Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 11, pp.61268-61275, November, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

MODERN DAY HEROES: A MULTIPLE-CASE STUDY OF HOW SUCCESSFUL FLIGHT CREW AND AIR TRAFFIC CONTROL COORDINATION HELPED PREVENT DISASTER

***Janice R. McCall**

Parks College of Engineering, Aviation and Technology, Saint Louis University, USA

ARTICLE INFO

Article History:
Received 29th August, 2017
Received in revised form
30th September, 2017
Accepted 16th October, 2017
Published online 30th November, 2017

Key words:
Coordination,
Shared understanding,
Situational awareness.

ABSTRACT

Three successful commercial airline in-flight emergencies were explored using a retrospective multiple-case study, through a constructivist worldview, to understand how coordination between and amongst flight crew and Air Traffic Control (ATC) helped save lives. The cases in this study, Qantas 32, Air Transat 236, and US Airways 1549, covered a period from 2000-2012 and were selected to learn what flight crews and ATC did right during in-flight emergencies that led to the successful outcome and no loss of life. The scope of the study was limited to identifying major themes within archival data collected from public final investigation reports, transcribed audio recordings, photos, and news interviews either published or televised, along with autobiographical books published by flight crewmembers. Constant comparison analysis, through a three-phase coding process, was used to identify four major themes that enhance coordination between flight crews and ATC: reluctant hero, trust in others roles, embracing training, and coping with crises. An additional theme of emotional trauma was identified as a byproduct of experiencing the in-flight emergency, no matter the outcome. Based on the findings, recommendations for future research involve expanding on the current study of what went right during in-flight emergencies to develop resiliency for both individuals and organizations.

Citation: Janice R. McCall, 2017. "Modern day heroes**:** A multiple-case study of how successful flight crew and air traffic control coordination helped prevent disaster", *International Journal of Current Research*, 9, (11), 61268-61275.

INTRODUCTION

Survival Onboard Qantas Flight 32

The final investigation report on Qantas Flight 32, published by the Australian Transport Safety Board on 27 June 2013, tells a compelling story of survival. On November 4th, 2010, 469 passengers and crew boarded Qantas Airbus 380, Flight 32, to fly from Singapore Changi Airport to Sydney, Australia. That morning, the sky was clear and the winds light as the world's largest passenger aircraft departed runway 20C to begin its initial climb. Soon after, as the plane climbed through 7,000 feet, there were two loud bangs and the aircraft began to yaw. The captain immediately stopped the climb and leveled the aircraft. At the same time the highly automated, fly-by-wire Airbus 380 (A380), directed the First Officer's attention to a host of emergency and troubleshooting procedures, 100-130 alerts were displayed on the flight-deck monitors, to deal with the uncontained failure of the number 2 engine rotor. Debris from the engine was discharged with such force it caused damage not only to a variety of aircraft systems but also structures on the ground at Batam Island, Indonesia.

Corresponding author:* **Jan McCall,
Parks College of Engineering, Aviation and Technology, Saint Louis University, USA

With the aircraft stabilized the crew began the process of assessing damage, loss of their number 2 engine, associated equipment, and options for landing the now crippled aircraft. Working through the list of faults took well over an hour. Passengers startled by the loud bangs and aware of the engine failure could see the hole in the top of the left wing on the in-flight video monitors. They sat listening to instructions from the flight attendants and preparing themselves for whatever may happen next. The A380 was severely damaged but still flying, so the crew coordinated with Air Traffic Control (ATC) to return the overweight aircraft back to the runway at the Changi Airport. On the ground reverse thrust and maximum braking was applied to bring the aircraft to a stop, just 500 feet short of the end of the runway. As the aircraft came to a full stop the crew and passengers breathed a sigh of relief but the emergency was far from over. The hot brakes coupled with fuel leaking from the left wing, had the emergency rescue workers scrambling outside the aircraft and delayed the evacuation. If all that wasn't enough, when the crew attempted to shut down the number 1 engine it would not shut down. The controls to the engine had been severed and it was running on its own. Only after attempting to drown the number 1 engine with water and then runway foam were the fire-fighters able to finally contain the runaway engine and safely evacuate the passengers and crew.

Photo 1: Qantas Flight 32 gets hosed down (www.abc.net)

Miraculous as the story of Qantas, Flight 32 seems, it is not the only story of the heroic efforts of flight crews in recent history. Qantas is one of a number of flights that highlights the importance of coordination between flight crewmembers and Air Traffic Control (ATC) in order to manage a crippled aircraft and avoid disaster. It is also what led to this study focused on improving safety through learning what went right during in-flight emergencies. This retrospective multiple-case study was designed to explore how coordination, between and amongst flight crew and ATC during the direst of situations, aids in saving lives aboard three commercial airplanes. What did these three crews, working with ATC, do to facilitate a shared understanding of the emergency and plan to handle it? Along with the Qantas Flight 32, this study examined, Air Transat Flight 236, Airbus 330, fuel starvation over the Atlantic Ocean (2001), and US Airways Flight 1549, Airbus 320, landing on the Hudson River following bird-strikes (2009).

