

In-Flight Collaboration Amongst Flight Attendants

Stephanie Wong and Carman Neustaedter

School of Interactive Arts and Technology, Simon Fraser University

250 – 13450 102nd Avenue, Surrey, BC, Canada

swa163@sfu.ca, carman@sfu.ca

ABSTRACT

Collaboration is a core component of work activities amongst flight attendants as they work to promote onboard safety and a high level of customer service. Yet we know little of how flight attendants collaborate and whether or not technology adequately supports their practices. Through an interview study with flight attendants, we explored their collaborative practices and processes and how technology aided such practices. While technologies like interphones and flight attendant call buttons acted as collaboration tools, we identified instances where the usability and functionality of these devices were the main barriers for maintaining efficient communication, situation awareness, and information exchange. Our findings inform the design of future technologies for enhancing communication and collaboration in an aircraft setting amongst flight attendants with an emphasis on real time information access and direct communication between flight attendants and crewmembers, regardless of their location.

Author Keywords

Flight attendants; situation awareness; workspace awareness; collaboration; pursers; cabin crew; Crew Resource Management (CRM)

ACM Classification Keywords

H.5.3 [*Computer-supported cooperative work*]: Group and Organization Interfaces

INTRODUCTION

Collaboration amongst flight attendants is important as they are responsible for the delivery of both customer service and on-board safety. Miscommunication or error has the potential to be embarrassing and highly publicized [36,40]. It can also lead to critical accidents and incidents [36,40]. Understanding that communication needs to be optimized, past research [27,36,40,47] has emphasized the improvement of communication processes between pilots in the cockpit and cabin crew, but there has been little research that focuses solely on how flight attendants collaborate during flight operation [12]. Thus, there is a gap in understanding how new technologies can support the collaboration needs and practices of flight attendants and if

such new technologies are even needed.

We conducted in-depth interviews with ten flight attendants from domestic and international airlines with the goal of bridging this gap. Our study focuses around the concepts of situation and workspace awareness in an aircraft setting. To foreshadow, our results show that the tools currently available to flight attendants to aid collaboration (e.g., interphones, call buttons, visual displays), do not easily fit within their needs and routines. Instead, in order to match their on-the-job needs, workarounds are required to communicate with one another and maintain a high level of awareness of the environment. In times of emergency, these tools provide an added cognitive load and were difficult to access. Without the proper integration of these tools with current work practices, flight attendants lacked the support necessary to easily communicate and collaborate when in-flight. These results suggest that in order to gain a high level of situation awareness for workspace collaboration, future technologies should be designed to make communications clearer, and be easy to use and accessible. Technologies should provide real time information access, be hands-free to assist work activities, and be ubiquitous enough to assist in emergency situations.

The paper is structured as follows. First, we provide background on the importance of collaboration in the airline industry and theoretical frameworks for collaborative practices. Second, we describe the interview methodology we used in our study. Third, we present the findings and insights derived from the study. We conclude with design suggestions for future technologies to foster a high level of situation awareness and workplace collaboration amongst flight attendants.

RELATED WORK

Aviation and Training

In the 1950s, as flight operations expanded from single to multi-operator, the significance of synchronized teamwork in the aviation industry was initially overlooked and underestimated [23]. This posed a challenge to aviation safety [23]. For example, in the case of U.S. commercial and charter flights, the number of flight accidents in the 1960s and 1970s did not decrease; it was estimated that three to five lives out of an average of two hundred and forty were lost per year [28]. However, in the early 1970s, insights from interviews with pilots led to an understanding that safety-critical errors may be a result of crew coordination and communication and not a lack of

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individual skill [24]. Thus in 1981, United Airlines (an American air carrier) was the first airline to provide training for its cockpit crews[28]. By the 1990s, it had become a global standard and training was extended from cockpit to the entire flight crew [24]. This was called the Crew Resource Management (CRM) training [24,30,36]. In 1999, the Federal Aviation Administration (FAA) of the United States made CRM a mandatory training component for airlines based in the country [24,28]. While other nations' airlines have gradually adopted similar policies, some have faced challenges in integrating them into their specific organizational culture and operational needs [24].

The CRM focuses on training crew members to develop skills in team building, information sharing, problem solving, decision-making, situational awareness, and dealing with automated systems for the safety and efficiency of a flight [24,30,36]. While beneficial, training is focused on critical situations and emergency evacuation and not the more typical situations faced by flight attendants on a daily basis [24,28,36]: non-emergency communication amongst the flight team, social support [22,45], feedback, supervision, and leadership [3].

The basic collaboration tools found in today's aircraft are the interphone, the flight attendant call button, visual indicators (no-smoking sign, seat belt sign), and audio alerts [7,8]. Pilots on a simulated aircraft reflected that the availability of these collaboration tools was directly related to a higher degree of awareness and coordination amongst crew members [28]. Crew members became more responsive because they were acknowledged and they began to spend more time communicating and making shared decisions [28].

It is highly likely that, in the near future, flight decks will become increasingly automated and communication systems will become more advanced [2,14,26,34]. This will allow crewmembers to adapt faster to each other and avoid misunderstanding and conflict for both emergency and everyday situations [5,32]. As part of these efforts, it is critical to understand the routines and needs of flight attendants in order to properly guide design and development of such collaborative systems.

