COMMUNICATION IN AVIATION SAFETY: LESSONS LEARNED AND LESSONS REQUIRED

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> *Mom once said, "Don't ever get in a rut, 'cause a rut is just a shallow grave." Very well could have been! My rut: From the same uncontrolled [air] field, over the past four years, we get the clearance, "After takeoff, 360 degrees, climb to 7000 feet, contact Center on ____." Today, for us, everything was the same except, ". . . climb to 3000," with lots of communication traffic, noise, readbacks, relays, and then finally we got on the party line. Right after acknowledgment, we called out levelling at 4000. Center's reply was, "What altitude are you cleared for?" We check our notes, swallowed hard, and replied, "Ah, 3000, can we have 4?" Center replied, "Cleared to 7000 feet; by the way we had an aircraft holding at 4000 over the airport." I had hot flashes for the next hour and still do and shudder at the thought of the could-be-reality of my rut.*

Communication has long been suggested as a critical issue in all aspects of human interaction. The above example from the ASRS database amply illustrates just how critical communication is in aviation and aviation safety, from the cockpit-controller interface to coordination in the cockpit to cockpit-cabin interaction to the management of safety and creation of a safety culture.

Communication is essential for organizational and managerial performance and success in any endeavor, including in the aviation environment. Chester Barnard, the father of management theory, stated that the primary function of a manager is to develop and maintain a system of communication (Barnard, 1938). Herbert Simon, a Nobel-prize winner in economics, feels that communication is essential to the functioning of an organization, especially with regard to effective decision-making (Simon, 1957). Indeed, ". . . information flow is the 'lifeblood' of an organization. In order for decision makers to arrive at the best possible decisions from a set of alternative decisions, accurate information is a necessity" (Sussman & Krivonos, 1976, p. 1).

As in any human activity, communication plays an integral function in air travel, especially from the perspective of aviation safety. There are numerous findings noting the crucial nature of communication in aviation safety. Young (1994) made this connection when she indicated that: "The overall objective is to prevent accidents through improved communication in air carrier operations, and keep safety at the highest possible level" (p. 14). Nevile (2006) indicates the important role of communication in aviation incidents and accidents when he states that that:

> ". . . communication is especially critical, because it is typically through communication that other human factors are actually realised or made possible across members of a crew, such as information gathering and sharing, planning, leadership, decision-making, and identification and management of errors and problems (p. 5).

Helmreich and Foushee (1993) note that 70% of aircraft accidents involve human error, listing several specific accidents as examples (see also Foushee, 1982, 1984; Kayten, 1993; Krifka, Martens, & Schwarz, 2003; O'Hare, Wiggins, Blatt, & Morrison, 1994; Sexton & Helmreich, 2000; and Taneja, 2002 for treatment of the relationship between human error and aircraft accidents and incidents). They go on to state that: "The theme of these cases is human error resulting from failures in interpersonal communication" (Helmreich and Foushee, 1993, p. 21). In fact Krifka, *et al*. (2003) posit that "Factors related to interpersonal communication have been implicated in up to 80% of all aviation accidents in the past 20 years" (p. 1). The FAA also estimates that human error is a contributing factor in 60-80% of all air carrier incidents and accidents, citing ineffective communication and other communication-related indicators as underlying causes of such human error (Federal Aviation Administration, 2004).

Sexton and Helmreich (2000) posit that communication is essential for the safety and efficiency of any flight; the crew needs to convey information, communicate to issue orders, acknowledge commands, conduct briefings, execute callouts, and ask questions:

> In order for cockpit crewmembers to share a "mental model," or common understanding of the nature of events relevant to the safety and efficiency of the flight, communication is critical. This is not to say that effective communication can overcome inadequate technical flying proficiency, but rather the contrary, that good" stick & rudder" skills can not overcome the adverse effects of poor communication (p.1).

Smith-Christensen and Durkert (1995) posit that effective communication in the cockpit is a prerequisite for safety. Foushee (1982) notes that "At the very least, communication patterns are crucial determinants of information transfer and crew coordination . . ." (p. 1063). Nagel (1988) observes that: "The results of communication errors in aviation can lead to serious impacts on margins of safety" (p. 284). "Perhaps no other essential activity is as vulnerable to failure through human error and performance limitations as spoken communication" (Monan, 1988, p. 3).

