use one outlet on my fleet, which requires stringing a cord across the cockpit, which isn't the safest solution."
- "We have been slow to retrofit EFB chargers on the 737 fleet - the work around is adequate but

presents a cockpit organization challenge when the captain has to have his charging cord run across the cockpit to the charging port behind the first officer's chair."

- "Battery life is not acceptable for regional flight schedules. Pilots are encouraged to leave their tablets dark as much as possible to insure battery power throughout a 12 plus hour duty day. This 'policy' indirectly causes many pilots to avoid using the enroute charts and looking up minor technical questions in order to preserve battery life. There are no approved external battery devices at this airline."

Pilots in the group discussions provided the following examples:

- "We [pilots] are all good innovators because we are trained to be resilient. You will see all kinds of 'devices' in the airplane to extend their [EFB] life."

- One pilot said that he turns the tablet off after takeoff, and it remains off until 10 minutes prior to landing or top-of-descent, but thought that the battery life was appropriate for his usage.

Pilots in the individual and group discussions also agreed that operating an aircraft without a dedicated power source for tablets is a significant distraction to pilots and can introduce a safety risk. Pilot concerns are summarized in the following comments:

- "When you don't have a dedicated power source in the airplane, it is a huge distraction to us… I have to meter or monitor my EFB use to make sure I don't run out of electricity before I land. That's wrong."

- "That is a huge distraction. No, I don't want to turn the iPad on because I only have a little bit of juice. I think I remember what's on this arrival. That's a problem…it introduces a safety risk."

- "During the flight, we are managing battery life that's now, watching it wind down from 100% to 0%, so we have to kind of manage. I may want to do some studying but I have to think about the return flight, and at hour 10… I've been down as low as 18%, 17%, thinking ok, well at least the day is done now."

- Another pilot mentioned that the indictor of battery life on his tablet shows the combined charge of the main and spare battery making it impossible to know how charged the spare battery is.

Another pilot in the group discussions shared an experience that highlights the importance of training on EFB power and batteries:

- Soon after transitioning to a new device, the pilot recalled removing the tablet from the mount to conduct a briefing but was unaware that removing the tablet also disconnected the power. The device then shut down unexpectedly because it was not reconnected to the power source when it was placed back in its mount.

Charging the tablet between trips can also be a concern for pilots. Pilots in the group discussions

mentioned that they found that their EFB did not charge because of a loose connection or other issue.

- In one example, a pilot thought his EFB was charging overnight through the hotel lamp outlet, but when he turned off the lights, the power to the outlet turned off without him realizing, disabling the charge to the tablet. The pilot managed the low battery level by charging the tablet at every opportunity throughout the day.

3.6 Electronic Charts

Overall, pilots are satisfied with using electronic charts. Survey data show that 88 percent of pilots agree/strongly agree that the application selection areas for Standard Instrument Departures (SIDs), Standard Terminal Arrival Routes (STARs), and Instrument Approach Procedures (IAPs) are easy to read and select. Additionally, 76 percent of pilots agree/strongly agree that the chart selection areas require minimal head, arm or torso adjustments to properly read and select.

Pilots in the interviews and group discussions are also satisfied with electronic chart functionality, however they identified areas where they would like to see improved functionality. The following comments provide examples of what pilots find beneficial, as well as what they feel needs improvement:

- Twelve pilots comment on the value of depicting ownship position on electronic charts while taxiing. Although all the pilots recognize the value of ownship on the ground and in flight, pilots have mixed views on its reliability. Two of the pilots work for airlines with approval for ownship in flight and note that the Global Positioning System (GPS) signal is very poor enroute[1]. One pilot recalls noticeable errors that were quite large. Other pilots explain that they may quickly refer to ownship on their chart, but would not rely on that data. Instead, they continue to rely on their installed aircraft systems.

- Two pilots note that they find the search feature on electronic charts very useful for locating fixes and navigation aids.

- Electronic charts with an automatic pop-up feature that brings up taxi charts while on landing rollout are considered particularly useful at unfamiliar airports or at night.

- Five pilots mentioned that electronic charts could be improved by redesigning them specifically for viewing on electronic formats, for example data-driven charts rather than digital copies of paper charts. Data-driven formats allow for decluttering and other capabilities that are not currently available.

Pilots report that they often need to use the zoom function to view charts and documents on the EFB. Just over half (55%) of the pilots responding to the survey say that they could not clearly view the

[1] Note that this reflects GPS capabilities at the time of the group discussions in February 2018, and does not reflect more recent improvements in GPS accuracy.

information on IAPs without adjusting the zoom level while the EFB is in the mount. For example, one pilot notes that,

- "In order to read the notes or amplifying information on an IAP, you have to zoom. However, the overall flight profile, restrictions, limitations and frequencies are easily read without having to zoom."

When pilots need to adjust the zoom level or otherwise interact with IAPs, most pilots (93%) agree/strongly agree that they can easily do so while the autopilot is on. However, fewer pilots (56%) felt that they could easily interact with IAPs while hand flying the aircraft. This is expected since pilots require both hands on the flight controls while hand flying and are likely to ask the pilot monitoring for assistance if they need information. Pilot comments include:

- "To manipulate the EFB, I have to either let go of the controls (which I don't do) or use my throttle hand to cross-reach to the EFB, which completely destroys/obstructs my instrument scan. In these cases, I ask the Pilot Monitoring to give me the information I need at the time."

- "When hand flying I either have to reach across my body with my inside hand the one operating the thrust levers to manipulate the EFB located on the side window, or switch hands on the control yoke to use my outside hand. Basically when hand flying I make sure I already have the info up on the EFB that I want so I don't have to change it."

Similarly, during the interviews, pilots indicated that they liked the zooming capability on electronic charts, particularly when charts such as IAPs have very small text. However, pilots also cautioned that information may be easily missed when it is off-screen due to zooming. For example,

- Some speed restrictions at certain altitudes along an arrival may be in text boxes in the margin, outside of the visible viewing area.

- One pilot recalled an experience on arrival when a controller called in to check their speed. The pilot and first officer were unable to find the published speed restriction until the controller suggested that they zoom out on their arrival chart.

When it comes to viewing electronic charts in dark conditions at night, survey data show that 94 percent of pilots with night mode capabilities agree/strongly agree that the charts are usable when displayed in night mode.

3.7 Electronic Documents

Overall, survey data show that over half of the pilots responded positively to questions regarding the use of electronic documents. When problems did arise, the same types of issues were described across all three data collection efforts.

Survey data show that 58 percent of pilots agree or strongly agree that their electronic documents are

organized and indexed in a manner that allows them to quickly and easily search for information. We identified 251 survey comments that point out specific issues with document searching that are summarized by the following quotes:

- "Emergency procedures are extremely difficult to access because you must type the procedure exactly as it appears in the manual. For example, you cannot type 'Engine Failure.' You must type 'ENG 1 (2) FAIL.' Even typing 'Engine fail' will bring up zero results."

- "The search function requires exact word order and speeling. And yes I spelled spelling incorrectly, because in a time critical situation during a word search for 'engine out driftdown', I should get results for 'eng out drftdown,' 'engin oot drifdown,' 'drift down egine out,' or any reasonably close approximation. The algorithm should use some level of Baysian probability instead of a 100% match!"

Sixty percent of pilots who were surveyed about updates and revisions to documents and manuals agree or strongly agree that revisions can be easily viewed to help pilots understand the specific material that has been changed. Pilots who felt document revisions cannot be easily viewed provided the following examples of how this can impact how they review manuals and other materials for flight (250 comments were provided):

- "Revisions are fast to update and do not force the pilot to become familiar with the new changes."

- "Revisions and changes are hard to spot. Too much info is crammed at will. Notes and highlighting are always lost upon revisions. This makes studying hard and things difficult to review."

- "When we had paper, at least you would glance at the changes before inserting in the manuals. Now, it just downloads into the EFB and changes are just overlooked."

- "Revision material is readily indicated but since revision is automatic (requires minimal if any pilot action) most pilots seldom bother to look at revision information."

Pilots also commented in the interviews and group discussions on changes in how pilots review document revisions using electronic formats.

- "There are no hyperlinks to the changes, so it's difficult to find the revisions to see what information has been changed."

- "How do you let pilots know what you've revised? Paper was more tedious but we were probably more in tune with what the changes were."

- "When we have a whole com revision, the whole thing gets redone. We will probably just tap the hyperlink to take us to the revision, to the new section. We'll kind of go through that [hyperlinks], but I'm not necessarily going to read through the whole thing start to finish again. If I had a paper copy, I'd be more inclined to read more into it."

Pilots across all three data collection efforts expressed the need for a paper Quick Reference Handbook (QRH) in addition to electronic versions. From the survey, 88% of pilots agree (with 68% strongly agree) that a paper copy of the QRH for non-normal situations should be available. Pilot comments from the survey include issues with managing more than one chart or document on the same screen during an emergency.

- As one pilot noted, "Paper copies of the QRH allow you to look at the QRH while referencing other things in the EFB simultaneously. That reduces time in what could be a critical situation."

Other concerns include the potential for EFB failures, for example:

- "In a non-normal environment, EFB failures of any kind cannot be tolerated. You don't have time to figure it out. Paper QRH referencing doesn't require a charged battery, passwords, lighting displays, or reference locating to use. They are readily available when needed."

Pilots express similar opinions in the interviews and group discussions about maintaining a paper copy of the QRH, particularly for non-normal or emergency operations as shown below.

- Ten pilots stated that the QRH should always be presented on paper because it would be too cumbersome in an electronic format, especially in non-normal situations. This is because of the risk involved in only having electronic information available to pilots in these conditions, as well as increasing the number of documents that must be managed on the same device at once.

- "If we were to use the QRH on the EFB, I think we would have a problem because we would be referencing three documents on one tablet."

- Another pilot stated that it would be challenging to use an electronic QRH during an emergency "in the heat of battle," particularly when using a touch screen to switch between applications which require using the correct finger gestures.

Pilots also addressed information search using electronic documents during the interviews and group discussions. Pilots thought that electronic search functions are helpful when compared to paper, however 13 comments from pilots describe shortcomings with search functionality.