Awareness for Team Interaction

Successful collaboration involves an entire team achieving their goal and not just an individual. This requires teams to have the right process (awareness and cognition) and right tools (technology and information) to create a collaborative culture. We explore these core concepts next.

Situation Awareness

Situation awareness is defined as "being aware of what is happening around you and understanding what that information means to you now and in the future" [1,12]. Situation awareness helps people to have a clear mental model that aids them in deciding what information is important in order to accomplish a particular goal and how

knowledge is created through interaction within the environment [12,17,20]. Highly dynamic environments make the role of situation awareness pivotal; this has been shown in studies of commercial aviation [38], air traffic control [42], and anesthesiology [15]. Situation awareness can also differ between team members; even when collaborators are able to see or hear the same information, they may understand it differently [11,12,20,37]. Situation awareness can be divided into three main levels: perception, comprehension, and the prediction of what will happen in the near future [18]. Many teams face challenges in the third level when they attempt to apply what they know from their current situation to predict future actions and outcomes [12]. In our study, we explore how flight attendants maintain situational awareness when in-flight and working.

Workspace Awareness and Coupling

Workspace awareness is part of situational awareness; it is the "up-to-the-moment understanding of another person's interaction in a shared workspace" [17]. Workspace awareness is a combination of verbal and visual communication [6,19]. People gain workspace awareness by observing and monitoring each other's gestures, activities, whereabouts, conversations, and the presentation and manipulation of artefacts [18,19]. This helps collaborators coordinate tasks and resources and assists in transitioning between individual and shared activities. People use this knowledge to anticipate the actions of others, interpret deictic references to objects, and find opportunities to assist one another with their tasks [17,18,19,39]. The latter involves moving into and out of closely-knit group work [17,18,19,39]. The degree to which collaborators work together is called "coupling" [43,44]. When a collaborator needs to wait for a team member to finish their work before beginning his/her own task, it is called "tightly-coupled" work. When collaborators can continue with their own tasks without any interaction with other group members for long periods of time, the work is called "loosely-coupled" [31]. In our study, we explore how flight attendants move into and out of tightly and loosely coupled collaboration as they shift between performing their own tasks on flight and helping other flight attendants.

Team Interactions and Team Cognition

In a fully functional system, the coordination of actions in a collaborative activity is "seamless." That is, actions are executed in the right time, right order, right place, and meets a task's constraints [18]. This execution of coordinated behaviors amongst team members is called team cognition [13,25]. Effective team cognition requires collaborators to have an awareness (situation and workspace awareness) of the pre-existing conditions and communication of ongoing interactions between team members [9,21]. This means that team members who know each other and have been trained together tend to develop team cognition more quickly [9,21]. Having team members

who are familiar with one another also allows them to perform their tasks better in a group setting [42].

To achieve successful team cognition, teams must share the same “mental model” or “mental representation” of a situation [4,29,31]. Teams with a shared mental model are likely to work better together as they interpret cues and prioritize information in a similar manner [12,21,29]. They take coordinated actions and make compatible decisions to manage situations in their environment [12,21,29]. Studies of flight attendants have shown that they prefer to be scheduled together for successive shifts and long periods of time; however, this is challenging to achieve in practice and crew members must frequently work with new team members [40].

Even within a highly coordinated and equipped training system, as in case in the aviation industry, individuals may still experience difficulty in accessing shared knowledge or may encounter a mismatch in shared expectations [33,35]. This can lead to major breakdowns and a failure to act in the right manner at the right time [35].

Overall, the related research illustrates the need for flight attendants to achieve a high degree of team cognition, built on their ability to maintain situational and workspace awareness. We explore these concepts in our study to understand how flight attendants collaborate in detail and what ways technology supports or hinders such processes.

STUDY METHODOLOGY

We conducted an interview-based study with flight attendants in order to understand their current work practices, the manner in which they collaborate with one another, the role of technology in supporting these collaborations, and the benefits and challenges faced when using technology to support collaboration and awareness.

Participants Demographics

We chose to interview flight attendants who worked for either domestic or international airlines to get a broad understanding of the work practices across both types of airlines. We recruited ten participants through snowball sampling (word-of-mouth) [16], social media (posts on Twitter and Facebook), and by requesting locally-based airlines to distribute our advertisement to their employees. Participants included three males and seven females who were employed by one domestic airline and five different international airlines. These airlines were based in Canada, the United States, Germany, China, and Dubai. The median age of participants was 41 years old with a range of 26 to 56 years old. The median numbers of years worked in the aviation industry was 8.25 years with a range of 2 to 25 years. Participants were very familiar with the use of technologies like tablets, laptops, and smartphones. Two owned wearable devices such as smart watches. Participants included three pursers and seven lead/cabin crewmembers. We describe these roles in our results. Pursers were from three different international airlines and leads/cabin

crewmembers were from a mix of domestic and international airlines (some had worked in both).