Literature Review

The purpose of this research is therefore to explore how coordination between and amongst crewmembers and ATC increases survivability. For this project flight crew coordination is defined as "the interaction between crewmembers (communications) and actions (sequence or timing) necessary for flight tasks to be performed efficiently, effectively, and safely" (Simon *et al*., 1992). In the study of aviation emergencies and abnormal situations the National Aeronautics and Space Administration (NASA) reported that the handling of emergency and abnormal situations is affected by the quality of communication and coordination among all involved including flight crew, cabin crew, ATC, dispatchers, maintenance personnel, airport rescue and fire fighters, and medical personnel (Burian *et al*., 2005). "Safety is maximized when there is good crew coordination and the flight crew works together effectively as a team" ("Normal Checklists and Crew Coordination," 2011). For coordination to exist each crewmember must share a common mental model of how the flight is progressing as viewed through their scope of responsibilities, commonly referred to as situational awareness. In other words, effective crew and ATC performance requires that each hold a common or overlapping cognitive representation of task requirements, procedures, and role responsibilities (Converse, 1993). Situational awareness is the "perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future" (Endsley, 1988). Building this shared common picture during emergencies or adverse situations, is what Orasanu (1994) referred to as "shared problem models," that facilitate coordination. "Having a shared problem model does not mean that all crew members think exactly the same, but it does increase the likelihood that they are all moving in the same direction, with the same understanding of what the problem is, what is to be accomplished, and how" (Orasanu, 1994). Crew coordination can be seen as the transfer of information from one crew member to another, as required for developing situational awareness across the team (Endsley, 1999). This type of social distribution of cognition between crewmembers and ATC may also be viewed in terms of "distributed cognition" as described by Hutchins and Klausen (1996) during their study of airline cockpit cognition. The focus of this study is intended to build on the work of Predmore (1991) in Crew Resource Management under stressful, high workload conditions and the work of Al Haynes, the Captain of United Airlines, Flight 232, Sioux City, Iowa, on luck, communication, preparation, execution, and cooperation (1991). It also continues the work of Eisen (2009) and Nelson (2007) which includes learning from what went right and best practices. Improved coordination is also related to current concepts of resilience engineering in safety by helping teams and organizations prepare for the unexpected (Woods & Hollnagel, 2006). Identifying and describing best practices for dealing with unexpected and potentially catastrophic events in commercial aviation has the potential to improve safety throughout high-risk industries.

Overview of cases

Along with Qantas 32, two other successful in-flight emergencies were selected for this study, Air Transat 236 and US Airways 1549. Each offered an example of flight crews experiencing a severe in-flight emergency and successfully managing the emergency to a safe outcome. Unlike Qantas 32, the other two flights lose all engines and complete two of the most famous forced landings in aviation history.

Air Transat 236

On 24 August 2001 while enroute from Toronto, Canada to Lisbon, Portugal, Air Transat 236 developed a fuel leak that resulted in complete loss of power to both engines while over the Atlantic Ocean at night. The mismatched installation of a hydraulic tube and a fuel tube resulted in the tubes coming into contact with each other. This created a fracture in the fuel tube and led to the fuel leak that caused fuel exhaustion (Aviation Accidents Prevention and Investigation Department, Portugal, 2004).

Photo 2. Air Transat 236, fuel pipe crack (AAPID, 2004, p. 17)

Exacerbating the problem was difficulty diagnosing the emergency for the flight crew, and a checklist that led to cross-feeding fuel out of the leak. This happened a second time when maintenance dispatch suspected the wrong engine and again had the crew cross-feed fuel to the leaking tank. The result was an Airbus 330 turned into a giant glider with 306 passengers and crew onboard. Through assistance from ATC the pilots were directed to Lajes Airport on Terceira Island in theAzores. From an altitude of 34,000 feet, and 65 nautical miles from the airport, the pilots could see the runways lights being flashed by the controllers. Through their coordinated effort the flight crew, led by ATC, managed to glide the aircraft to a landing. The only injuries occurred during evacuation when "fourteen passengers and two cabin-crew members received minor injuries and two persons received serious injuries" (AAPID, 2004).

US Airways 1549

One of the most famous flights in recent history, involved an Airbus 320, operated by US Airways as Flight 1549, which was forced to land on the Hudson River after being struck by migrating Canada geese. After departing LaGuardia Airport in New York, USA, on 15 January 2009, the aircraft collided with a flock of Canada geese causing some of the birds to be ingested into both engines. The pilots, assisted by ATC, were faced with little time to determining the safest place to the land the narrow-body jet in the most populated city in the USA. Three minutes and thirty second after the birds hit the aircraft it landed on the Hudson River. "The 150 passengers, including a lap-held child, and 5 crewmembers evacuated the airplane by the forward and overwing exits. Seven New York Waterway ferries, two US Coast Guard small boats, and a NY Fire Department fire rescue boat responded to the crash rescuing passengers from the sinking aircraft (NTSB, 2010). One flight attendant and four passengers were seriously injured, and the airplane was substantially damaged" (National Transportation Safety Board, 2010).