Communication-related issues have comprised a sizeable portion of NASA's Aviation Safety Reporting System (ASRS) database since its inception. Over 70% of the reports to the ASRS database between 1976 and 1981, the first five years of the reporting system, were either directly or indirectly related to communication issues and problems; (Billings & Reynard, 1981; Grayson & Billings, 1981; see also, Billings & Cheaney, 1981; Monan, 1988, 1991 for further explication of these findings), and continue to make up a large part of ASRS reports (see for example George, 1993; Callback, 2001, March; Callback, 2003, October; Callback, 2004, April). "Communication problems are mentioned in a high percentage of incidents reported to ASRS" (Callback, 2003, October, p. 1). Billings and Reynard (1981) go even further when they posit that communication problems involve an even larger proportion of problems in the aviation system that the 70% that was found in their study.

The Tenerife tragedy, the worst crash in aviation history, can be attributed in large part to communication causes. Other high profile accidents, including the Avianca crash in Jamaica Bay near JFK and the American Airlines crash in Columbia in 1995, are again, at least in part, the results of communication problems. The evidence is not simply anecdotal—the effect of communication on safety in aviation has been firmly established (see, for example, Cushing, 1994; Federal Aviation Administration, 2004; Faith, 1996; Foushee, 1984; Foushee & Helmreich, 1988; Helmreich, 1997; Kanki & Palmer, 1993; Kayten, 1993; and Wiener & Nagel, 1988). In fact Flight Safety Information (2004) reports that "Between 1976 and 2000, more than 1100 passengers and crew lost their lives in accidents in which investigators determined that language had played a contributory role" (p. 12).

This paper will briefly explore the role of communication in aviation safety, especially as communication functions to provide information, establish interpersonal relationships, coordinate activity, monitor conditions, and as a management tool. Lessons learned from these areas will be used to propose future communication-related research needed in aviation safety and possible topics and methods of communication training for improved aviation safety.

Kanki and Palmer (1993) highlight the importance of communication in aviation safety when they state that ". . . we would like to underscore the importance of communication for efficiency and safety in aviation . . ." (p. 99). They further note that: "By now it should be evident that communication at its simplest is a multi-faceted, slippery concept. It is clearly a means to an end; that is, communication is required in accomplishing the flying task" (Kanki & Palmer, 1993, p. 129). While communication, in its multi-faceted nature, can have myriad functions in a variety of settings and situations, Kanki and Palmer (1993) provide an excellent structure for the functions communication plays in aviation and aviation safety, especially as it affects crew performance:

1. Communication provides information
2. Communication establishes interpersonal relationships
3. Communication establishes predictable behavior patterns
4. Communication maintains attention to task and monitoring
5. Communication is a management tool (p. 112)

Although there are many ways to conceptualize communication, Kanki and Palmer's (1993) taxonomy provides an excellent framework for viewing communication lessons for aviation safety. It should be noted, however, that while these categories appear to be discreet in nature, communication is a much more complex, "multi-faceted" and "slippery" process that does not always allow for such simple classification. For example crew briefings might realistically be put into most, if not all of the five categories. Thus, while examples will be somewhat arbitrarily assigned to a single category, they more likely than not could be seen as appropriate for examination in multiple categories.

LESSONS LEARNED

COMMUNICATION PROVIDES INFORMATION

Information sharing is a critical part of the aviation safety environment. The first topic that will be explored with regard to problems of information transfer is that of expectation. Billings and Reynard (1981) in their analysis of ASRS data found expectation was a key factor in messages being misunderstood. Using the same database Grayson and Billings (1981) found that: “Pilots and controllers alike tend to hear what they expect to hear” (p.48).

The following report to ASRS amply illustrates the impact of expectation on problems with information transfer for aviation safety, where anticipating a message—hearing what we expect to hear—can create any number of problems for pilots and controllers.

> Engines were started and taxi commenced to the pre-briefed departure runway, Runway 36. Before Takeoff checklist was called for and completed during the initial taxi…My attention turned to observing for bird flocks as large numbers of seagulls were present on the airport…I remarked to the First Officer that the flocks seemed to have moved away from the runway. We continued the taxi southbound…Nearing the end of this taxi, I remarked again to the First Officer that the large flocks of birds seemed to be away from the runway… Nearing the departure end of Runway 36, Ground queried us asking ‘Air carrier X, are you on frequency?’ The First Officer replied ‘Affirmative, is there a problem?’ (I was **anticipating information** concerning a gate hold at ZZZ or perhaps a bird report.) Ground replied, ‘You taxied without a clearance.’ We both were in disbelief, thinking we had been cleared to taxi. Ground then asked us to change to Tower control, which we did, and were subsequently cleared for takeoff on Runway 36 (*Callback*, 2007, March, p. 2; emphasis added).