Interview Method

We conducted semi-structured interviews with each participant with the goal of understanding their work practices from the moment they boarded the plane to the point at which it landed and all passengers had disembarked. The interview questions were divided into two phases. The first phase explored participants’ demographics and work experience, e.g., job positions, time in positions, knowledge of technology. In the second phase, we investigated the flight attendants’ daily routines at work, their use of technology, information exchange, work challenges, and ideas to improve work practices. For example, questions included: “How do you communicate with your crewmembers and when?”, “Where are you located?”, “What works well about this activity?”, “What does not work well?”, “Do you use technology to support this activity?”, “If so, how?”, and “Are there any drawbacks or obstacles to using technology as part of this activity?” We ordered the interview questions from general to specific in order to give the participants more time to think about and reflect on their practices. Since it was not easily possible to observe flight attendants during their actual work due to security and safety concerns from the airlines, we had flight attendants describe a range of specific stories of their experiences in-flight, e.g., “Tell me about a time when communication with other flight attendants worked well” and “Tell me about a time when there were communication breakdowns.”

Data Collection and Analysis

Interviews were conducted over the telephone or a video communication system (e.g., FaceTime, Skype) and lasted 45 to 90 minutes. Each participant was given a \$30 gift card or cash. We collected data in the form of researcher’s notes and audio-recorded all interviews. All interviews were transcribed. With collaboration theories and perspectives in mind (e.g., situational awareness, mental models), we analyzed our results first by iteratively reading through our data. Next, we analyzed our transcripts and field notes using inductive thematic coding [10]. This involved initial coding and then explorations for categories and central themes. Our coding revealed key themes around the cabin crews’ collaborative practices including: roles, activities, and coordination; gestures and simplified communication; communication tools; and, shared information and reporting procedures. We detail these next in our findings.

ROLES AND ACTIVITIES

Our participants explained that there are four main types of people and roles that manage the in-flight experience: the pilots, the cabin senior director, the pursers/leads, and the cabin crew members. The reporting lines are defined in that order from highest ranked to lowest.

Pursers are found on international flights and their role is to supervise and manage the team of flight attendants and oversee the flight attendants' workflows to ensure a comfortable and safe flight. Depending on the size of the plane, there can be 2-3 pursers, either divided on a per cabin basis (first/business/economy class) or by tiers, e.g., a short or long haul purser. Long haul pursers have higher seniority than short haul pursers and are responsible for greeting the passengers, while the short haul pursers are expected to manage the entire cabin crew of the flight.

In domestic flights, flight attendants have a compulsory rotation in the three positions of the aircraft: Position 1, the fore (front); Position 2, the aft (back); and, Position 3, the middle. Position 1, also known as the lead, is in charge of the same responsibilities as a purser on international flights. Positions 2 and 3 act in the role of cabin crewmembers. As P1 explains: *"It is part of the training to know what every position entails."* P1 further described that flight attendants rotate between these positions in successive flights. Thus, while they are assigned to a single position for an entire flight, over several flights, they will likely work in a series of different positions.

Work activities are typically split into three stages, regardless of whether the flight is international or domestic:

1. **Pre-flight:** Briefing the cabin crew members, completing the safety and security checks, boarding the passengers, final walkthrough check, and, lastly, announcement for takeoff.
2. **In-flight:** Lunch/water service depending on flight time, routine checks every 15- 30 minutes, announcements for landing, final walkthrough check, and, lastly, un-boarding passengers.
3. **Post-flight:** Safety and security checks at a lower level, then crew change or layover for another flight.

All crewmembers are given a pre-flight briefing before being boarded. Crewmembers are introduced to each other and are assigned their positions by the lead/purser. The Crew Resource Management (CRM) trains the crew members on how to operate in each flight position so the briefing is a discussion on the flight time, possible turbulence enroute, safety and security issues, and questions that might impact the flight. Depending on the availability of crew members and the culture of the airline, the briefing is carried out by the most senior crew member in the following order: captain, cabin senior director, and lead/purser.

During the in-flight stage, the lead/purser coordinates when each activity will occur. This is timed by the lead/purser who maintains an awareness of how long it has been since takeoff, how many passengers are on the plane, if crewmembers are currently busy with passengers, whether or not there is turbulence, etc. The lead/purser lets the cabin crew members know that it is time to start serving guests once the relative time has come and the seat-belt sign is off.

Crewmembers wait for the lead/purser to let them know which row to start from. The lead/purser tries to coordinate serving amongst crewmembers to ensure the food is served at approximately the same time to all passengers.

"I am responsible for coordinating with the other flight attendants and also doing the tasks of serving the guests in my area. I need to crosscheck to make sure that the meals are served hot when it is placed on a guest table." - P5, Male, Purser

As the complexity and work load is high during this time, the lead/purser will frequently glance around the cabin to monitor and see if anyone needs help.

"We are like Galitarians, who are always on the lookout for each other to make sure that things are working out as they are supposed to be in the environment." - P2, Male, Lead/Cabin Crew Member

Lead/pursers take special care to note if there are flight attendants with less experience on board. They do this by making use of subtle cues like crew members' pace of work or visually scanning the tag number of employees; higher tag numbers often indicate new crewmembers. In an effort to ensure consistency of service, the leads/pursers will sometimes walk to the less experienced crewmembers and provide coaching tips in a discreet manner.