- As one pilot put it, "Has it [EFB] saved us versus paper? Absolutely... If I know where to find or look for the information that's very, very helpful, and being able to search."

- Searching electronic documents can affect pilot workload if too many steps are required to find the needed information. One pilot noted that there can be many more steps to get to the desired information on a tablet than with paper (i.e., turn on the device, enter a passcode, go to the application, find the index, and use the menus to drill down to the information needed (aircraft, system manual)).

- Five pilots stated that they could only search within one document at a time and felt a function that searched all documents at once would make things more efficient.

- Six pilots stated they could search all the electronic documents at once, however, this was not always helpful. Similarly, to the survey comments, if the search term were too specific no results would be given, but if it were too general, such as *FMS [Flight Management System]* and *full thrust takeoff*, there could be too many results.

Pilots additionally commented that bookmark, notation, and highlight capabilities are useful tools for marking frequently used information for easy future access and can make navigating long documents and manuals both easier and faster. However, pilots also noted that bookmarks, notations and highlighting are not saved, which is problematic during operations, as well as when reviewing document revisions and updates.

- Of the 18 pilots, 17 commented that their bookmarks, notes, and highlights are deleted when a document is updated.

- Two pilots mentioned that they stopped using these features due to frustration with disappearing bookmarks and annotations, and tend to read manuals less thoroughly than they would with paper documents. Instead, they choose to look up the information as they need it.

Pilots also shared similar comments (39) in the survey relating to bookmarks and searching for information, which are best summarized by the following quotes:

- "Does not retain bookmarks so I spend a lot of time searching for things I need."

- "It's not as easy to try to find information as it is to go to a tabbed book, especially when bookmarked items disappear with every upgrade. Why even bookmark anything when the bookmark or highlight goes away with revisions?"

- "Every time a manual is updated, the Bookmarks do not move. Every bookmark is now wrong and must be manually changed. This is time consuming and confusing. Especially when it happened to me the night before a checkride."

3.8 Workload and Head-Down (Away) Time

In the survey, pilots were asked if they needed to interact with their EFB (e.g., switching applications, data entry, etc.) due to departure, arrivals or runway changes. Almost all pilots (94%) agree/strongly agree that they did. During high workload events such as runway changes, approach changes, and emergency procedures, most pilots agree/strongly agree that they could access information as easily with paper charts or manuals (79%).

The survey also included a question about airline guidance and policy for high workload scenarios. Pilots were asked if their airline provides policy and adequate procedural guidance for operating with EFBs at critical terrain airports during engine-out events when the special chart is not in view. Approximately half (53%) of pilots felt that guidance and policy was adequate. Other pilots felt that they were not given adequate guidance and policy (29%), and still other pilots were not provided with any policy or guidance

for the situations (18%).

The majority of pilots felt that managing EFB information during line operations decreases or slightly decreases workload (75%), whereas only 25 percent of pilots felt that EFB use increases or slightly increases workload.

Similarly, pilots in the interviews and group discussions felt that workload and head-down time is improved with the EFB compared to completing the same tasks with paper.

- For one pilot, the most valuable benefit is that he does not need to sort through a series of paper charts. For example, with paper, the pilot would keep three or four possible approaches out when landing at airports where runway changes are common. The pilot stated that with a tablet, "I know it's quick. It's a very fast button click. It has decreased the time spent finding stuff." Likewise with paper manuals and documents, "The ability to find information is much quicker. That has been the biggest benefit I've seen, and not dealing with paper."

- "Compared to paper charts, workload decreases, but overall using an EFB takes away from flying the airplane."

Some pilots commented (25 comments) in the survey that they did not see a difference in workload, and that interacting with an EFB is about the same as interacting with paper on the flight deck.

- "I don't really think that the EFB decreases pilot workload, but I think that it is overall more effective in managing information. For example, it is often necessary to manipulate the EFB. However, it was also necessary to shuffle different plates in the paper world."

Pilots in the interviews and group discussions noted that EFB functions changed the way they perform their tasks, including workflow, time management, flight planning, information organization, and managing flight paperwork. There is a "shared workflow" that is unique to EFBs that can be both helpful and hindering. As one pilot explained in the following comment:

- "In terms of flow, if you're both using a device that shares, and I beat you to loading the chart clip or vice-versa, I may ask [for it] or just give it to you. So there's a shared workflow that didn't exist with paper that could be an inefficiency. One guy is working harder, and the other guy's not because he hasn't got the charts yet. Well I'll send them to you. You can't do that with the iPad. So if that's your habit, and for some captains it is, they say 'hey when you're ready, send me the charts.' And the [fist officer] goes 'Oh I'm not using the [installed] EFB, I'm using the iPad.' So there's maybe a workflow interruption."

Pilots provided additional examples of how EFBs impacts workflow and/or workload including:

- "I've had to change the way I think and what I do to get information."

- Things that were intuitive using paper now require more thought; for example, with EFBs, each side of a two-sided chart or document may need to be selected separately.

- The number of EFB functions in use can impact workload. For example, various calculations and checklists may need to be completed on a single screen.

- Finger gestures can be challenging when using two different applications as well as using two different devices with different interfaces.

    - "[Permanently mounted EFBs] were fixed in time… you would see pilots use touch screen gestures, but it would yield a different result than they expected." For example, "a tap would zoom rather than a pinch."

    - Applications "will have similar functions, but completely different, contrasting interfaces."

    - "The operating system is not that seamless. [The chart] has different gestures to switch charts than the operating system uses to switch between applications." For the charts it's "two fingers to move around the screen, three fingers to switch charts, then it's four fingers to switch between applications. It can get confusing."

In the survey, pilots were asked if they remove their tablet from its mount to aid in briefing during times of low workload such as pre-departure briefing at gates or an approach brief at altitude prior to descent. Pilot responses were mixed with 26 percent of pilots always removing it, 19 percent never removing it, and 55 percent removing the tablet some of the time. This may reflect differences in airline policy and recommendations for conducting briefings, as well as individual differences in the way pilots manage communicating on the flight deck.

For head-down time, the survey data show that 65 percent of pilots felt that managing EFB information during line operations decreases or slightly decreases their head down time when managing EFB information, while 35 percent felt their head-down time increased or slightly increased.

Pilots' comments from the survey on head-down time were most telling regarding when excessive EFB head-down time could become a problem. Pilot comments included:

- "Just like any electronic device, people lose track of how much heads down time they are engaged in. As a relief pilot, I have had several occasions where I needed to remind the PF [Pilot Flying] and PM [Pilot Monitoring] to have one of them fly the aircraft as they were both head-down with their EFB."

- "There has been zero guidance policy on PM/PF use of the EFB. As a result, the concept of 'someone is always flying' has gone out the window. From the jump seat I have seen both pilots with their seats back from the controls, looking at their EFB's. They did not see any problem with this. Many times, I, as CA [captain]/PM have communicated I am going heads down for the runway change on arrival only to look over at the PF to see him completely absorbed with his EFB. No one was flying the airplane and our 'SA' [Situation Awareness] was completely gone."

Other pilots in the interviews and group discussions felt that additional communication is all that is needed to handle any additional head-down time, for example:

- "Don't go heads-down too long, [and] make sure one person's flying if the other person is buried in programming. So state that you're going to be heads-down on the EFB and open multiple pages in a way of trying to reduce heads-down time."

Pilots in the interviews and group discussions mentioned that tablets can be more distracting than paper in some ways, partly due to the wealth of information available on electronic devices. Pilots also felt that the tablet initially "introduces a new pathway for distraction that wasn't there before," until pilots become comfortable with using the tablet for flight operations and gain proficiency (7). Pilots provided the following examples of EFB distraction:

- One pilot felt more distracted while using an electronic device both on the flight deck and in daily life. The pilot observed that it can be more difficult to get someone's attention while using a tablet or smartphone, and that it can take one's attention away from their environment, stating that the EFB "hypnotizes you and sucks your attention away from everything. I don't hear anything, I lose my peripheral vision." He also described electronic devices as "stimulating" due to the "color, the movement, interaction." Other pilots felt that there is a difference in the way they interact with the flightcrew or someone who enters the flight deck, for example, while looking at weight and balance information on paper compared to a tablet.

- "I've got four apps open and I need to figure out which one I'm going to use for [a particular task]. I got a lot of cool stuff on there."

- "I think you just opened Pandora's Box. Now you're talking distraction, because right now, we're only limited to what is native or whatever's installed on that [tablet]. Plain and simple. Guys aren't going to be sitting there reading the manual or whatever the whole time."

- "It's real easy to go to the EFB without first saying is it appropriate to go to the EFB. It has the potential for the opposite if you don't use it right."

- "You cannot let it distract you to the point where you're missing radio calls or handoffs or things like that, and it has. I think you have to use it as a tool, but you have to know when to stop."

- "In a domestic environment where language isn't an issue, clearances are very consistent, the pure challenge is keeping awareness and EFBs make [that] more difficult."

4. Summary

This document provides the results of a two-year effort from July 2016 to August 2018 to better understand pilot perceptions of managing information on devices used for EFB functions.

Tablet battery and power issues were the most reported concerns across the three data collection efforts. Most pilots reported that they do not have enough power to last a full day of flight and must carry backup batteries or connect to aircraft power; however, not all pilots have a power source available. Some airlines impose a battery life requirement for pilots on the first and last leg of flight each day. In order to meet these requirements, 67 pilots reported needing to turn off their device to save power or implement creative solutions on the flight deck that may or may not be airline approved.

The reliability of EFB hardware and software was not a cause of distraction for most pilots who responded to the survey. For pilots who did find reliability to be problematic, issues included auto-lock and sleep mode activation at inopportune times during flight, and the need to continually enter a password in order to sign back into the device each time, as well as software freezing or slowing down, resulting in the need to restart the device. Lack of reliability in the system can potentially take pilots away from other tasks.

Pilots perceived their workload and head-down time to be decreased in some areas and increased in others with EFB use compared to paper. For example, pilots had to learn new strategies for finding the information necessary for flight using electronic sources, and adjust their workflow to accommodate these changes.