Photo 3. US Airways Flight 1549, aircraft on Hudson River, with occupants on the wings and slide/rafts after the evacuation (NTSB, 2010, p. 5)

METHODOLOGY

"Case studies are pertinent when your research addresses either a descriptive question—'What is happening or has happened?'—or an explanatory question—'How or why did something happen?" (Yin, 2011). For this reason, a retrospective multiple-case study was used to explore how coordination, between and amongst flight crew and Air Traffic Control (ATC) during the direst situations, helped save lives aboard three commercial airplanes. In this study, archival data was analyzed on three flight crews, working with ATC, to reveal how they facilitated shared understanding of the crises and developed plans to manage the emergencies.

Researchers Perspective

The methodological approach for this study was based on an interpretivist-constructivist worldview. Interpretivist researchers attempt to "understand, explain, and demystify social reality through the eyes of different participants" (Beck, 1979). The philosophical underpinnings of interpretivism can be traced back to Hume (1748/2011), Kant (1781 & 1787, as cited in Guyer and Wood, 1998), and Dilthey (1991). Constructivism is frequently associated with interpretivism in qualitative research. Constructivist researchers are often concerned with the processes of interaction among individuals and focus on the specific contexts in which people live and work, in order to understand the historical and cultural settings of the participants" (Creswell, 2013). Crotty (1998) defined constructivism as "the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essential social context" (p. 42). Of primary concern in this study is the construction of events in and between flight crew members and ATC.

Rational for Multiple-Case Study Design

Bromley defines a case study as a "systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest" (1990, p. 302). The multiple-case study method capitalizes on acquired insights. "Case studies provide unique means of developing theory by utilizing in-depth insights of empirical phenomena and their contexts" (Dubois and Gadde, 2002). For this reason, the multiple-case approach was selected for this study and to "contribute to our knowledge of individual, group, organizational, social, political, and related phenomena" (Yin, 2014). The scope of this study is limited to gaining knowledge from individual and group successful in-flight emergencies. Cases are used also to explain, describe, or explore events or phenomena in the everyday contexts in which they occur (Yin, 2014). Studying the three inflight emergencies separately, then in comparison to one another, allowed for analysis of phenomena in and across context. "The evidence created from this type of study is considered robust and reliable, but it can also be extremely time consuming and expensive to conduct" (Baxter & Jack, 2008, p. 550). While multiple-case design is more difficult to implement, the ensuing data can provide greater confidence in the findings (Yin, 2011).

Case Selection

Case selection is the primary task of the case study researcher, for in choosing cases, one also sets out an agenda for studying those cases (Seawright & Gerring, 2008). The cases selected for a multiple-case study "should follow a replication rather than sampling logic" (Yin, 2014, p. 26). For that reason, the three cases in this study were selected based on the theoretical focus of this study; to explore how coordination, between and amongst flight crew and Air Traffic Control (ATC) helped save lives. Each flight, Air Transat 236, Qantas 32, and US Airways 1549 were selected for the common experience of

having an in-flight emergency that crippled the aircraft, and the subsequent safe landing within a period covering the years from 2000-2012. In addition, these flights were selected based on the respective government final investigation reports, from Australia, Portugal, and the United States of America, along with available interview comments from crewmembers and ATC. The in-flight emergency cases selected for this study are what Stake (2013) referred to as 'bounded' system of complex interrelated elements or characteristics that have clearly identifiable boundaries. Viewed together the selected cases also make up what Stake referred to as a "series of instances" for analysis (p. 2).

Data Collection Methods

In order to complete the study within the 90-day window and minimize expense, an archival data collection method was selected. Yin (2014) reports the advantages of using documents and archival records to be, stability, unobtrusive, exact, and providing broad coverage over an extended time span. In contrast, the weakness highlighted by Yin (2014) include, difficulty with retrievability, biased selectivity, reporting bias, and limited access. Rather than denying bias, this study is somewhat dependent on it. For the researcher to expand on what is known of coordination between flight crews and ATC there must be some familiarity with the topic. "The proximity to reality, which the case study entails, and the learning process which it generates for the researcher will often constitute a prerequisite for advanced understanding" (Flyvbjerg, 2006). In this case, the researchers experience as a former airline pilot aids in identifying cases and collecting of data. Data was extracted from public final investigation reports of each in-flight emergency, transcribed Cockpit Voice Recordings (CVR), photos, and news interviews either published or televised of crewmembers and ATC, along with autobiographical books by flight crewmembers. These sources were used to capture the crewmember and controllers quoted description of events in their own words. Crewmember comments during the televised interviews were transcribed before being coded. The investigation reports were also used to provide context for the in-flight emergencies. Use of multiple sources of evidence allowed for "triangulating—or establishing converging lines of evidence" (Yin, 2011). Sufficient data was collected to provide the reader a view of the realities and permit them to understand the complexity of the cases (Stake, 2013).