"If they are new - we take extra care to help them get their work done. I just go and offer if they need help physically completing the task or remembering the next task to do or all the tasks they need to get done." - P6, Female, Lead/Cabin Crewmember

After the service, the lead/purser collaborates with the crewmembers in a loosely-coupled style by splitting the team into halves to either perform duties or to rest. In the international airline where P4 works, crew members can rest in the flight attendants' cabin while other crewmembers make rounds every 15 to 30 minutes to check the toilets or serve beverages to the passengers. After one half of the crew members have rested, the purser would wake the crew via an interphone and instruct the other half to take a rest.

"Just making sure that everyone gets to have their breaks and eat well. So some days that can be very challenging and I have to make sure that they are taken care of - as they in-turn will take care of my guests. Happy crew and happy plane!" - P6, Female, Lead/Cabin Crewmember

Throughout the flight, the lead/purser also has to coordinate with the pilots in the cockpit to see if they need anything. For example, in the case of P3, his airline's safety and security policy entails that two people have to be always present in the flight deck. This means that pilots sometimes ask the purser/lead to send a flight attendant to the cockpit when they have to leave.

"If the captain needs to use the washroom, he has to call a flight attendant and she/he has to stay in there while he is

out and then switch when he comes back in.” - P3, Female, Lead/Cabin Crewmember

Sometimes the various roles that flight attendants take on need to change on-the-fly due to different circumstances. This can make it difficult to practice one’s role and follow standard procedures. For example, P3 experienced frustration when she could not refuse a request by the pilot of the crew. She needed to do extra work, which took her away from her normal duties as lead.

“If I’m the lead I do my service first and after finishing it, I call the flight deck to ask if they need anything. Sometimes some pilots would ask us to call them right after taking off i.e. before we begin our service, they want us to call and check with them first for their meals. It is not a huge thing but as we strictly follow the SOP [Standard Operating Procedures] so we all need to follow the same things and some people are moving away from them and that can create miscommunications, frustrations in the crew.” - P3, Female, Lead/Cabin Crewmember.

At times, crewmembers may not share the workload, or they may fail to follow the typical communication procedures that most are used to. These situations, again, left our participants feeling frustrated.

“Difficulty comes in when the other person does not follow the open communication and team code. This impacts our service as at that time we were having a heavy load and we were not as fast and efficient as we could be. Even if it is one person, it would help us. Even the purser did not help much and control the situation because she was busy in the front and was chatting with the other pursers.” - P8, Female, Cabin Crewmember

GESTURES AND SIMPLIFIED COMMUNICATION

Once crewmembers are aboard the aircraft, verbal communication is typically kept to a minimum since flight attendants are very busy and pressed for time. After takeoff, the plane’s motors can be very loud making it hard to hear people. Instead of large portions of speech, our participants described relying heavily on gestures and jargon to simplify communication. For example, after performing an initial passenger safety check, flight attendants said they would look down the aisle to the next visible flight attendant and give a “thumbs-up” gesture to signal that their area was clear and ready. Flight attendants who were in close proximity to each other would verbally say, “Cabin is secure.”

“When it comes to reporting the safety and security checks; the right hand side will inform the left hand side and they will in return inform the purser for the Economy cabin.” - P5, Male, Purser

P2 and P3 described using hand gestures for sitting down, picking up the phone, getting oxygen masks, and request to “please bring more blankets”.

When speaking to one another, cabin crewmembers also made use of jargon like, “FAM,” short for Flight

Attendants’ Manual and, “GEM,” short for Guest Experience Manual. Other jargon included terms for emergency situations and their location, e.g., “Lavsmoke L2” meant smoke in the bathroom at the second door. The different stages of turbulence were referred to in a succinct fashion as “light chop” and “heavy chop,” as stated by P2. Such short form communication was frequently used to communicate quickly between flight attendants. It also kept some information private from passengers who did not always understand the jargon.

On smaller aircraft, our participants said it was typically easy to see hand gestures from flight attendants who were far away, providing that both were situated in the same aisle and passengers were not obstructing the view. However, unpredictable incidents could happen and these made it harder to share information verbally or through gestures between flight attendants.

“Once I was standing at the back and a gentleman fainted after using the washroom. Although I got hold of him and landed him down on the ground, but the other crewmembers especially in the front, could not see this happen as both of us were on the ground and the bathroom door was left open.” - P3, Female, Lead/Cabin Crew

In the above situation, P3 was pulled into the washroom and could not release herself as the passenger was on top of her. The only way she was able to get out of the situation was to ask the closest passengers for help. A similar experience was echoed by P6 who thought that the layout of the aircraft made it difficult to move around and get the help of others.

“If someone has a seizure at the aft during boarding, there is no way I would be able to get there unless I get everyone back into the seat, which is very time consuming and hard to do because all passengers have their hand luggage down. But that is how it is.” - P6, Female, Lead/Cabin Crewmember

Another instance comes from P5 who was caught in the middle of two kitchens when a passenger had first-degree burns. Other cabin crewmembers could not see them and so he was unable to notify them that there was a problem.