For electronic documents, most pilots responding to the survey reported being able to easily search for information; however, those pilots that did not find the document search functionality to be adequate experienced the same types of issues across the all three data collection efforts. One overarching issue is the challenge of finding the correct search term. If terms are too specific, too few results are returned, while if terms are too broad, then too many results are returned which can be difficult to manage.

Pilots across all three efforts strongly agree that a paper copy of the Quick Reference Handbook (QRH) needs to be maintained on the flight deck. Pilots cited reasons including the potential for EFB failure, the need for power, passwords, lighting and other potential electronic hurdles in an emergency. Other pilots noted that they did not feel as confident finding information on the EFB, as they did using paper.

Pilots are generally satisfied with their electronic chart software and functionality. Almost all pilots who responded to the online survey said that they could easily interact with their charts, (e.g., adjusting the zoom level or making inputs), while the autopilot is engaged. However, pilots felt that making inputs and adjusting the zoom level was more difficult while hand flying the aircraft. A few pilots (19) explicitly stated that they would not attempt to do this for safety reasons and/or they would ask the pilot monitoring for assistance.

In all three data collection efforts, EFB training varies across airlines (e.g., topics covered, training format

– classroom vs. online learning, and documentation). Overall, the survey data revealed that most pilots are satisfied with the training and documentation they receive at their airlines. Additionally, most survey responses show that pilots are satisfied with additional training or documentation they receive when there are changes to EFB hardware or software when they received it, but other pilots (151 from the survey) said they do not receive it with every change. Although hands-on training was important to pilots, pilots felt that their proficiency with EFB use is attained from hands-on operational experience rather than the various types of training they received.

Pilots also shared their opinions about improving training at their airlines. Pilots noted that it would be helpful for training to be developed around the operational tasks that require use of EFB information, rather than being overwhelmed with details on all the capabilities available on their devices. Overall, pilots also felt that classroom training is preferable to online or distance learning for EFB functions and devices, because they have the opportunity to actively participate, to use their devices, and to ask questions.

Appendix A: Individual Interview Questions

Table 1. List of Questions for Individual Pilot Discussions

Question #	Individual Discussion Question
1	How long have you been working with a [insert name] as an EFB?
2	Did you have experience with this type of device prior to using it as an EFB? Or experience with other EFB devices?
3	What tasks do you use your EFB for? During what phase(s) of flight?
4	Have you ever used more than one application or document on the EFB at the same time?
5	If response to Question 4 is no, skip to Question 11. If response to Question 4 is yes, then ask the pilot to describe the task(s): a. What is the purpose of the task(s); b. What apps or documents were used; c. Phase of flight; d. How often does this task(s) occur
6	What are the biggest challenges in using the EFB for more than one task
7	While managing multiple tasks using the EFB, have you ever experienced more workload than you considered desirable?
8	If response to Question 7 is yes, ask the pilot to describe the tasks involved: a. What tasks were involved; b. When during the flight did this occurred; c. Were they successful in completing the tasks.
9	While managing multiple tasks using the EFB, have you ever experienced more head-down time than you considered desirable?
10	If response to Question 9 is yes, ask the pilot to describe the tasks involved: a. What tasks were involved; b. When during the flight did this occurred; c. Were they successful in completing the tasks. d. If not already included in their response, follow up by asking about workload and head-down time while searching for information on the EFB.
11	Has using the EFB introduced new tasks for you to manage that you were not responsible for prior to using the EFB? If response is no, skip to Question 14.
12	If response to Question 11 is yes, ask the pilot about those tasks and if the new tasks came with training?
13	Have these new tasks interrupted usual workflow?
14	Have you ever been distracted from other flight deck duties while using the EFB?
15	If response to Question 14 is yes, ask the pilot to elaborate on the situation in which they found themselves distracted.
16	What aspects of the layout or design of the EFB are helpful when managing multiple tasks using the EFB, such as physical characteristics like button size and placement, auto-lock, built-in

Question #	Individual Discussion Question
	functionality, such as search options, bookmarks, customizable features, or other aspects of the software and hardware?
17	What aspects of the layout or design of the EFB are hindering when managing multiple tasks using the EFB such as physical characteristics like size and weight of device, button size and placement, brightness and reflection, auto-lock, built-in functionality, such as search options, bookmarks, customizable features, or other aspects of the software and hardware? Note: If they responded "NO" for multiple tasks on Question 4, ask about single tasks or just general usage.
18	What techniques do you use to make switching between applications/documents easier such as bookmarks or organize screen icons, etc.?
19	What techniques do you use to minimize head-down time while using the EFB?
20	Does EFB training cover techniques to minimize head-down time or workload, or make switching between applications and documents easier
21	If response to Question 20 is yes, ask the pilot if there are techniques included in training materials such as presentations, hand-outs, or provided verbally as supplemental information from the training instructor
22	What did you find most helpful about EFB training?
23	What would you like to see included in EFB training that is currently not covered?
24	Is there anything else you would change about EFB training?
25	Do you have any additional comments or insights about EFB training or EFB use in general that you would like to add?

Appendix B: Group Discussion Questions

Table 2. List of Questions for Pilot Group Discussions

Question #	Group Discussion Question
1	What types of EFBs do you currently use?
2	What information do you remember being included in (new-hire, recurrent) training on the EFB?
3	What was the format of your (new-hire, recurrent) EFB training and how well did the type of training fit with the information provided?
4	In simulator training, are there scenarios specifically for EFB training, or is EFB use embedded in other simulator scenarios?
5	After simulator training, do you feel prepared and confident in using your EFB in flight operations? Are there any additional training scenarios involving EFB use that you feel would be beneficial to include in the training?
6	Are there procedures you feel are currently or should be in place at your airline that help you understand how to best use the EFB during operations?
7	What do you like or not like about the EFB hardware? What about the battery, for example, battery life or charging?
8	What do you like or not like about the approved mount location for the EFB? Have you seen or experienced any issues with the EFB mount or its location? How has the mount location impacted your head-down time?
9	Do you feel that the EFB is adequately protected from unauthorized access (physical access or hacking), or does it need enhancement? In what ways?
10	Which applications do you use for electronic documents on the EFB, and what are the positives and negatives you've experienced with them?
11	Which applications do you use for electronic charts on the EFB, and what are the positives and negatives you've experienced with them?
12	In what ways has the use of an EFB changed the way you complete tasks during flight operations? How has the EFB changed your workload and head-down time during flight operations?
13	What is the most frequent issue you have with your EFB
14	What was the most serious or stressful issue you had with your EFB
15	If you have a problem with your EFB or questions about how to use your EFB, does your airline provide dedicated support for you, such as a help desk? Are there ways to improve that support?
16	Outside of having specific problems and needing technical support, is there a way to provide feedback about EFBs to your airline? When feedback is provided on EFBs, do you feel that pilot concerns are addressed?
17	Is there anything additional that you would like to add about EFBs that hasn't already been discussed?

Appendix C: ALPA EFB User Survey Questions

Table 3. Air Line Pilots Association (ALPA) Online Survey Questions

Question #	Survey Question
2	During airline operations, I currently use: (check all that apply) • Portable EFB that cannot be mounted • Portable EFB that can be mounted to aircraft • Permanently mounted EFB (not portable) • Installed EFB
3	Years of experience with an EFB for operations a. At current airline: b. At any airline: c. For general aviation (GA):
4	When I received my portable EFB, it took _____ to set up. • 0-15 minutes • 5-30 minutes • 30-45 minutes • 5-60 minutes • 60+ minutes
5	The internal EFB battery has sufficient power to support EFB flight deck operations during a normal flying day without the need for a spare battery or charging using airplane electrical source. • Strongly Disagree • Disagree • Agree • Strongly Agree • N/A
6	If a portable spare battery or airplane electrical source is used for normal operations, it is easy to use. • Strongly Disagree • Disagree • Agree • Strongly Agree • N/A
7	I use the mount that has been supplied to me to view the EFB: • Never • Sometimes • Always • N/A
8	I use the mount in an approved location on the flight deck: • Never • Sometimes • Always

Question #	Survey Question
	• Don't Know • N/A
9	The location of the mounted EFB distracts me from monitoring the primary flight instruments and/or monitoring what the other pilot is doing. • Strongly Disagree • Disagree • Agree • Strongly Agree • N/A
10	When the EFB is in the mount on the flight deck: a. The information displayed can be seen clearly in all lighting conditions. b. The information displayed can be seen clearly in bright sunlight (glare) conditions. c. The information displayed can be read without adjusting the zoom level. d. Information on Instrument Approach Procedures (IAPs) can be clearly viewed without adjusting the zoom level. e. I can easily shift my eyes between viewing the mounted EFB and viewing traditional flight deck instruments with minimal head movements. f. I can easily switch between apps, view different pages on the mounted EFB, and enter data from the normal pilot flying position. g. While manually flying the airplane (autopilot and autothrust off) as the pilot flying (PF), I can still easily use the mounted EFB to switch between apps, view different pages, and enter data. h. The mounted EFB does not cause the pilot to bump the EFB while accessing controls or switches or completing flight control checks. i. The mounted EFB does not obstruct visual or physical access to aircraft controls or displays. j. The mounted EFB will not interfere with crew egress in the event of an emergency on the ground. Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • N/A If you disagree or disagree with any statements under Question 10, please explain.
11	The airline's documentation provided adequate information and guidance for EFB operational use during: a. Initial EFB rollout (switching from paper to an EFB) b. New-hire training c. Recurrent training Answers: • Strongly Disagree • Disagree

Question #	Survey Question
	• Agree • Strongly Agree • No Documentation Provided • N/A If you disagree or strongly disagree with any statements under Question 11, please explain.
12	I am satisfied with EFB training I have received at my airline when changes to EFB software or hardware occur (e.g., new applications or modifications to EFBs). • Strongly Disagree • Disagree • Agree • Strongly Agree • No Training Provided • N/A If you disagree or strongly disagree, please explain:
13	I received adequate documentation on: a. Touch screen gestures b. EFB buttons and switches c. EFB power management d. How to use the EFB when there is a SID, STAR or runway change e. Engine-out critical terrain operations f. How to use the EFB while "hand flying" the aircraft (autopilot and autothrust off) g. Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen h. Managing EFB workload i. Managing EFB head-down time (i.e., not monitoring primary flight instruments) j. EFB information management Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • No Documentation Provided • N/A If you disagree or strongly disagree with any statements under Question 13, please explain.
14	I received adequate classroom and/or distance learning (DL) training on: a. Touch screen gestures b. EFB buttons and switches c. EFB power management d. How to use the EFB when there is a SID, STAR or runway change e. Engine-out critical terrain operations f. How to use the EFB while "hand flying" the aircraft (autopilot and autothrust off) g. Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen h. Managing EFB workload