Another incident involving a General Aviation pilot also clearly demonstrates the effect of expectation:

> Our IFR clearance was, "As filed, maintain 3,000 feet, expect 5,000 feet within 10 minutes." Sometime after our frequency change to Departure Control, we were cleared to climb to 5,000 feet. As we approached 5,000 feet, I asked the pilot-not-flying to request 7,000 feet. At that point, ATC said he had cleared us to 4,000 feet -- not 5,000 feet. I had understood 5,000 feet, had written it down, and had set the altitude alerter to 5,000 feet. The Controller told us to "just stay at 5,000 feet and I'll work on a higher [altitude]." Perhaps the fact that I had been **expecting** 5,000 feet within 10 minutes, per the clearance received prior to takeoff, lured me into the error (*Callback*, 1999, March, p. 2; emphasis added).

Callback, the monthly publication of the ASRS, often includes analysts’ comments. The ASRS analyst’s comments preceding the next incident report to ASRS exemplify the expectation factor as a communication problem in aviation safety.

A B757 pilot shows that even when we think we are paying attention, the thinking process can be short-circuited by a preconceived notion.

> Approach said, "Expect Runway 18R." On short final I thought I heard, "Cleared to land Runway 18R." I asked [Tower to] confirm clearance to land. Again, I thought he said, "Cleared to land Runway 18R." After landing, Tower said both transmissions were, "Cleared to land Runway 18L." [I] don't know what to say. I just kept thinking Runway 18R.

The Captain involved in this same incident had expectation on his mind:

> I had been doing this same flight for almost 2 months; runway 22 had been the runway 90% of the time, and every landing on 22 had been followed by, "Exit the highspeed, cross 27, [contact] Ground the other side." **I mistakenly expected this**, and wanted to hear it (*Callback*, 2002, October, p.1; emphasis added).

Monan (1988) perhaps summarized the issue of expectation best when commenting on his analysis of hearback problems in the ASRS database when he stated that: “Pilots heard what they expected to hear, heard what they wanted to hear and frequently did not hear what they did not anticipate hearing . . .” (p.11).

A concept allied to that of expectation is that of making assumptions. When we make assumptions, we interpret the message—or situation—to mean what we assume it to mean, not necessarily what was actually said or perceived.

The following cases from the ASRS database not only illustrate how making assumptions can lead to misunderstandings, but also how such unchecked assumptions can impact safety:

> Engine start was uneventful until the after start flows were accomplished. At that point we experienced a problem with the left bleed air valve. The MEL (Minimum Equipment List) showed this as a "return to gate" item. At this point, I told the mechanic we needed to be towed back in. His response sounded like he was asking us to release the parking brake; however, neither of us quite understood what he had said about the brakes. I asked him if he was asking us to release the parking brake, to which he responded, "Release parking brake." I released the parking brake and the tug operation commenced.
>
> With the tug operation underway, I turned my attention towards the logbook, thinking about how I was going to write up this problem. The First Officer was looking over the MEL. What seemed like a few seconds after we began to be tugged, the First Officer asked, "Where is this guy taking us?" I looked up I saw the end of the paved ramp approaching rapidly and heard the First Officer say something about stopping the aircraft. At that point we were both simultaneously on the brakes. After leaving about 20 feet of skid marks on the ramp, the aircraft came to a stop with the nose wheel approximately eight feet from the end of the paved surface... without the tug connected!

When the aircraft was stopped and the engines shut down, my next concern was the location of the mechanic and whether he was okay. He was.

Although this mechanic speaks fairly good English, I was truly surprised at the level of communication breakdown that had just occurred. The mechanic told me he thought I was telling him that I was releasing the parking brake.

Once we started rolling he did not tell us to stop, but instead simply unplugged his headset and got out of the way.

What lessons can be learned or relearned from all of this? First of all this is a reminder of something we all know, that being towed is an operation which requires someone to be monitoring the aircraft. Secondly, **never assume anything**. Since we never saw the tug pull away (it pulled away while we were in the books) and we were told to release the parking brake, we thought we were under tow.

During approach briefings, simulator training, and line non-normal operations flight, someone is always assigned the task of monitoring the aircraft. Let this serve as a reminder to do the same during tow operations.

Thank goodness no one was hurt, no metal was bent, and no careers were put in jeopardy, but we sure came darn close (*Callback*, 2005, November, p. 1; emphasis added).