“The passenger had not only split coffee on his hand but also on the metal watch he was wearing, which exasperated his pain. I needed help to wash off the coffee and at the same time I wanted to ask for medical assistance and inform the captain about the incident.” - P5, Male, Purser

COMMUNICATION TOOLS

The common communication tools found in today’s aircraft are the interphone, the flight attendant call button, visual indicators (no-smoking sign, seat belt sign), and audio alerts [7,8,46]. The interphone is a device used for public announcements played on speakers throughout the aircraft, internal conference calls between all interphones, and cabin-to-cabin communication between pairs of interphones. An interphone is stationed at each key area: the

cockpit, the galleys, and (most often) at each exit door. When calls come in, a panel indicates which other interphone initiated the call through a display panel [41]. The flight attendant call button is designed to be used by passengers for requesting services from flight attendants. Various chime sounds accompany the visuals provided by the interphone display and call buttons [7,46]. For example, if the flight attendant panel displays a pink color and a 'ding dong' sound is heard once, it means that the flight deck is calling and it should be attended to without delay. We describe how flight attendants use each of these communication tools next.

Interphone

When flight attendants are unable to visually see each other to share information using body language and they are not in close proximity to talk, they make use of the interphone. Given the interphone's placement in each cabin, flight attendants can call one another to exchange information. Pilots can also share information with the purser/lead who can then relay this information to the other flight attendants. For example, when the plane is currently going through or about to go through turbulence, the pilot will typically notify the purser/lead by calling him/her on the interphone. The benefit is that information can be clearly explained to the purser who can then share it with the other crewmembers.

"In our job, we have to be very clear in our communication. If the flight deck says the ride is very bumpy we have to double check to make sure if they mean they want us to sit down or do they don't want us to do our service or put the carts away. We just have to make sure that we understand what they want us to do." - P3, Female, Lead/Cabin Crewmember.

Despite this clear benefit, use of the interphone faced several challenges. First, information on situations such as turbulence can change rapidly. Pilots typically do not repeatedly call to relay new information; thus, use of the interphone typically results in only static information sharing where up-to-date knowledge of the situation is unknown. Many of our participants desired to have more frequent information in such situations.

"The hardest part is that we don't have a face-to-face communication with the pilots and that is hard as sometimes we cannot relay a complete message on the interphone." - P2, Male, Lead/Cabin Crewmember

"The reason why the flight is delayed is because this information comes from the captain and no one is allowed to go in the cockpit, when it is 'secure cabin' during take-off. We are then supposed to wait. We waited for an hour last time and we didn't know what was happening." - P1, Female, Lead/Cabin Crewmember

Second, flight attendants need to be in close proximity to the interphone in order to hear it ring and answer it. However, there are many points in time when flight

attendants are not close to an interphone since there are so few on the plane and flight attendants are highly mobile within their own cabin area. For example, in one situation, P5 used an interphone to call for help when a passenger was in pain. Yet there were no flight attendants close enough to another interphone to hear it ring. P5 decided that the only way to communicate with the other crewmembers was to make a public announcement over the interphone to indicate to the cabin senior director that he needed help. This unfortunately made the incident more public than he had wanted as all passengers on the plane heard.

Lastly, several participants said that it was difficult to know whether sounds were coming from the interphone or the flight attendant call button and whether or not it was a normal or emergency call. All audio alerts coming from a particular destination had the same sound. For instance, if a flight attendant called another flight attendant using either the interphone or the flight attendant call button, it would play double twin chimes, but there would be no difference in the notes. So unless someone was close enough to see the associated flight attendant panel display (which lights up when someone is calling), the ringtones would be indistinguishable. Participants felt that distinguishing calls was important as it could indicate the urgency of a situation.

Flight Attendant Call Button

Flight attendant calls button are installed in each aircraft for passengers to notify flight attendants when they need assistance. Yet flight attendants routinely use them as a means to notify other crewmembers that they themselves need assistance. For example, if a flight attendant in the aft requires help from someone in the back, she might push a passenger call button near her. This creates an audio alert that is heard in the present and adjacent cabins. Flight attendants can look at the flight attendant panel next to an interphone to see which seat light is illuminated. If it is an urgent situation, sometimes a flight attendant will push multiple call buttons to notify a team member.

"If six call buttons go out at the same time, you know that it is a serious situation and that way you will get their attention." - P3, Female, Lead/Cabin Crewmember

While certainly beneficial, the call button raises several challenges for flight attendants. First, like the interphone, a press of the call button may not be heard since the alert is only played in the present and adjacent cabins and the noise from the aircraft is generally loud.

Second, sometimes it can be difficult for a flight attendant to push a call button rendering it an ineffective tool for notifying others. On domestic flights, our participants said that the call button is usually easy to reach and always in the same position: above the passengers' heads on a ceiling control panel. Yet international airlines often have the call button in varied locations depending on the aircraft and not all locations are easy to find or natural for flight attendants to reach. For example, sometimes the call button is located

on the armrest of a passenger's seat. Pushing these call buttons may require asking a passenger to do it, which is less desired, or, awkwardly reaching in front of a passenger or under their arm. As such, our participants felt hesitant to make use of such call buttons.