Data Coding and Analysis

Initial coding involved a review of the data, followed by categorizing, and coding. Open and axial coding was completed using Microsoft Word 2013 and Adobe Acrobat Reader XI. The code-to-line analysis focused attention on "meaningful, undivided qualitative units rather than lines of text to create the system of codes and analytical memos" (Chenail, 2012).

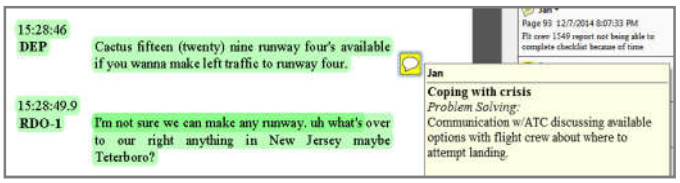

Figure 1. Open and axial coding using code-to-line analysis of US Airways Flight 1549 CVR transcripts, in Adobe Acrobat Reader XI

These codes where cut and sorted for further analysis. The code structure was then analyzed to describe shared themes.

Evaluating Criteria –Trustworthiness

"Issues of trustworthiness and credibility, as opposed to the positivist criteria of validity, reliability and objectivity, are key considerations in the interpretivist paradigm" (Tuli, 2011). Therefore, trustworthiness and credibility should be considered for this study seeking to explore how coordination, between and amongst flight crew and Air Traffic Control (ATC) during the direst of situations, aids in saving lives.

Lincoln and Guba (1985), propose one simple question to determine trustworthiness: "How can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?" (p. 290). Lincoln and Guba (1985), and Bryman (2008, p. 49) argue that other criteria is necessary for evaluating qualitative work and provide the four criteria listed below.

- Credibility, parallels internal validity – that is, how believable are the findings?
- Transferability, parallels external validity – that is, do the findings apply to other context?
- Dependability, parallels reliability – that is, are the findings likely to apply at other times?
- Confirmability, parallels objectivity – has the investigator allowed his or her values to intrude to a high degree?

Viewed this way, it is left to the researcher and reader to determine credibility. Readers familiar with theories put forward by Predmore, Eisen, Woods & Hollnagel, and Nelson, may find communication during in-flight emergencies transferable and dependable. Predmore (1991) and Eisen (2009) found that Crew Resource Management (CRM) improves crew effectiveness. Woods and Hollnagel (2006) call for a paradigm shift in safety towards a proactive and anticipatory stance found in resilience engineering. Nelson (2007) encourages learning from failure and success to develop best practices. Lastly, confirmability is concerned with bias which is addressed under ethical considerations.

Ethical Considerations

The use of previously disclosed public archival data helped minimize ethical concerns. All data collected was previously disclosed as part of the government investigations and recorded in the final investigation reports, or through publicly televised interviews with crewmembers and ATC for which there should be little expectation of privacy. For that reason, there is little if any risk to individuals or organizations associated with the three commercial flights used in this study. Marshall and Rossman (2006) describe the strength of reviewing documents and their analysis as "unobtrusive and nonreactive" because it can be conducted without disturbing the setting in any way. In addition, the researcher had no affiliation with any of the airlines/carriers included in this study and does not anticipate any issues of bias. Measures were taken to guard against bias, but as mentioned above to some degree, this study relied on a certain level of bias. Firestone (1987) points out in qualitative research "bias can be minimized but not eliminated" (p. 15). The purpose of this research is to describe how coordination between and amongst

crewmembers, and ATC increases survivability. It accomplishes this goal through a retrospective multiple-case study used to explore how coordination, between and amongst flight crew and Air Traffic Control (ATC) during in-flight emergencies, helped save lives aboard three commercial airplanes. The results of this study may aid in identifying and describing best practices for dealing with unexpected and potentially catastrophic events in commercial aviation

Limitations

This study was restricted to 90 days. The time constraint limited expanding the data collection to include the cabin crew, which would have added to this study. In addition, no funding was available which restricted collection of data to those sources publicly available. An unexpected limitation was the need for language translation of interviews conducted with the Air Transat 236 Captain. Most were presented in French and very few offered an English translation. Also, access to the CVRs was limited to only the saved transcript of US Airways 1549.

RESULTS

This retrospective multiple-case study explored how coordination, between and amongst flight crew and ATC during the direst of situations, helped to save the lives of passengers and crew members aboard three commercial airliners. Analysis of the data offered insight into what these three flight crews, working with ATC, did to facilitate a shared understanding of the emergency and develop a plan to cope with the crises. Through analysis of the data four themes were revealed that enhanced coordination during these emergencies. They are depicted in the figure below.