Question #	Survey Question
	i. Managing EFB head-down time (i.e., not monitoring primary flight instruments) j. EFB information management Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • No Classroom or DL Training Provided If you disagree or strongly disagree with any statements under Question 14, please explain:
15	I received adequate simulator training on: a. Touch screen gestures b. EFB buttons and switches c. EFB power management d. How to use the EFB when there is a SID, STAR or runway change e. Engine-out critical terrain operations f. How to use the EFB while "hand flying" the aircraft (autopilot and autothrust off) g. Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen h. Managing EFB workload i. Managing EFB head-down time (i.e., not monitoring primary flight instruments) j. EFB information management Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • No Simulator Training Provided • N/A If you disagree or strongly disagree with any statements under Question 15, please explain
16	How satisfied are you with the following types of EFB training received at your airline? a. Initial EFB rollout (switching from paper to an EFB) b. New-hire EFB training c. Recurrent EFB training Answers: • Very Unsatisfied • Unsatisfied • Satisfied • Very Satisfied • Training Not Received
17	I was adequately compensated for my personal time and effort required to learn how to use my current EFB. • Strongly Disagree • Disagree

Question #	Survey Question
	• Agree • Strongly Agree • No Compensation Provided
18	I felt comfortable using my EFB during line operations after _____. • Less than 1 month • 1 month • 2-3 months • 4-6 months • 6-12 months • I am not comfortable using my EFB during line operations
19	The EFB is reliable and requires little, if any, pilot interaction for reboots during normal line operations. • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree, please explain:
20	EFB brightness adjustments are easily made with few steps. • Strongly Disagree • Disagree • Agree • Strongly Agree
21	EFB brightness levels are adequate for: a. Daylight operations (including direct sunlight) b. Night Operations Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree with any statements under Question 21, please explain
22	The following items are usable to me in dark conditions when displayed in night mode (i.e., black background with light text/diagrams): a. Charts b. Documents Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • No Night Mode Capability If you disagree or strongly disagree with any statements under Question 22, please explain
23	I feel the EFB is secure from:

Question #	Survey Question
	a. Physical access by an unauthorized user b. Hacking (i.e., malware, internet or WiFi access) Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree • Don't Know If you disagree or strongly disagree with any statements under Question 23, please explain
24	EFB security and power settings (e.g., screen going to sleep, password changes, screen lock, settings, etc.) have distracted me during flight operations. • Strongly Disagree • Disagree • Agree • Strongly Agree
25	Organization and indexing of airline manuals on EFBs allow for quick and easy searches for information. • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree, please explain:
26	When airline manuals are updated on the EFB, revisions can be easily viewed to help pilots understand the specific material that has been changed. • Strongly Disagree • Disagree • Agree • Strongly Agree
27	I am satisfied with using digital documents on my EFB for the following: a. New-hire training b. New aircraft training course (type training) c. Recurrent training d. Flight Operations Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree, please explain:
28	A paper copy of the Quick Reference Handbook (QRH) for non-normals should be available for use in addition to the EFB. • Strongly Disagree • Disagree • Agree

Question #	Survey Question
	• Strongly Agree Please explain:
29	If only a part of the IAP chart is viewed, the pilot can easily interact with the EFB to view the desired information on the digital IAP chart when: a. Using the autopilot b. "Hand flying" the aircraft (autopilot and autothrust off) Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree
30	Charting application selection areas for SIDs, STARS, IAPs: a. Are easy to read and select b. Require minimal head, arm or torso body adjustments to properly read and select c. EFB Workload and Head-Down Time Answers: • Strongly Disagree • Disagree • Agree • Strongly Agree
31	During line operations, I have needed to interact with the EFB (e.g., switching applications, data entry, etc.) due to departure, arrival and/or runway changes. • Strongly Disagree • Disagree • Agree • Strongly Agree
32	The airline provides policy and adequate procedural guidance for operating with EFBs at critical terrain airports (e.g., KLAS, KRNO), during engine-out events when the special chart is not in view. • Strongly Disagree • Disagree • Agree • Strongly Agree • Policy and Guidance Not Provided
33	I remove the EFB from the portable mount as an aid in briefing pilots during times of low workload, such as a pre-departure briefing at the gate or an approach brief at altitude prior to descent. • Never • Sometimes • Always
34	Managing information with the EFB _____ pilot workload. • Decreases • Slightly Decreases • Slightly Increases

Question #	Survey Question
	• Increases If workload increases or slightly increases, please explain:
35	Managing information with the EFB _____ pilot head-down time (i.e. not monitoring primary flight instruments). • Decreases • Slightly Decreases • Slightly Increases • Increases If head-down time increases or slightly increases, please explain:
36	I can easily access the information I need on the EFB during high workload events (e.g., approaches, runway changes, approach changes, and emergency procedures), similar to the paper charts or books they replaced. • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree, please explain:
37	I am satisfied with how EFBs are being used for flight operations at my airline. • Strongly Disagree • Disagree • Agree • Strongly Agree If you disagree or strongly disagree, please explain:
38	I _____ contact the EFB support team at my airline. • Never • Sometimes • Often • No Support Provided
39	I am satisfied with EFB support at my airline. • Strongly Disagree • Disagree • Agree • Strongly Agree • No Support Provided If you disagree or strongly disagree, please explain:
40	Submitting EFB-related feedback to my airline is _____. • Difficult • Easy • Don't Know • My airline does not provide a way for me to provide EFB-related feedback If it is difficult, please explain:
41	Pilots' concerns regarding EFB use at my airline are being addressed. • Strongly Disagree • Disagree • Agree

Question #	Survey Question
	• Strongly Agree • No Concerns Describe any specific concerns regarding EFBs at your airline.
42	Include any additional comments about what has worked well at your airline regarding EFB implementation or training in the space below.
43	Include any additional comments about what has not worked well at your airline regarding EFB implementation or training in the space below.
44	Enter any additional comments about EFBs that were not included in this survey in the space below.
45	What is your current position? • Captain • First Officer • Other
46	Number of years in current position:
47	Age: • 20-29 years • 30-39 years • 40-49 years • 50-59 years • 60-69 years • I Prefer Not To Answer

Appendix D: Data Tables

Pilot Background

1. Pilot position (Q45) by age (Q47)

Q45. Age Group	Q47. Current position	Count	Percent of Age Group
20-29 years	Captain	18	28%
	First officer	46	72%
	Other	0	--
	No response	0	--
	Total	64	100%
30-39 years	Captain	66	35%
	First officer	119	64%
	Other	0	--
	No response	1	<1%
	Total	186	100%
40-49 years	Captain	98	41%
	First officer	139	59%
	Other	0	--
	No response	0	--
	Total	237	100%
50-59 years	Captain	272	70%
	First officer	113	29%
	Other*	1	<1%
	No response	3	<1%
	Total	389	100%
60-69 years	Captain	115	86%
	First officer	16	12%
	Other	0	--
	No response	2	<1%
	Total	133	100%
Not provided	Captain	6	30%
	First officer	2	10%
	Other	0	--
	No response	12	60%
	Total	20	100%
I Prefer Not To Answer	Captain	15	83%
	First officer	3	17%
	Other	0	--
	No response	0	--
	Total	18	100%

*Line Check Airman (LCA)

2. Number of years in current position (Q46, Q47)

Q46. Number of years in current position*	Q47. Current position	Count	Percent years in current position
Less than 1 year	Captain	18	56%
	First officer	14	44%
	Other	0	--
	No response	0	--
	Total	32	100%
1-4 years	Captain	194	44%
	First officer	244	55%
	Other	0	--
	No response	2	<1%
	Total	440	100%
5-9 years	Captain	71	63%
	First officer	40	36%
	Other	0	--
	No response	1	<1%
	Total	112	100%
10-19 years	Captain	175	71%
	First officer	70	28%
	Other (Line Check Airman)	1	<1%
	No response	1	<1%
	Total	247	100%
20-29 years	Captain	77	66%
	First officer	39	33%
	Other	0	--
	No response	1	<1%
	Total	117	100%
30-39 years	Captain	14	93%
	First officer	1	7%
	Other	0	--
	No response	0	--
	Total	15	100%
40 or more years	Captain	1	100%
	First officer	0	--
	Other	0	--
	No response	0	--
	Total	1	100%
No Response	Captain	40	48%
	First officer	30	36%
	Other	0	--
	No response	13	16%
	Total	83	100%

*Q46 May have been interpreted by some pilots as total years of experience rather than just in their current position.