"It is placed either at a weird location that is near the guest's lap or in the middle of their entertainment screen- it is not normally found at the top and is not easy to find." - P5, Male, Purser

Third, it can be difficult to know if a flight attendant or a passenger pushed the call button. Flight attendants are able to push the call button in a certain configuration to create a different alert sound, yet, in times of emergency, it may be difficult to remember to do so. The configuration for using the call button is: one push creates a single chime meaning a passenger is calling, while two pushes creates double twin chimes meaning a flight attendant is calling. However, P5 said that in an emergency situation their *"presence of mind is completely gone,"* so knowing the button's location or the configuration is an extra step.

In these situations, flight attendants will opt to try to call out loud (yell) to others in order to get their attention. However, this practice is contrary to what is taught in CRM training about passenger in-flight experience. Flight attendants are not supposed to create panic amongst the passengers.

Visual Indicators

As mentioned, a flight attendant panel is located next to each interphone and shows which seat call button is pushed or which interphone is calling the current location.. Participants said this panel saved them from unnecessary search and directed them to them to the specific location that required their attention when call button notifications came in.

"The aircraft is huge, so when a passenger call is heard, we do not start looking everywhere, but simply look at the display of the flight attendant panel. It will tell me exactly which row and seat the passenger is calling from." - P2, Male, Lead/Cabin Crewmember

A corresponding visual cue to the flight attendant panel is the seat light above the passenger's seat, which is turned on when the passenger presses the flight attendant call button. Participants said that seeing the light was generally easy if they knew which general area to look in. But those that served on international flights faced challenges because the amount of space to look in was larger. Flight attendants would look at the flight attendant panel to see which area they needed to go to and memorize the seat number. However, on their way, they might be distracted by another passenger's request. This sometimes made them forget the seat number. While they could look for the seat light, if they did not remember the approximate location, this task was very difficult.

"I kept repeating the passenger seat number so that I would not forget and was looking for the seat light too, suddenly this lady who did not press the flight attendant call button asks me to get her a glass of water and some other items. I was upset as I had to attend to the one who pressed the button first; I told her politely that I will attend to her as soon as possible. However, I realized I forgot the passenger seat number and had to go back to check again." - P5, Male, Purser

Another problem came from not remembering to reset the flight attendant button to neutral after they attended to the passenger. Most flight attendants focus on attending to the needs of the passenger and it is easy to forget to reset the button so that the passenger's seat light and the light on the flight attendant panel is turned off. This can create miscommunication for the other crewmembers and, at times, can cause multiple crewmembers to attend to the same passenger.

SHARED INFORMATION AND REPORTING

During international flights, flight attendants have more time and allowance from the airlines to interact with one another. Interactions came in the form of both informal and formal discussions. Sometimes these focused on personal life, and other times they focused on work. At times, conversations smoothly flowed between the two topics.

"We talk about everything under the sun. We call it 'jumpseat confessionals.' Our life is a bit strange. We are thrown into a situation with people you probably have not met before and probably will not again so lot of the people that I work with that I will never ever see again in my career. There is a certain kind of anonymity when we are talking to each other, so people tend to disclose lots of personal information." - P3, Female, Lead/Cabin Crewmember

When talking about work, participants said they would share ideas and feedback on improving customer service, policies, procedures and workflows. Next we describe how these interactions involved the sharing and access of paper-based materials as well as digital copies.

Paper-Based Information

When discussing work activities, flight attendants would sometimes look at portions of training manuals together. They also had instructions for each city that they might fly into, along with detailed information on all passengers. This information was generally in paper format, which made it hard to find information within it. It was also large, heavy, and cumbersome to carry around and prone to pages going missing.

"I don't like carrying the manual around. It weighs about 2 or 3 pounds. I would like to see a pdf copy." - P2, Male, Lead/Cabin Crew Member

"Sometimes the Guest Experience Manual is missing a whole bunch of pages or sections – we need to reference it

and we don't have that information on our finger tips." - P3, Female, Lead/Cabin Crewmember

Some of our participants were allowed to bring their own devices like mobile phones or tablets on to the planes, as long as they did not use them when they were supposed to be working. To avoid missing pages in the Guest Experience Manuals, some participants downloaded them on to their own mobile devices so they could be read during portions of the flight when it was not busy. Some flight attendants preferred to learn and memorize the information in the manual, yet they felt this was difficult to do. New employees faced an especially challenging time. This meant they would either have to ask the lead/purser for information or re-read portions of the manual while in-flight.

"I reference it fairly often almost every day. As I am pretty familiar with it and I can recall a lot of information without having to look it, so I am usually showing people where they can find that info or if they doubt what it says because maybe it was different before- thence I use it for the team. - P6, Female, Lead/Cabin Crewmember

Other more experienced flight attendants said that it was hard to memorize information when they were going to unfamiliar places or when the policies and rules of a country suddenly changed.

"It is better to better memorize the information, so you do not have to reference the paper, but if you are flying to Cancun and you don't fly there very often, so it is harder to keep Cancun specific information fresh in mind so it is definitely handy to have that sheet for reference." - P3, Female, Lead/Cabin Crewmember

Information about a crew's flight can also change at the last minute. If this happens for a domestic flight, our participants told us that the leads typically do not find it difficult as they have to only reconfigure the seating arrangements. However, for the international airlines, the pursers in our study said that such changes had a large impact on their work. Typically they prepared ahead of time by reading and learning about the airplane they were going to be flying on and the location's custom formalities, regulations, duties, and transit information. Last minute changes meant they did not have a chance to learn this information for the new location.