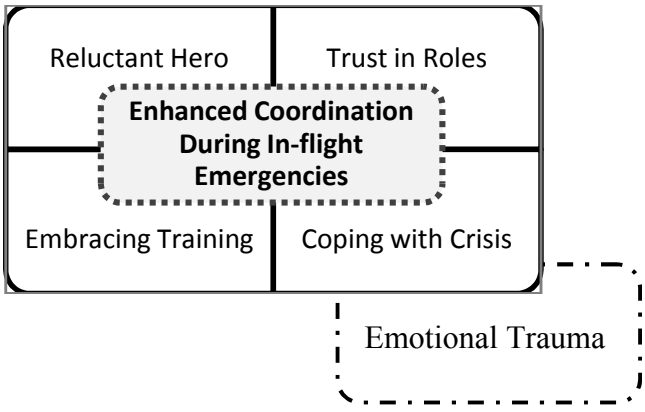

Figure 2. Four themes associated with enhancing coordination during in-flight emergencies and an additional event related theme of emotional trauma

In addition to these four themes one additional theme, unrelated to coordination, also surfaced. That is the *emotional trauma* experienced by the flight crewmembers and controllers following the events. The captains spoke most poignantly of the impact the in-flight emergency had on their mental health.

Reluctant Heroes

"The reluctant hero is most often an ordinary person who is forced to rise to meet extraordinary circumstances" (Gibson, 2014). Each crew member expressed similar sentiment that they were doing their job, what they had trained for, and did not consider themselves heroes. The same characteristics that lead to a reluctant hero also aid in coordination during in-flight emergencies. They are expressed as *humility* and a *willingness to ask for help* in determining the options for returning the aircraft to the ground and averting disaster.

Table: Flight Crew Listed by Flight

Qantas 32	
Captain	Richard de Crespigny
1st Officer	Matt Hicks
2nd Officer	Mark Johnson
Check Captain	Harry Wubben (Observer)
Check Captain	David Evans (Observer)
Air Transat 236	
Captain	Robert Piché
1st Officer	Dirk De Jager
US Airways 1549	
Captain	Chesley Sullenberger
1st Officer	Jeff Skiles

Below are just a few of the comments from flight crewmembers that describe how reluctant heroes facilitate coordination between crewmembers and ATC:

- Piche' - I don't consider myself a hero, sir. I could have done without this (Crossette, 2001).
- De Crespigny - As the leader of the QF32 team that day, I believe my approach was never that of a hero, but that of an experienced leader who absorbs and gains from the wisdom of those who know more than I do and who are willing to share and work as a team (De Crespigny, 2012).
- Sullenberger - My wife actually looked it up in the dictionary. We decided between ourselves that it describes someone who chooses to put himself at risk to save another. That didn't quite fit my situation, which was thrust upon me suddenly. Certainly, my crew and I were up to the task. But I'm not sure it quite crosses the threshold of heroism (Gambino, 2010).

Trust in Roles

Critical to successful coordination between flight crew members and ATC was the trust each person put in the others fulfilling their roles and responsibilities. On the flight deck there is a division of tasks as each pilot works through their specified duties in coordination with each other. This type of coordination can clearly be seen in the comments by the captain and first officer of US Airways 1549. Highlighted below are comments from the NTSB final investigation report (2009, p. 91) on the flight crews' roles and coordination during the three and a half minutes they had from the bird strike to the landing on the Hudson river.

- The first officer stated that they each had specific roles, knew what each other was doing, and interacted when necessary.
- The captain indicated that, because of the time constraints, they could not discuss every part of the decision process; therefore, they had to listen to and observe each other.

Another example of how trust in others fulfilling their roles and responsibilities facilitated survival can be found in the actions of the Lajes air traffic controller assisting Air Transat 236. The flight crew was initially provided vectors to Terceira

Island. Then the controller repeatedly flashed the runway lights allowing the Air Transat flight crew to keep the runway in sight from over 60 nautical miles away.

- Assisted by radar vectors and flashing of the runway lights, the aircraft arrived about 8 miles off the approach end of runway 33 at approximately 13,000 feet on a track of about 270° (AAPID, 2004, p. 8).

Each of the flights selected for this study offered data supporting the importance of trust in other crewmembers and ATC fulfilling their roles as a critical component of surviving in-flight emergencies. In addition to knowing the capabilities of flight crewmembers, observers can help prevent task saturation by accepting additional duties as delegated by the captain. In the case of Qantas 32 having additional crewmembers on board, two check captains, helped prevent repeating the Air Transat fuel cross-feed error.

- The 'FUEL: wings not balanced' checklist appeared and Matt [First Officer Matt Hicks] was reaching up to open the fuel cross-feed valves when I suddenly called out 'STOP!' It seemed instinctively wrong to me, and I stared at the ECAM and the fuel synoptic display, then back to the ECAM. 'Should we be transferring fuel out of the good right wing into the leaking left wing?' I asked. 'No!' Mark, Harry and Dave all said loudly. I didn't have to say anything more. They all knew the case of Air Transat TS236, an A330 flight from Toronto to Lisbon in 2001 (De Crespigny, 2012).
- In a flight deck team, you never have all pilots focusing on the same functions: you have task sharing, which means each pilot is responsible for their activity, and together they support each other (de Crespigny, 2012).

The trust crewmembers had in others fulfilling their roles enhances coordination and stems from embracing training.