Q3. Years of experience with an EFB for operations

Q3. Years of experience with EFB	Operational experience	Count	Percent years of experience
Less than 1 year	Current airline	28	6%
	Any airline	41	8%
	General aviation	437	86%
	Total	506	100%
1-4 years	Current airline	733	54%
	Any airline	497	36%
	General aviation	135	10%
	Total	1365	100%
5-9 years	Current airline	208	40%
	Any airline	198	38%
	General aviation	116	22%
	Total	522	100%
10-19 years	Current airline	40	35%
	Any airline	43	38%
	General aviation	30	27%
	Total	113	100%
20 or more years	Current airline	27	42%
	Any airline	27	42%
	General aviation	10	16%
	Total	64	100%
No Response	Current airline	11	2%
	Any airline	241	42%
	General aviation	319	56%
	Total	571	100%

Survey Questions (Q2-41)

Q2. During airline operations, I currently use:	Portable EFB that can be mounted to aircraft		
		Count	945
		% of total	91%
	Portable EFB that can be mounted to aircraft, Installed EFB		
		Count	37
		% of total	4%
	Portable EFB that cannot be mounted		
		Count	20
		% of total	2%
	Portable EFB that can be mounted to aircraft, Permanently mounted EFB (not portable)		
		Count	19
		% of total	2%
	Portable EFB that can be mounted to aircraft, Permanently mounted EFB (not portable), Installed EFB		
		Count	9
		% of total	1%
	Installed EFB		
		Count	6
		% of total	1%
	Permanently mounted EFB (not portable)		
		Count	5
		% of total	<1%
	Portable EFB that cannot be mounted, and Portable EFB that can be mounted to aircraft		
		Count	3
		% of total	<1%
Total:		Count	1044
		Percentage	100%
Overall χ^2 χ^2 (7, N=1,044) = 5816.58, p < .001			

Q4. When I received my portable EFB, it took ___ to set up.	0-15 minutes		
		Count	124
		% of total	12%
	15-30 minutes		
		Count	258
		% of total	25%
	30-45 minutes		
		Count	217
		% of total	21%
	45-60 minutes		
		Count	166
		% of total	16%
	60+ minutes		
		Count	279
		% of total	27%
Total:		Count	1044
		Percentage	100%
Overall X^2 χ^2 (4, N=1,044) = 75.10, p < .001			

Q5. The internal EFB battery has sufficient power to support EFB flight deck operations during a normal flying day without the need for a spare battery or charging using airplane electrical source.	Strongly Disagree		
		Count	254
		% of total	24%
	Disagree		
		Count	350
		% of total	34%
	Agree		
		Count	312
		% of total	30%
	Strongly Agree		
		Count	126
		% of total	12%
Total:		Count	1042
		Percentage	100%
Overall X^2 X^2 (3, N=1,042) = 110.54, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,042) = 26.45, p < .001			

Q6. If a portable spare battery or airplane electrical source is used for normal operations, it is easy to use.	Strongly Disagree		
		Count	63
		% of total	7%
	Disagree		
		Count	99
		% of total	11%
	Agree		
		Count	355
		% of total	38%
	Strongly Agree		
		Count	421
		% of total	45%
Total:		Count	938
		Percentage	100%
Overall X^2 X^2 (3, N=938) = 413.97, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=938) = 401.91, $p < .001$			

Q7. I use the mount that has been supplied to me to view the EFB:	Never		
		Count	9
		% of total	1%
	Sometimes		
		Count	86
		% of total	9%
	Always		
		Count	923
		% of total	91%
Total:		Count	1,018
		Percentage	100%
Overall X^2 X^2 (2, N=1,018) = 1514.63, $p < .001$			

Q8. I use the mount in an approved location on the flight deck:	Never		
		Count	8
		% of total	1%
	Sometimes		
		Count	53
		% of total	5%
	Always		
		Count	946
		% of total	94%
Total:		Count	1,007
		Percentage	100%
Overall X^2 X^2 (2, N=1,007) = 1667.64, $p < .001$			

Q9. The location of the mounted EFB distracts me from monitoring the primary flight instruments and/or monitoring what the other pilot is doing.	Strongly Disagree		
		Count	580
		% of total	56%
	Disagree		
		Count	310
		% of total	30%
	Agree		
		Count	105
		% of total	10%
	Strongly Agree		
		Count	39
		% of total	4%
Total:		Count	1,034
		Percentage	100%
Overall X^2 X^2 (3, N=1,034) = 687.65, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,034) = 538.22, $p < .001$			

Q10a. When the EFB is in the mount on the flight deck: The information displayed can be seen clearly in all lighting conditions.	Strongly Disagree		
		Count	38
		% of total	4%
	Disagree		
		Count	139
		% of total	13%
	Agree		
		Count	537
		% of total	52%
	Strongly Agree		
		Count	323
		% of total	31%
Total:		Count	1,037
		Percentage	100%
Overall X^2 X^2 (3, N=1,037) = 557.84, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,037) = 449.84, p < .001			

Q10c. When the EFB is in the mount on the flight deck: The information displayed can be read without adjusting the zoom level.	Strongly Disagree		
		Count	129
		% of total	12%
	Disagree		
		Count	458
		% of total	44%
	Agree		
		Count	371
		% of total	36%
	Strongly Agree		
		Count	78
		% of total	8%
Total:		Count	1,036
		Percentage	100%
Overall X^2 X^2 (3, N=1,036) = 393.07, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,036) = 18.38, p < .001			

Q10d. When the EFB is in the mount on the flight deck: Information on Instrument Approach Procedures (IAPs) can be clearly viewed without adjusting the zoom level.	Strongly Disagree		
		Count	119
		% of total	11%
	Disagree		
		Count	456
		% of total	44%
	Agree		
		Count	369
		% of total	36%
	Strongly Agree		
		Count	91
		% of total	9%
Total:		Count	1,035
		Percentage	100%
Overall X^2 X^2 (3, N=1,035) = 381.58, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,035) = 12.78, $p < .001$			

Q10e. When the EFB is in the mount on the flight deck: I can easily shift my eyes between viewing the mounted EFB and viewing traditional flight deck instruments with minimal head movements.	Strongly Disagree		
		Count	96
		% of total	9%
	Disagree		
		Count	308
		% of total	30%
	Agree		
		Count	432
		% of total	42%
	Strongly Agree		
		Count	198
		% of total	19%
Total:		Count	1,034
		Percentage	100%
Overall X^2 X^2 (3, N=1,034) = 242.24, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,034) = 49.40, p < .001			

Q10f. When the EFB is in the mount on the flight deck: I can easily switch between apps, view different pages on the mounted EFB, and enter data from the normal pilot flying position.	Strongly Disagree		
		Count	82
		% of total	8%
	Disagree		
		Count	158
		% of total	15%
	Agree		
		Count	510
		% of total	49%
	Strongly Agree		
		Count	286
		% of total	28%
Total:		Count	1,036
		Percentage	100%
Overall X^2 X^2 (3, N=1,036) = 406.41, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,036) = 298.39, p < .001			

Q10g. When the EFB is in the mount on the flight deck: While manually flying the airplane (autopilot and autothrust off) as the pilot flying (PF), I can still easily use the mounted EFB to switch between apps, view different pages, and enter data.	Strongly Disagree		
		Count	236
		% of total	23%
	Disagree		
		Count	389
		% of total	38%
	Agree		
		Count	304
		% of total	30%
	Strongly Agree		
		Count	99
		% of total	10%
Total:		Count	1,028
		Percentage	100%
Overall X^2 X^2 (3, N=1,028) = 175.25, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,028) = 47.94, $p < .001$			

Q10h. When the EFB is in the mount on the flight deck: The mounted EFB does not cause the pilot to bump the EFB while accessing controls or switches or completing flight control checks.	Strongly Disagree		
		Count	31
		% of total	3%
	Disagree		
		Count	98
		% of total	9%
	Agree		
		Count	426
		% of total	41%
	Strongly Agree		
		Count	481
		% of total	46%
Total:		Count	1,036
		Percentage	100%
Overall X^2 X^2 (3, N=1,036) = 598.76, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,036) = 584.25, $p < .001$			

Q10i. When the EFB is in the mount on the flight deck: The mounted EFB does not obstruct visual or physical access to aircraft controls or displays.	Strongly Disagree		
		Count	18
		% of total	2%
	Disagree		
		Count	47
		% of total	5%
	Agree		
		Count	414
		% of total	40%
	Strongly Agree		
		Count	556
		% of total	54%
Total:		Count	1,035
		Percentage	100%
Overall X^2 X^2 (3, N=1,035) =831.92, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,035) = 791.33, $p < .001$			

Q10j. When the EFB is in the mount on the flight deck: The mounted EFB will not interfere with crew egress in the event of an emergency on the ground.	Strongly Disagree		
		Count	59
		% of total	6%
	Disagree		
		Count	146
		% of total	14%
	Agree		
		Count	439
		% of total	43%
	Strongly Agree		
		Count	387
		% of total	38%
Total:		Count	1,031
		Percentage	100%
Overall X^2 X^2 (3, N=1,031) = 393.97, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,031) = 374.05, $p < .001$			

Q11a. The airline's documentation provided adequate information and guidance for EFB operational use during: Initial EFB Rollout (switching form paper to an EFB).	Strongly Disagree		
		Count	129
		% of total	14%
	Disagree		
		Count	165
		% of total	18%
	Agree		
		Count	437
		% of total	48%
	Strongly Agree		
		Count	183
		% of total	20%
Total:		Count	914
		Percentage	100%
Overall X^2 X^2 (3, N=914) = 260.88, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=914) = 116.28, $p < .001$			

Q11b. The airline's documentation provided adequate information and guidance for EFB operational use during: New-Hire Training	Strongly Disagree		
		Count	38
		% of total	8%
	Disagree		
		Count	61
		% of total	14%
	Agree		
		Count	218
		% of total	48%
	Strongly Agree		
		Count	138
		% of total	30%
Total:		Count	455
		Percentage	100%
Overall X^2 X^2 (3, N=455) = 175.62, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=455) = 145.16, $p < .001$			

Q11c. The airline's documentation provided adequate information and guidance for EFB operational use during: Initial EFB Rollout (switching form paper to an EFB).	Strongly Disagree		
		Count	92
		% of total	11%
	Disagree		
		Count	174
		% of total	20%
	Agree		
		Count	456
		% of total	53%
	Strongly Agree		
		Count	145
		% of total	16%
Total:		Count	867
		Percentage	100%
Overall X^2 X^2 (3, N=867) = 368.07, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=867) = 129.44, $p < .001$			

Q12. I am satisfied with EFB training I have received at my airline when changes to EFB software or hardware occur (e.g., new applications or modifications to EFBs).	Strongly Disagree		
		Count	121
		% of total	12%
	Disagree		
		Count	194
		% of total	19%
	Agree		
		Count	486
		% of total	49%
	Strongly Agree		
		Count	199
		% of total	20%
Total:		Count	1000
		Percentage	100%
Overall X^2 X^2 (3, N=1,000) = 312.30, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,000) = 136.90, $p < .001$			