"Every aircraft is designed differently so we need to study before boarding. I studied the aircraft the whole night and when I came the next morning it was all changed and my team was asking me for their tasks." - P5, Male, Purser

Our participants described needing to complete mandatory reports at the end of each flight. This was necessary in case situations arose that might cause passengers to complain to the airline. Thus, having a flight attendant's record of the event was valuable. We found that retaining and compiling this information was challenging for our participants. The leads and pursers in our study wrote this information out on

paper or their mobile phones during the flight so they would remember. Those who collected it on paper worried that their hands would be occupied and the information could be lost. Other participants struggled to compile the reporting information because of a lack of time and energy.

"The problem with the current way of reporting is that there is the time lapse, that you lose the information when you leave the aircraft and some time you don't even get to it, because you only have to report it within 24 hours and people won't do it in their own time, as they are not paid for that." - P1, Female, Lead/Cabin Crewmember

Several participants felt that if they had in-flight access to WiFi (which not all planes had), they would be able to complete their report immediately before leaving the plane.

"I would like to report incidences from the aircraft so that it is done before I leave, so that the information is even fresher in my brains. With WiFi, the management could have the report before we even reach the ground. That is one piece of the job that I would like to complete on the aircraft, rather than at home." - P6, Female, Lead/Cabin Crewmember

Tablet Computers

Tablets (e.g., iPads) were recently introduced into the airplanes of several of our participants as a replacement to the paper information that they previously needed to use. The goal was to facilitate sharing of ideas and optimizing the in-flight workflow and passenger experience. For example, on the international airlines, iPads were allocated to the pursers so they would have access to flight attendant manuals, the pre-briefing flights details, and reporting forms. P5 said it *"makes us look very professional, well informed and knowledgeable about customer's profile."* In addition, P5 felt that the iPad allowed him to build customer relationships more easily because it contained details about each passenger. He would use it to greet important and frequent passengers and also to confirm their preference of meals, seats and connecting flights in a short time. P5 described how his team also benefitted from the tablet as they were able to cross-reference each other on updated information in the manuals, ideas about changes in the procedures, and also about suggested policy changes that they noted in their shared reports.

Conversely, despite the iPads being of great convenience, the pursers in our study found them to be overwhelming to manage. Participants said that sharing them was not easy.

"There are some difficulties using this technology as it crashes from time to time and because it is just one iPad it runs out of battery fairly quickly when carried to the other crewmember." - P5, Male, Purser

At times they would be completing a report on the iPad and another crewmember wanted to access the flight attendant manual. They would then need to negotiate its use and also ensure there would be enough battery power to complete their work later. Naturally, they could plug the iPad in to

charge, but this was awkward and confined them to a single location.

“We can not really do many things on the iPad and use it some times as there are only 3 in total for 3 pursers. In case of emergencies, we would reference it for the manuals, but otherwise we can see only some information about the flight, the aircraft layout and the seat number and connecting flight of the passengers. - P8, Female, Cabin Crewmember

Another factor that concerned the pursers in our study was the size of the iPad. They could not easily fit it into their pocket and so were forced to hold it in their hands. This made the iPad prone to accidental damage.

“I am always carrying the iPad, when I am serving the food to the guest I place it on the cart. There are times and chances of coffee spilling over the iPad or the screen becoming crack - in that case I find this gadget might not be useful.” - P5, Male, Purser

The iPad contained personal details of each passenger and pursers said they were responsible for ensuring its privacy. This meant that they had to keep the iPad near them at all times. This, again, was awkward.

DISCUSSION

In our discussion section, we explore our results by framing them in terms of collaboration theories and looking at the implications of our findings for informing the design of collaborative technologies for flight attendants.

Maintaining Situation and Workspace Awareness

Our findings revealed that the CRM training only provides the necessary groundwork for implementing theories of team and distributed cognition, yet, in actual practice, engaging in such acts is more challenging for flight attendants given their working environment and the availability of appropriate technology. Team and distributed cognition starts to develop early at the pre-flight briefing when a shared mental model is developed amongst crew members. This model is extended by the lead/purser each time they communicate and coordinate with the pilot, cabin senior director and the cabin crewmembers. To avoid miscommunication and information breaks, the lead/purser tries to make the workflow efficient by communicating the mental model of the flight to the other flight attendants using the in-flight collaboration tools. However, our results show that these collaboration tools do not always enable flight attendants to work more efficiently or to improve the level of situation awareness needed for collaboration. Flight attendants face problems in maintaining situation awareness, during both routine and emergency situations, and sharing pertinent information with others.