Embracing Training

Within the data all of the captains in this study expressed that they had been preparing for such an event most of their lives. Through their training they not only gained knowledge and experience but of equal importance they gained confidence in themselves, their crews, the processes defined in their SOPs, and the emergency procedures as laid out in the Quick Reference Handbook (QRF). Each crew member credited the training they had received as essential to their success. Captain Piche' went even further acknowledging that the time he spent in a US prison after being convicted of using an aircraft to smuggle marijuana, also helped him prepare for the emergency that night in August of 2001.

- Piche' - I understood that prison and an aircraft in distress are pretty much the same. You have no choice but to deal with the situation if you want to come out in one piece (Cusson, 2004).
- Piche' - You do as you've been taught (Crossette, 2001).
- Sullenberger - My entire life up to that moment had been a preparation to handle that particular moment (Chi, 2009).
- De Crespigny - We were worried, but our training kicked in. We knew every part of the A380. I had been flying for 35 years and had over 15,000 hours of flying experience, plus at least a thousand hours in simulators experiencing stressful scenarios (De Crespigny, 2012).

It is not just the flight training these captains spoke of but specific training in Crew Resource Management (CRM) that helped facilitatecoordination. CRM focuses on interpersonal communication, leadership, and decision making in the cockpit (Marcellin, 2014). It also extends to the cabin crew, ATC, emergency rescue, dispatch, and any other available resources to assist. The significance of effective CRM in these three cases cannot be overstated, especially considering that 29.4% of commercial aviationaccidents can be attributed to *Crew Resource Mismanagement* (Wiegmann and Shapell, 2001).

- Sullenberger - (NTSB, 2010) The captain credited the US Airways CRM training for providing him and the first officer with the skills and tools that they needed to build a team quickly and open lines of communication, share common goals, and work together (p. 61).
- Evans - It was nearly a two-hour process to go through those items [emergency and troubleshooting procedures] and action each one (or not action them) depending on what the circumstances were. Our role in the backseat was to deal with some serious issues as we were doing each item. We were part of the CRM process, to either suggest to go ahead with the procedure or not (Robinson, 2010).

Coping with Crises

Through the reliance on their training flight crews and air traffic controllers were able to control their initial emotions and focus on the crises at hand.

- Piche' - You don't have time to think about anything else than taking care of the safety of the passengers. (Crossette, 2001).
- De Jager "reacted to the emergency with the same focus as he would a test in a flight simulator…of course, you go 'oops,' but you only go 'oops' for maybe a second and then it's back to business (Hanes, 2001).
- Patrick Harten (Controller for US Airways 1549, ATC New York's Terminal Radar Approach Control Center) - I was flexible and responsible, and I listened to what the pilots said, and I made sure I gave him the tools he needed. I was calm and in control" (Robbins, 2009).
- De Crespigny - The aircraft was flying and, although our heartbeats were elevated, we knew we needed to stay calm and in control (De Crespigny, 2012).

The ability to remain focused allowed for communication and coordination between crewmembers and ATC, which facilitated a shared mental model of the in-flight emergency. "These shared models consist of common knowledge and understanding about the aircraft systems, the task, crewmember roles, standard procedures and company policy" (Orasanu, 1994). Still, no matter how well coordinated or successful an in-flight emergency is, it can lead to emotional trauma.

Emotional Trauma

While working through the data to explore how coordination between and amongst flight crews and ATC aided in saving lives, one theme continually reemerged, *emotional trauma*.

Even though all the passengers and crew survived the threat of near death, the overwhelming sense of responsibility, and stress, took a toll on flight and cabin crew members, ATC, passengers, and families.

Listed below are a few of the comments that draw attention to the issue of post-traumatic stress.

- Piche' - I was not concerned about how I would face the public; but, I was concerned about how I would handle the resurgence of all the emotions that had been bottled up inside for so many years (Cusson, 2004).
- Sullenberger - if I could have clicked my heels and made the whole incident go away, I would have done so. Lorrie and the girls also wished it had never happened. Though I never thought I was going to die, they certainly felt as if they had almost lost me on January 15. It was hard for them to shake the horror of that feeling (Sullenberger and Zaslow, 2009).
- Harten (NY ATC) - It may sound strange, but to me the hardest, most traumatic part of the entire event was when it was over. During the emergency I was hyperfocused, I had no choice but to think and act quickly. But when it was over, it hit me hard" (Robbins, 2009).
- De Crespigny - Confused and exhausted, I finally told the psychologist about the loop. With his help and advice, I eventually managed to extract myself from the loop (De Crespigny, 2012).

These are merely a few of the comments that tell a compelling story of struggling to cope after the in-flight emergencies. Following the event, Captain Piche' entered an alcohol detoxification program and is depicted in the French Canadian biographical film *Piché: The Landing of a Man*, as he struggles to come to terms with the flight and his time in prison. In his book, *Highest Duty*, Captain Sullenberger describes the suicide of his father and later the loss of his mother to colon cancer. Sullenberger exams his own philosophy on the preservation of life. Captain De Crespigny courageously volunteers his own experience dealing with the aftermath and need for professional assistance dealing with the post-traumatic stress in his book QF32. Through this study exploring how coordination between flight crews and ATC aided in saving lives five themes were revealed. Four themes, reluctant hero, trust in others roles, embracing training, and coping with crises directly contribute to improved coordination between and amongst flight crew members and ATC. An additional theme of emotional stress was identified as a byproduct of dealing with in-flight emergencies.