Q13a. I received adequate information on: Touch screen gestures	Strongly Disagree		
		Count	121
		% of total	12%
	Disagree		
		Count	194
		% of total	19%
	Agree		
		Count	486
		% of total	49%
	Strongly Agree		
		Count	199
		% of total	20%
Total:		Count	1,000
		Percentage	100%
Overall X^2 X^2 (3, N=1,000) = 312.30, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1,000) = 136.90, $p < .001$			

Q13b. I received adequate information on: EFB buttons and switches	Strongly Disagree		
		Count	49
		% of total	5%
	Disagree		
		Count	175
		% of total	18%
	Agree		
		Count	554
		% of total	57%
	Strongly Agree		
		Count	189
		% of total	20%
Total:		Count	967
		Percentage	100%
Overall X^2 X^2 (3, N=967) = 586.93, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=967) = 278.55, $p < .001$			

Q13c. I received adequate information on: EFB power management	Strongly Disagree		
		Count	67
		% of total	7%
	Disagree		
		Count	217
		% of total	22%
	Agree		
		Count	529
		% of total	54%
	Strongly Agree		
		Count	160
		% of total	17%
Total:		Count	973
		Percentage	100%
Overall X^2 X^2 (3, N=973) = 494.70, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=973) = 168.58, $p < .001$			

Q13d. I received adequate information on: How to use the EFB when there is a SID, STAR, or runway change	Strongly Disagree		
		Count	56
		% of total	6%
	Disagree		
		Count	194
		% of total	21%
	Agree		
		Count	523
		% of total	55%
	Strongly Agree		
		Count	174
		% of total	18%
Total:		Count	947
		Percentage	100%
Overall X^2 X^2 (3, N=947) = 508.45, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=947) = 210.99, $p < .001$			

Q13e. I received adequate information on: Engine-out critical terrain operations	Strongly Disagree		
		Count	85
		% of total	10%
	Disagree		
		Count	221
		% of total	25%
	Agree		
		Count	449
		% of total	51%
	Strongly Agree		
		Count	126
		% of total	14%
Total:		Count	881
		Percentage	100%
Overall X^2 X^2 (3, N=881) = 360.97, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=881) = 82.14, $p < .001$			

Q13f. I received adequate information on: How to use the EFB while "hand flying" the aircraft (autopilot and autothrust off)	Strongly Disagree		
		Count	140
		% of total	18%
	Disagree		
		Count	317
		% of total	40%
	Agree		
		Count	263
		% of total	34%
	Strongly Agree		
		Count	64
		% of total	8%
Total:		Count	784
		Percentage	100%
Overall X^2 X^2 (3, N=784) = 202.50, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=784) = 21.56, $p < .001$			

Q13g. I received adequate information on: Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen	Strongly Disagree		
		Count	115
		% of total	13%
	Disagree		
		Count	280
		% of total	30%
	Agree		
		Count	399
		% of total	44%
	Strongly Agree		
		Count	119
		% of total	13%
Total:		Count	913
		Percentage	100%
Overall X^2 X^2 (3, N=913) = 247.95, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=913) = 16.57, $p < .001$			

Q13h. I received adequate information on: Managing EFB workload	Strongly Disagree		
		Count	86
		% of total	10%
	Disagree		
		Count	250
		% of total	28%
	Agree		
		Count	456
		% of total	50%
	Strongly Agree		
		Count	112
		% of total	12%
Total:		Count	867
		Percentage	100%
Overall X^2 X^2 (3, N=904) = 380.85, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=904) = 59.54, $p < .001$			

Q13i. I received adequate information on: Managing EFB head-down time (i.e., not monitoring primary flight instruments)	Strongly Disagree		
		Count	81
		% of total	10%
	Disagree		
		Count	257
		% of total	29%
	Agree		
		Count	443
		% of total	50%
	Strongly Agree		
		Count	109
		% of total	12%
Total:		Count	890
		Percentage	100%
Overall X^2 X^2 (3, N=890) = 371.75, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=890) = 51.46, $p < .001$			

Q13j. I received adequate information on: EFB information management	Strongly Disagree		
		Count	85
		% of total	10%
	Disagree		
		Count	237
		% of total	25%
	Agree		
		Count	485
		% of total	52%
	Strongly Agree		
		Count	119
		% of total	16%
Total:		Count	867
		Percentage	100%
Overall X^2 X^2 (3, N=926) = 425.10, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=926) = 85.88, $p < .001$			

Q14a. I received adequate classroom and/or distance learning (DL) training on: Touch screen gestures	Strongly Disagree		
		Count	100
		% of total	11%
	Disagree		
		Count	217
		% of total	24%
	Agree		
		Count	446
		% of total	50%
	Strongly Agree		
		Count	138
		% of total	15%
Total:		Count	901
		Percentage	100%
Overall X^2 X^2 (3, N=901) = 320.08, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=901) = 79.12, $p < .001$			

Q14b. I received adequate classroom and/or distance learning (DL) training on: EFB buttons and power switches	Strongly Disagree		
		Count	95
		% of total	10%
	Disagree		
		Count	182
		% of total	20%
	Agree		
		Count	503
		% of total	54%
	Strongly Agree		
		Count	146
		% of total	16%
Total:		Count	926
		Percentage	100%
Overall X^2 X^2 (3, N=926) = 441.06, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=926) = 149.44, $p < .001$			

Q14c. I received adequate classroom and/or distance learning (DL) training on: EFB power management	Strongly Disagree		
		Count	94
		% of total	10%
	Disagree		
		Count	212
		% of total	23%
	Agree		
		Count	475
		% of total	52%
	Strongly Agree		
		Count	133
		% of total	15%
Total:		Count	914
		Percentage	100%
Overall X^2 X^2 (3, N=914) = 386.19, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=914) = 99.79, $p < .001$			

Q14d. I received adequate classroom and/or distance learning (DL) training on: How to use EFB when there is a SID, STAR, or runway change.	Strongly Disagree		
		Count	93
		% of total	10%
	Disagree		
		Count	211
		% of total	24%
	Agree		
		Count	458
		% of total	52%
	Strongly Agree		
		Count	125
		% of total	14%
Total:		Count	887
		Percentage	100%
Overall X^2 X^2 (3, N=887) = 369.18, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=887) = 87.76, $p < .001$			

Q14e. I received adequate classroom and/or distance learning (DL) training on: Engine-out critical terrain operations	Strongly Disagree		
		Count	112
		% of total	12%
	Disagree		
		Count	243
		% of total	29%
	Agree		
		Count	391
		% of total	46%
	Strongly Agree		
		Count	108
		% of total	13%
Total:		Count	854
		Percentage	100%
Overall X^2 X^2 (3, N=854) = 252.03, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=854) = 24.28, $p < .001$			

Q14f. I received adequate classroom and/or distance learning (DL) training on: How to use the EFB while "hand-flying" (autopilot and autothrust off)	Strongly Disagree		
		Count	141
		% of total	18%
	Disagree		
		Count	295
		% of total	38%
	Agree		
		Count	261
		% of total	34%
	Strongly Agree		
		Count	72
		% of total	10%
Total:		Count	769
		Percentage	100%
Overall X^2 X^2 (3, N=769) = 168.38, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=769) = 13.80, $p < .001$			

Q14g. I received adequate classroom and/or distance learning (DL) training on: Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen	Strongly Disagree		
		Count	119
		% of total	14%
	Disagree		
		Count	259
		% of total	30%
	Agree		
		Count	377
		% of total	43%
	Strongly Agree		
		Count	113
		% of total	13%
Total:		Count	868
		Percentage	100%
Overall X^2 X^2 (3, N=868) = 220.20, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=868) = 14.45, $p < .001$			

Q14h. I received adequate classroom and/or distance learning (DL) training on: Managing EFB workload	Strongly Disagree		
		Count	104
		% of total	12%
	Disagree		
		Count	246
		% of total	28%
	Agree		
		Count	409
		% of total	47%
	Strongly Agree		
		Count	109
		% of total	13%
Total:		Count	868
		Percentage	100%
Overall X^2 X^2 (3, N=868) = 286.35, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=868) = 32.52, $p < .001$			

Q14i. I received adequate classroom and/or distance learning (DL) training on: Managing EFB head-down time (i.e., not monitoring primary flight instruments)	Strongly Disagree		
		Count	104
		% of total	12%
	Disagree		
		Count	247
		% of total	30%
	Agree		
		Count	385
		% of total	46%
	Strongly Agree		
		Count	106
		% of total	12%
Total:		Count	842
		Percentage	100%
Overall X^2 X^2 (3, N=842) = 256.75, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=842) = 23.28, p < .001			

Q14j. I received adequate classroom and/or distance learning (DL) training on: EFB information management	Strongly Disagree		
		Count	104
		% of total	12%
	Disagree		
		Count	232
		% of total	26%
	Agree		
		Count	440
		% of total	50%
	Strongly Agree		
		Count	111
		% of total	12%
Total:		Count	887
		Percentage	100%
Overall X^2 X^2 (3, N=887) = 333.12, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=887) = 52.11, p < .001			

Q15a. I received adequate simulator training on: Touch screen gestures	Strongly Disagree		
		Count	122
		% of total	11%
	Disagree		
		Count	223
		% of total	24%
	Agree		
		Count	263
		% of total	38%
	Strongly Agree		
		Count	74
		% of total	11%
Total:		Count	682
		Percentage	100%
Overall X^2 X^2 (3, N=682) = 134.76, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=682) = .09, $p = .759$			

Q15b. I received adequate simulator training on: EFB buttons and power switches	Strongly Disagree		
		Count	120
		% of total	18%
	Disagree		
		Count	207
		% of total	30%
	Agree		
		Count	280
		% of total	41%
	Strongly Agree		
		Count	72
		% of total	11%
Total:		Count	679
		Percentage	100%
Overall X^2 X^2 (3, N=679) = 150.65, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=679) = .92, $p = .337$			

Q15c. I received adequate simulator training on: EFB power management	Strongly Disagree		
		Count	116
		% of total	18%
	Disagree		
		Count	224
		% of total	34%
	Agree		
		Count	249
		% of total	37%
	Strongly Agree		
		Count	72
		% of total	11%
Total:		Count	661
		Percentage	100%
Overall X^2 X^2 (3, N=661) = 130.63, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=914) = .55, $p = .460$			