For instance, in a normal service routine, the leads/pursers gain an awareness of the cabin crew's work activities by personally walking to each crewmember's station to inquire and provide assistance. An alternative is to use the interphone or the flight attendant call button, but these can

not be relied on for immediate feedback or to provide a visual display of each crewmember's current activity. Crewmembers need to be in close-proximity to where these tools are located (galleys, exit doors) or where the sounds can be heard. This can cause delays in waiting times or interference with current tasks. In an emergency situation, these collaboration tools become more inaccessible or are burdensome to use. Although the common practice is to gesture or shout to others for help, gestures can be hard to see and shouting is easily not heard. The audio alerts from the interphone and the flight attendant call button do not indicate what level of emergency and assistance is required. Only when an interphone call is answered or when the crewmember physically moves to the passenger's seat to assess the situation can the crewmember understand its level of urgency.

This illustrates that the current technology used by the flight attendants we studied does not strongly support collaboration. Instead, proximity is a precursor for collaboration and collaboration is only smooth when flight attendants are in close physical proximity. Yet the challenge is, this is rare. The flight attendants in our study were not always able to retain, share or disseminate information to other crew members at the right time or at the right place. This suggests that in-flight technologies should be potentially redesigned to better facilitate smooth collaboration and awareness amongst flight attendants. Here we see that an emphasis should be placed on notifying flight attendants with real-time emergency information first and then other routine information second. Designs should also provide immediate access for flight attendants to communicate with other crewmembers, regardless of where they are on the plane.

There are many potential solutions for these problems. One might imagine, for example, the use of wearable technologies that could let flight attendants send messages to each other or view status information about the flight at-a-glance without having to hold a device such as a tablet or smartphone. Smart watches could allow crewmembers to receive calls from any part of the aircraft and simultaneously help to clarify and communicate messages with one another. Other design solutions may involve the increased use of embedded devices throughout the plane so that flight attendants can access technologies more readily or gather awareness information from them regardless of where they are on the plane. These suggestions are certainly speculative, however, and future work would find promise in pursuing such design explorations.

Information Sharing and Optimizing Workflow

This responsibility of sharing information with crewmembers and updating the captain and cabin senior director is the responsibility of the purser. They have to ensure that the information they have is updated and accurate, so that others may be able to follow their mental model and take the next decisions or action. In our findings,

we found this took place during both formal and informal conversations amongst flight attendants. Conversations often involved the sharing of contextual information that was either static or dynamic in nature. Static information included information embedded in manuals, preflight briefings, and reporting details. Our results showed that participants used either the paper or the digital format of the information and were not necessarily satisfied with either. Paper information was easy to lose, difficult to search, and heavy to carry. For digital information, our participants found that the act of sharing tablets created, perhaps, more challenges than benefits. Flight attendants had a difficult time holding an object that could easily break if dropped. It could also easily be stolen. These findings offer suggestions for the future design of technologies for flight attendants as it relates to static information. Such needs equate to technology that is lightweight, robust and easy to carry or hold on oneself (without the constant need to use one's hands) as well as the use of multiple devices amongst groups of flight attendants.

Dynamic information includes customs regulations, crewmember details, and passenger details. As recorded in our results, pursers prepared themselves in advance about the aircraft, customs and the people they would work with, so that they could be efficient in maintaining situation and workspace awareness while in-flight and working. However, this information was prone to last minute changes. As such, paper-based copies of this information did not work well and flight attendants would highly value technologies that give them quick access to dynamic information. To improve and encourage information sharing practices amongst crewmembers, future designs may want to consider how dynamic information could be made easily available to flight attendants so that it is ready-at-hand when they need it and that they can quickly discern what has changed.

LIMITATIONS

Our study is limited in that we were not able to directly observe flight attendant practices due to security and safety concerns on-board flights. Our interview results could have been validated or extended with such observations of actual practices. After all, people's recollections of what they do are not always reflective of what they actually do. That said, our study should act as a basis for understanding what types of observations would be valuable to make as a part of future studies, if one is able to observe flight attendants' practices during flights.

Our study did not contain interviews or data collected from crewmembers that were not flight attendants, such as pilots. This would have provided further details on the communication practices occurring within airplanes and a different perspective from the flight attendants that we studied. We chose to study flight attendants as an initial step, however, future work should consider including pilots

and other crewmembers. Nonetheless, our results should be interpreted with this limitation in mind.

Our last limitation is in the disclosure of the name of the airlines with whom our flight attendants worked for and the specific types of aircrafts that they flew on. This information may have helped the reader understand if there are particular differences across airlines and how various cultures are represented in the study. In order to ensure that participants' privacy is protected and respected as a part of ethical procedures, and for safety reasons, we had to exclude the name of participants' organizations.

CONCLUSION

Our paper contributes to the growing research and demand for incorporating new technologies in the aviation industry. We conducted a series of in-depth interviews with flight attendants that highlight the challenges and limitations they face in maintaining situation and workspace awareness that persist in both the domestic and international airlines that we studied. We discovered a diverse set of challenges and communication breakdowns that were focused around team mental models, physical space, and technology that lead to incidents and mishaps. Therefore, our suggestion is to focus on the design of future technologies that can enhance the communication practices of flight attendants and foster a high level of situation awareness to help them collaborate more easily. Future work should continue the study of flight attendants and their work practices, along with design explorations of new technologies, while incorporating a broader set of stakeholders such as pilots and ground crewmembers.

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