Conclusion and Recommendations

This retrospective multiple-case study allowed for comparison of data between and across cases to reveal four themes that enhance coordination between flight crews and ATC: reluctant heroes, trust in others roles, embracing training, and coping with crises. The study also identified the additional theme of emotional trauma as a result of having lived through the near-death event of an in-flight emergency or having an overwhelming sense of responsibility for others during an emergency. What did these three crews, working with ATC, do to facilitate a shared understanding of the emergency and plan to handle it? These flight crew members and controllers approached each day with humility, and a deep commitment to embracing the training they were provided. Through this training, they learned to understand and trust others to fulfill their roles and responsibilities during crises. This enhanced communication through development of shared mental models that supported problem solving. They also developed confidence in themselves, others, and the aircraft to deal with adverse events. While they were successful in saving lives, it did not come without an emotional cost. Even here these modern day heroes humbly offer a path for others to follow in rebuilding their lives. This study examined three cases of successful in-flight emergencies in the years of 2000-2012. Undoubtedly there is more to be learned by expanding on the study of what flight crews and ATC did right to facilitate a shared understanding of the events and save lives. Along with this, future research should focus on the emotional trauma experience by crew members involved in adverse events, no matter the outcome. Continued research into what flight crews and ATC did right may contribute to developing individual and organizational resiliency.

After all, the ordinary hero hiding in each of us is often the most powerful catalyst for change. -Tate Taylor, American actor, screenwriter, film producer, and director--

REFERENCES

Aviation Accidents Prevention and Investigation Department, Portugal, 2004. All Engines-out Landing Due to Fuel Exhaustion, Air Transat, Airbus A330-243 marks C-GITS, Lajes, Azores, Portugal, 24 August 2001 (Rep. No.22 /ACCID /GPIAA/2001).

Beck, R. N. 1979. *Handbook in social philosophy*. New York, NY: Macmillan.

Boehm-Davis, D. A., Holt, R. W. and Schultz, K. 1998. *Developing advanced crew resource management (ACRM) training: A training manual*. US Department of Transportation, Federal Aviation Administration, Office of the Chief Scientific and Technical Advisor for Human Factors.

Baxter, P. and Jack, S. 2008. Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), 544-559.

Bryman, A. 2012. *Social research methods*. Oxford university press.

Bromley, P. D. 1990. Academic contributions to psychological counseling. 1. A philosophy of science for the study of individual cases. *Counseling Psychology Quarterly*, *3*(3), 299-307. Bromley, P. D. (1990).

Burian, B. K., Barshi, I. and Dismukes, K. (2005). The challenge of aviation emergency and abnormal situations. *NASA Technical Memorandum*, *213462*.

Cayouette, P. and Cloghesy, R. 2003. *Robert Piché: Hands on destiny*. Outremont, Québec: Libre expression.

Chenail, R. J. 2012. Conducting Qualitative Data Analysis: Reading Line-by-Line, but Analyzing by Meaningful Qualitative Units. *Qualitative Report*, *17*(1), 266-269.

Chi, P. 2009. Hero pilot says life prepared him for crash landing. In *People.com*. Retrieved http://www.people.com/people/article/0,,20257694,00.html

Cohen, L., Manion, L. and Morrison, K. 2011. Research methods in education. Milton Park. *Abingdon, Oxon, [England]: Routledge*.

Converse, S. 1993. Shared mental models in expert team decision making. *Individual and group decision making: Current issues*, *221*.

Creswell, J. W. 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage.

Crossette, B. 2001. Jet pilot who saved 304 finds heroism tainted. *New York Times*.

Crotty, M. 1998. *The foundations of social research: Meaning and perspective in the research process*. Sage.

Couric, K. 2009. Flight 1549: A routine takeoff turns ugly. In *CBSnews.com*. Retrieved from http://www.cbsnews.com/news/flight-1549-a-routine-takeoff-turns-ugly/

Cusson, J. 2004. Had I not done time in prison, I would never have been able to land the aircraft . (G. St-Jean Trans.) In *Association des Services de Rehabiliataion Sociale du Quebec*. Retrieved from http://www.asrsq.ca/fr/salle/porte-ouverte/0403/salle_por_040304.php

De Crespigny, R. (2012). *QF32*. Macmillan.

Dilthey, W., Makkreel, R. and Rodi, F. (Eds.). 1991. *Introduction to the Human Sciences* (Vol. 1). Princeton: Princeton University Press.

Dubois, A. and Gadde, L. E. 2002. Systematic combining: an abductive approach to case research. *Journal of business research*, *55*(7), 553-560.

Eisen, L. A. and Savel, R. H. 2009. What went right lessons for the intensivist from the crew of US Airways Flight 1549. *CHEST Journal*, *136*(3), 910-917.