Q15d. I received adequate simulator training on: How to use EFB when there is a SID, STAR, or runway change.	Strongly Disagree		
		Count	115
		% of total	16%
	Disagree		
		Count	208
		% of total	30%
	Agree		
		Count	291
		% of total	41%
	Strongly Agree		
		Count	91
		% of total	13%
Total:		Count	705
		Percentage	100%
Overall X^2 X^2 (3, N=705) = 142.95, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=705) = 4.94, $p < .05$			

Q15e. I received adequate simulator training on: Engine-out critical terrain operations	Strongly Disagree		
		Count	124
		% of total	18%
	Disagree		
		Count	227
		% of total	33%
	Agree		
		Count	259
		% of total	37%
	Strongly Agree		
		Count	81
		% of total	12%
Total:		Count	854
		Percentage	100%
Overall X^2 X^2 (3, N=691) = 122.59, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=691) = .180, p = .676			

Q15f. I received adequate simulator training on: How to use the EFB while "hand flying" (autopilot and autothrust off)	Strongly Disagree		
		Count	142
		% of total	22%
	Disagree		
		Count	248
		% of total	38%
	Agree		
		Count	202
		% of total	31%
	Strongly Agree		
		Count	56
		% of total	9%
Total:		Count	648
		Percentage	100%
Overall X^2 X^2 (3, N=648) = 127.36, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=648) = 26.89, p < .001			

Q15g. I received adequate simulator training on: Managing multiple sources of information on the EFB (multiple apps and pages) at the same time with one screen	Strongly Disagree		
		Count	129
		% of total	19%
	Disagree		
		Count	230
		% of total	34%
	Agree		
		Count	243
		% of total	36%
	Strongly Agree		
		Count	71
		% of total	11%
Total:		Count	673
		Percentage	100%
Overall X^2 X^2 (3, N=673) = 121.24, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=673) = 3.01, p = .083			

Q15h. I received adequate simulator training on: Managing EFB workload	Strongly Disagree		
		Count	121
		% of total	17%
	Disagree		
		Count	220
		% of total	32%
	Agree		
		Count	274
		% of total	40%
	Strongly Agree		
		Count	73
		% of total	11%
Total:		Count	688
		Percentage	100%
Overall X^2 X^2 (3, N=688) = 145.99, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=688) = .05, p = .819			

Q15i. I received adequate simulator training on: Managing EFB head-down time (i.e., not monitoring primary flight instruments)	Strongly Disagree		
		Count	120
		% of total	18%
	Disagree		
		Count	231
		% of total	34%
	Agree		
		Count	263
		% of total	38%
	Strongly Agree		
		Count	70
		% of total	10%
Total:		Count	684
		Percentage	100%
Overall X^2 X^2 (3, N=684) = 145.42, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=684) = .47, $p = .431$			

Q15j. I received adequate simulator training on: EFB information management	Strongly Disagree		
		Count	120
		% of total	18%
	Disagree		
		Count	221
		% of total	32%
	Agree		
		Count	271
		% of total	40%
	Strongly Agree		
		Count	72
		% of total	10%
Total:		Count	684
		Percentage	100%
Overall X^2 X^2 (3, N=684) = 145.63, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=684) = .01, $p = .940$			

Q16a. How satisfied are you with the initial EFB rollout (switching from paper to an EFB) received at your airline?	Very Unsatisfied		
		Count	124
		% of total	14%
	Unsatisfied		
		Count	181
		% of total	20%
	Satisfied		
		Count	429
		% of total	47%
	Very Satisfied		
		Count	169
		% of total	19%
Total:		Count	903
		Percentage	100%
Overall X^2 X^2 (3, N=684) = 251.99, $p < .001$			
Satisfied/Very Satisfied vs. Unsatisfied/Very Unsatisfied X^2 (1, N=684) = 95.07, $p < .001$			

Q16b. How satisfied are you with the New-hire EFB training received at your airline?	Very Unsatisfied		
		Count	36
		% of total	7%
	Unsatisfied		
		Count	59
		% of total	13%
	Satisfied		
		Count	240
		% of total	51%
	Very Satisfied		
		Count	134
		% of total	29%
Total:		Count	469
		Percentage	100%
Overall X^2 X^2 (3, N=469) = 216.14, $p < .001$			
Satisfied/Very Satisfied vs. Unsatisfied/Very Unsatisfied X^2 (1, N=469) = 165.97, $p < .001$			

Q16c. How satisfied are you with the recurrent EFB training received at your airline?	Very Unsatisfied		
		Count	87
		% of total	11%
	Unsatisfied		
		Count	190
		% of total	23%
	Satisfied		
		Count	411
		% of total	50%
	Very Satisfied		
		Count	133
		% of total	16%
Total:		Count	821
		Percentage	100%
Overall X^2 X^2 (3, N=821) = 300.94, $p < .001$			
Satisfied/Very Satisfied vs. Unsatisfied/Very Unsatisfied X^2 (1, N=821) = 86.83, $p < .001$			

17. I was adequately compensated for my personal time and effort required to learn how to use my current EFB.	Strongly Disagree		
		Count	289
		% of total	35%
	Disagree		
		Count	271
		% of total	32%
	Agree		
		Count	240
		% of total	28%
	Strongly Agree		
		Count	45
		% of total	5%
Total:		Count	684
		Percentage	100%
Overall X^2 X^2 (3, N=684) = 145.63, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=684) = .01, $p = .940$			

Q18. I felt comfortable using my EFB during line operations after:	Less than 1 month		
		Count	577
		% of total	35%
	1 month		
		Count	138
		% of total	32%
	2-3 months		
		Count	154
		% of total	28%
	4-6 months		
		Count	57
		% of total	5%
	6-12 months		
		Count	53
		% of total	5%
Total:		Count	979
		Percentage	100%
Overall X^2 X^2 (4, N=979) = 848.52, $p < .001$			

Q19. The EFB is reliable and requires, if any, pilot interaction for reboots during normal line operations.	Strongly Disagree		
		Count	87
		% of total	9%
	Disagree		
		Count	154
		% of total	15%
	Agree		
		Count	508
		% of total	49%
	Strongly Agree		
		Count	277
		% of total	27%
Total:		Count	1026
		Percentage	100%
Overall X^2 X^2 (3, N=1026) = 401.20, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1026) = 288.44, $p < .001$			

Q20. EFB brightness level can be made with few steps	Strongly Disagree		
		Count	43
		% of total	4%
	Disagree		
		Count	99
		% of total	9%
	Agree		
		Count	600
		% of total	60%
	Strongly Agree		
		Count	273
		% of total	27%
Total:		Count	1015
		Percentage	100%
Overall X^2 X^2 (3, N=1015) = 743.340, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1015) = 526.46, $p < .001$			

Q21a. EFB brightness level are adequate for: Daylight operations (including direct sunlight)	Strongly Disagree		
		Count	46
		% of total	5%
	Disagree		
		Count	125
		% of total	12%
	Agree		
		Count	599
		% of total	58%
	Strongly Agree		
		Count	256
		% of total	25%
Total:		Count	1026
		Percentage	100%
Overall X^2 X^2 (3, N=1026) = 251.99, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1026) = 95.07, $p < .001$			

Q21b. EFB brightness level are adequate for: Night operations	Strongly Disagree		
		Count	32
		% of total	9%
	Disagree		
		Count	83
		% of total	15%
	Agree		
		Count	599
		% of total	49%
	Strongly Agree		
		Count	256
		% of total	27%
Total:		Count	1026
		Percentage	100%
Overall X^2 X^2 (3, N=1026) = 401.20, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1026) = 288.44, $p < .001$			

Q22a. [Charts] are usable to me in dark conditions when displayed in night mode (i.e., black background with light text/diagrams)	Strongly Disagree		
		Count	13
		% of total	1%
	Disagree		
		Count	52
		% of total	5%
	Agree		
		Count	538
		% of total	53%
	Strongly Agree		
		Count	416
		% of total	41%
Total:		Count	1019
		Percentage	100%
Overall X^2 X^2 (3, N=1019) = 807.78, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1019) = 775.58, $p < .001$			

Q22b. [Documents] are usable to me in dark conditions when displayed in night mode (i.e., black background with light text/diagrams)	Strongly Disagree		
		Count	20
		% of total	2%
	Disagree		
		Count	83
		% of total	8%
	Agree		
		Count	543
		% of total	55%
	Strongly Agree		
		Count	339
		% of total	35%
Total:		Count	985
		Percentage	100%
Overall X^2 X^2 (3, N=985) = 708.64, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=985) = 616.08, $p < .001$			

Q23a. I feel EFB is secure from: Physical access by an unauthorized user	Strongly Disagree		
		Count	19
		% of total	2%
	Disagree		
		Count	68
		% of total	7%
	Agree		
		Count	537
		% of total	59%
	Strongly Agree		
		Count	290
		% of total	32%
Total:		Count	914
		Percentage	100%
Overall X^2 X^2 (3, N=914) = 737.88, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=914) = 599.12, $p < .001$			

Q23b. I feel EFB is secure from: Hacking (i.e. Malware, internet or WiFi access)	Strongly Disagree		
		Count	31
		% of total	4%
	Disagree		
		Count	103
		% of total	14%
	Agree		
		Count	409
		% of total	57%
	Strongly Agree		
		Count	176
		% of total	25%
Total:		Count	719
		Percentage	100%
Overall X^2 X^2 (3, N=719) = 448.33, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=719) = 282.89, p < .001			

Q24. EFB security and power settings (i.e. screen going to sleep, password changes, screen lock, settings, etc.) have distracted me during flight operations.	Strongly Disagree		
		Count	149
		% of total	15%
	Disagree		
		Count	362
		% of total	35%
	Agree		
		Count	373
		% of total	37%
	Strongly Agree		
		Count	137
		% of total	13%
Total:		Count	1021
		Percentage	100%
Overall X^2 X^2 (3, N=1021) = 197.97, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1021) = 0.00, p = 975			