Endsley, M. R. 1988. Design and evaluation for situation awareness enhancement. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. Sage Publications. *32*(2), 97-101.

Endsley, M. R. 1999. Situation awareness in aviation systems. *Handbook of aviation human factors*, 257-276.

Firestone, W. A. 1987. Meaning in method: The rhetoric of quantitative and qualitative research. Educational researcher, 16(7), 16-21.

Flyvbjerg, B. 2006. Five misunderstandings about case-study research. *Qualitative inquiry*, *12*(2), 219-245.

Gambino, M. 2010. Q and A: Capt. Chesley "Sully" Sullenberger. In *SMITHSONIAN.com*. Retrieved from http://www.smithsonianmag.com/science-nature/q-and-a-capt-chesley-sully-sullenberger-63542623/

Gibson, N. 2014. Archetypal heroes: The reluctant hero. In *the Art of Writing: A Blog of Tobias Mastgrave*. Message posted to http://tobiasmastgrave.wordpress.com/2014/04/03/archetypal-heroes-the-reluctant-hero/

Hanes, A. 2001. 'I was just doing my job' - Heroic pilot tells how he landed crippled jetliner. In *Montreal Gazette*.

Haynes, A. C. 1991. *United 232: Coping with the" one-in-a-billion" loss of all flight controls*. Flight Safety Foundation.

Hume, D. 2011[1748]. An enquiry concerning human understanding. Broadview Press.

Hutchins, E. and Klausen, T. 1996. Distributed cognition in an airline cockpit. *Cognition and communication at work*, 15-34.

Kant, I., Guyer, P. and Wood, A. W. (Eds.). 1998. Critique of pure reason. Cambridge University Press.

Lincoln, Y. S. and Guba, E. G. 1985. Establishing trustworthiness. Naturalistic inquiry.

Marcellin, J. D. 2014. *The Pilot Factor: A new look into CRM*. Plane & Simple Solutions.

Marshall, C. and Rossman, G. B. 2006. Designing qualitative research. Sage Publications.

National Transportation Safety Board, 2010. Aircraft Accident Report. Loss of thrust in both engines after encountering a flock of birds and subsequent ditching on the Hudson river US Airways Flight 1549 Airbus A320-214, N106US Weehawken, New Jersey, January 15, 2009 (Rep. No. NTSB/AAR-10/03).

Nelson, R. R. 2007. IT project management: Infamous failures, classic mistakes, and best practices. *Quarterly Executive*, *6*(2), 67-78.

Normal Checklists and Crew Coordination. 2011. In *SKYbrary: Reference for Aviation Safety Knowledge*. Retrieved from http://www.skybrary.aero/index.php/Normal_Checklists_and_Crew_Coordination_(OGHFA_BN)

Oliveira, P. 2009. Ace of grace. *The New York Post*. Retrieved from http://nypost.com/2009/01/23/ace-of-grace/

Orasanu, J. 1994. *Shared problem models and flight crew performance*. In N. Johnston, N. McDonald, and R. Fuller (1994). Aviation Psychology in Practice. Aldershot, England: Ashgate Publishing. 255-285.

Predmore, S. C. 1991. Microcoding of communications in accident investigation-Crew coordination in United 811 and United 232.

Robbins, L. 2009. Air traffic controller tells gripping tale of hudson landing. In *The New York Times*.

Robinson, T. 2010. Exclusive - Qantas QF32 flight from the cockpit. In *Royal Aeronautical Society*. Retrieved from http://www.aerosociety.com/News/Insight-Blog/1567/EXCLUSIVE-Qantas-QF32-flight-from-the-cockpit

Seawright, J. and Gerring, J. 2008. Case Selection Techniques in Case Study Research A Menu of Qualitative and Quantitative Options. Political Research Quarterly, 61(2), 294-308.

Simon, R., Pawlik Sr, E. A. and Bronkhorst, T. M. 1992. *Development of Rating Instruments and Procedures for Aviation Mishap Investigation*. Dynamics Research Corp, Wilmington, MA, Systems Div.

Stake, R. E. 2013. Multiple-case study analysis. Guilford Press.

Strunsky, S. 2014. Air India flight from Newark forced back after engine fire. In *NJ.com*. Retrieved from http://www.nj.com/news/index.ssf/2014/07/air_india_flight_forced_back_to_newark_after_bird_strike.html

Sullenberger, C. and Zaslow, J. 2009. *Highest duty: my search for what really matters*. William Morrow.

Tuli, F. 2011. The basis of distinction between qualitative and quantitative research in social science: reflection on ontological, epistemological and methodological perspectives. *Ethiopian Journal of Education and Sciences*, *6*(1).

Woods, D.D. and Hollnagel, E. 2006. Prologue: Resilience engineering concepts. *Resilience engineering. Concepts and precepts*, 1-16.

Yin, R. K. 2011. *Applications of case study research*. Sage.

Yin, R. K. 2014. *Case study research: Design and methods*. Sage publications.

****