Q25. Organization and indexing of airline manuals on EFBs allow for quick and easy searches for information.	Strongly Disagree		
		Count	161
		% of total	16%
	Disagree		
		Count	249
		% of total	25%
	Agree		
		Count	468
		% of total	46%
	Strongly Agree		
		Count	140
		% of total	13%
Total:		Count	1018
		Percentage	100%
Overall X^2 X^2 (3, N=1018) = 265.09, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1018) = 38.51, $p < .001$			

Q26. When airline manuals are updated on the EFB, revisions can be easily viewed to help pilots understand the specific material that has been changed.	Strongly Disagree		
		Count	149
		% of total	15%
	Disagree		
		Count	247
		% of total	24%
	Agree		
		Count	484
		% of total	47%
	Strongly Agree		
		Count	144
		% of total	14%
Total:		Count	1024
		Percentage	100%
Overall X^2 X^2 (3, N=1024) = 297.10, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1024) = 52.56, $p < .001$			

Q27a. I am satisfied with using digital documents on my EFB for the following: New-hire training	Strongly Disagree	Count	62
		% of total	7%
	Disagree	Count	121
		% of total	14%
	Agree	Count	551
		% of total	60%
	Strongly Agree	Count	175
		% of total	19%
Total:		Count	909
		Percentage	100%
Overall X^2 X^2 (3, N=909) = 643.08, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=909) = 324.37, $p < .001$			

Q27b. I am satisfied with using digital documents on my EFB for the following: New aircraft training course (type training)	Strongly Disagree	Count	82
		% of total	8%
	Disagree	Count	165
		% of total	17%
	Agree	Count	555
		% of total	57%
	Strongly Agree	Count	174
		% of total	18%
Total:		Count	976
		Percentage	100%
Overall X^2 X^2 (3, N=976) = 549.61, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=976) = 238.04, $p < .001$			

Q27c. I am satisfied with using digital documents on my EFB for the following: Recurrent training	Strongly Disagree		
		Count	68
		% of total	7%
	Disagree		
		Count	116
		% of total	12%
	Agree		
		Count	618
		% of total	61%
	Strongly Agree		
		Count	206
		% of total	20%
Total:		Count	1008
		Percentage	100%
Overall X^2 X^2 (3, N=1008) = 747.71, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1008) = 406.35, $p < .001$			

Q27d. I am satisfied with using digital documents on my EFB for the following: Flight operations	Strongly Disagree		
		Count	50
		% of total	5%
	Disagree		
		Count	106
		% of total	10%
	Agree		
		Count	614
		% of total	60%
	Strongly Agree		
		Count	251
		% of total	25%
Total:		Count	1021
		Percentage	100%
Overall X^2 X^2 (3, N=1021) = 756.60, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1021) = 492.34, $p < .001$			

Q28. A paper copy of the Quick reference Handbook (QRH) for non-normals should be available for use in addition to the EFB.	Strongly Disagree		
		Count	46
		% of total	5%
	Disagree		
		Count	49
		% of total	5%
	Agree		
		Count	227
		% of total	22%
	Strongly Agree		
		Count	695
		% of total	68%
Total:		Count	1017
		Percentage	100%
Overall X^2 X^2 (3, N=1017) = 1103.24, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1017) = 672.50, $p < .001$			

Q29a. If only a part of the IAP chart is viewed, the pilot can easily interact with the EFB to view the desired information on the digital IAP chart when: Using the autopilot	Strongly Disagree		
		Count	16
		% of total	2%
	Disagree		
		Count	49
		% of total	5%
	Agree		
		Count	587
		% of total	57%
	Strongly Agree		
		Count	372
		% of total	36%
Total:		Count	1024
		Percentage	100%
Overall X^2 X^2 (3, N=1024) = 827.91, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1024) = 780.50, $p < .001$			

Q29b. If only a part of the IAP chart is viewed, the pilot can easily interact with the EFB to view the desired information on the digital IAP chart when: "Hand flying" the aircraft (autopilot and autothrust off)	Strongly Disagree		
		Count	120
		% of total	12%
	Disagree		
		Count	327
		% of total	32%
	Agree		
		Count	463
		% of total	45%
	Strongly Agree		
		Count	108
		% of total	11%
Total:		Count	1018
		Percentage	100%
Overall X^2 X^2 (3, N=1018) = 346.88, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1018) = 15.10, $p < .001$			

Q30a. Charting application selection areas for SIDs, STARS, IAPs: Are easy to read and select	Strongly Disagree		
		Count	25
		% of total	2%
	Disagree		
		Count	102
		% of total	10%
	Agree		
		Count	667
		% of total	65%
	Strongly Agree		
		Count	225
		% of total	22%
Total:		Count	1019
		Percentage	100%
Overall X^2 X^2 (3, N=1019) = 969.39, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1019) = 574.31, $p < .001$			

Q30b. Charting application selection areas for SIDs, STARS, IAPs: Require minimal head, arm or torso body adjustments to properly read and select.		
	Strongly Disagree	
	Count	51
	% of total	5%
	Disagree	
	Count	194
	% of total	19%
	Agree	
	Count	579
	% of total	57%
	Strongly Agree	
	Count	189
	% of total	19%
Total:	Count	1013
	Percentage	100%
Overall X^2 X^2 (3, N=1013) = 610.69, $p < .001$		
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1013) = 270.02, $p < .001$		

Q31. During line operations, I have needed to interact with the EFB (e.g., switching applications, data entry, etc.) due to departure, arrival and/or runway changes.		
	Strongly Disagree	
	Count	8
	% of total	1%
	Disagree	
	Count	50
	% of total	5%
	Agree	
	Count	617
	% of total	61%
	Strongly Agree	
	Count	340
	% of total	33%
Total:	Count	1015
	Percentage	100%
Overall X^2 X^2 (3, N=1015) = 950.92, $p < .001$		
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1015) = 796.26, $p < .001$		

Q32. The airline provides policy and adequate procedural guidance for operating with EFBs at critical terrain airports (e.g., KLAS, KRNO), during engine-out events when the special chart is not in view.	Strongly Disagree		
		Count	74
		% of total	9%
	Disagree		
		Count	219
		% of total	27%
	Agree		
		Count	396
		% of total	48%
	Strongly Agree		
		Count	137
		% of total	17%
Total:		Count	826
		Percentage	100%
Overall X^2 X^2 (3, N=826) = 283.07, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=826) = 69.73, $p < .001$			

Q33. I remove the EFB from the portable mount as an aid in briefing pilots during times of low workload, such as a pre-departure briefing at the gate or an approach brief at altitude prior to descent.	Never		
		Count	196
		% of total	19%
	Sometimes		
		Count	556
		% of total	55%
	Always		
		Count	267
		% of total	26%
Total:		Count	1019
		Percentage	100%
Overall X^2 X^2 (2, N=1019) = 214.09, $p < .001$			

Q34. Managing information with the EFB _____ pilot workload.	Decreases	
	Count	371
	% of total	36%
	Slightly decreases	
	Count	397
	% of total	39%
	Slightly increases	
	Count	183
	% of total	18%
	Increases	
	Count	72
	% of total	7%
Total:	Count	1023
	Percentage	100%
Overall X^2 X^2 (3, N=1023) = 282.66, $p < .001$		
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1023) = 257.25, $p < .001$		

Q35. Managing information with the EFB _____ pilot head-down time (i.e. not monitoring primary flight instruments).	Decreases	
	Count	227
	% of total	22%
	Slightly decreases	
	Count	440
	% of total	43%
	Slightly increases	
	Count	280
	% of total	27%
	Increases	
	Count	72
	% of total	7%
Total:	Count	1019
	Percentage	100%
Overall X^2 X^2 (3, N=1019) = 271.34, $p < .001$		
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1019) = 97.37, $p < .001$		

Q36. I can easily access the information I need on the EFB during high workload events (e.g., approaches, runway changes, approach changes, and emergency procedures), similar to the paper charts or books they replaced.	Strongly Disagree		
		Count	72
		% of total	7%
	Disagree		
		Count	142
		% of total	14%
	Agree		
		Count	566
		% of total	56%
	Strongly Agree		
		Count	239
		% of total	23%
Total:		Count	1019
		Percentage	100%
Overall X^2 X^2 (3, N=1019) = 562.26, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1019) = 342.77, $p < .001$			

Q37. I am satisfied with how EFBs are being used for flight operations at my airline.	Strongly Disagree		
		Count	53
		% of total	5%
	Disagree		
		Count	137
		% of total	13%
	Agree		
		Count	522
		% of total	51%
	Strongly Agree		
		Count	305
		% of total	30%
Total:		Count	1017
		Percentage	100%
Overall X^2 X^2 (3, N=1017) = 505.47, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=1017) = 398.99, $p < .001$			

Q38. I ____ contact the EFB support team at my airline.	Never		
		Count	367
		% of total	36%
	Sometimes		
		Count	605
		% of total	60%
	Often		
		Count	41
		% of total	4%
Total:		Count	1013
		Percentage	100%
Overall X^2 X^2 (2, N=1013) = 474.84, $p < .001$			

Q39. I am satisfied with EFB support at my airline.	Strongly Disagree		
		Count	58
		% of total	6%
	Disagree		
		Count	143
		% of total	14%
	Agree		
		Count	575
		% of total	58%
	Strongly Agree		
		Count	211
		% of total	21%
Total:		Count	987
		Percentage	100%
Overall X^2 X^2 (3, N=987) = 629.86, $p < .001$			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=987) = 346.73, $p < .001$			

Q40. Submitting EFB-related feedback to my airline is _____.	Difficult		
		Count	92
		% of total	14%
	Easy		
		Count	583
		% of total	86%
Total:		Count	675
		Percentage	100%
Overall X^2 X^2 (2, N=675) = 357.16, p < .001			

Q41. Pilots' concerns regarding EFB use at my airline are being addressed.	Strongly Disagree		
		Count	70
		% of total	8%
	Disagree		
		Count	205
		% of total	25%
	Agree		
		Count	443
		% of total	54%
	Strongly Agree		
		Count	110
		% of total	13%
Total:		Count	828
		Percentage	100%
Overall X^2 X^2 (3, N=828) = 405.21, p < .001			
Agree/Strongly Agree vs. Disagree/Strongly Disagree X^2 (1, N=828) = 93.34, p < .001			

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