While being vectored on a downwind leg to Runway 01L, Tower asked if we had the field in sight, which we did. At that time we were cleared for a visual approach to Runway 01L and a left turn back to the field was initiated to result in a final of approximately 6 miles. When approximately 60° from the runway heading, Tower reported traffic (a B-757) joining a final for runway 01R. While looking for the traffic the First Officer, who was flying the aircraft, took his eyes off the field and shallowed his bank... When I realized he was not just squaring off his final but was going to overshoot the runway I told him he was going to overshoot and ordered a turn back to our runway. He seemed disoriented and was slow in responding, resulting in a significant overshoot approaching the approach corridor for Runway 01R. A TCAS II-Resolution Advisory resulted with a "monitor vertical speed" command which was complied with. Tower questioned if we had the traffic in sight which we answered in the affirmative. We corrected back to the 01L centerline and landed with no further incident.

In talking to the First Officer after the landing, he indicated that he lost sight of the runway in the left turn. Also that he never actually saw the B-757. Although I indicated that I saw the traffic and pointed it out, the First Officer did not see it, but I **assumed** he did. I also **assumed** that he had the runway in sight, so I was unaware that he had lost situational awareness.

The lesson to me is to **never assume** another crew member is seeing the same thing I am and to work to communicate what I am seeing even when weather is

> good and "easy" visual approaches are being conducted (*Callback*, 1999, September, p. 2; emphasis added).

As important as the concepts of expectation and making assumptions are with regard to communication problems in aviation safety, perhaps the key issues for creating difficulties in information transfer involve meaning, language, and jargon. The ASRS database is rife with examples of how meaning can be misinterpreted within the cockpit, between the cockpit and ATC, between the cockpit and the cabin, and essentially throughout the aviation environment.

This type of misinterpretation can occur whether it is based on expectation, making assumptions, or the fact that we can interpret the meaning of a message to fits our frame of reference, not necessarily what the sender had intended the message to mean. As Redding and Sincoff (1984) posit, communication is not like a conveyor belt where the meaning is transferred from person to another, arriving—and being interpreted—exactly same way that it was sent. This type of misinterpretation can be seen in the following ASRS report.

> Approaching [destination airport] from the east we were cleared to 1l,000 feet/250 knots. We checked in with Approach at 11,000 feet with the ATIS information. When Approach acknowledged our check they issued a new altimeter setting of 30.00. We acknowledged the updated information. As I reset the two altimeters on the Captain's side, I inadvertently said 3000 (3 thousand), referring to the altimeter setting rather than a more appropriate verbiage of 30.00 (three zero zero zero). No other conversation was ongoing at the time. We were both monitoring Approach Control and at the time I thought my meaning was clear. Several moments later I noticed we were descending out of 11,000 feet and 3,000 was set in the altitude window. We began a climb back to 11,000 as I reconfirmed our assigned altitude...
>
> After landing we discussed the incident further and how a similar situation might be avoided in the future. The First Officer is relatively new a month or two with the airline. I learned that he had misinterpreted my verbalization of the altimeter setting as a newly assigned altitude and thought when I restated it that I wanted him to reset the altitude select window I explained that I would be more precise in the future. We also used this event as a basis for discussing why, per our [company] procedures, the Pilot Not Flying always is the person to reset the assigned altitude and that it is verified by the Pilot Flying prior to any altitude changes (*Callback*, 2001, August, p. 2).

The following exchange between the cockpit and the cabin also shows how susceptible we are to misinterpreting another person’s message:

> Prior to engine start, company procedure requires securing the cockpit door. This procedure was followed and the door indicated "locked." During climb out, the flight attendant called the flight deck. The Captain answered and after a brief conversation, he instructed me to level the aircraft and prepare to return to

> [departure airport] due to a disturbance in the cabin. During the descent, the Captain assumed control of the aircraft. As we were nearing [destination], the flight attendant called the flight deck to ask if we were landing. I replied that we were. The Captain took this opportunity to get additional information regarding the situation in the cabin. She advised him that the only problem was that the cockpit door was open. The door was then secured and the flight continued to its original destination. Apparently in her initial report to the Captain, the flight attendant had simply stated, "Turn around." Her intent was for the Captain to see the open door, but the Captain perceived her comment to mean that the flight was in jeopardy and the aircraft should be turned around and returned to [departure airport] (*Callback*, 2004, April, p. 2).

The fact that English is the international language of aviation can also lead to misunderstandings. As has been noted, it is easy enough for native speakers of English to misinterpret other peoples' messages. Putting non-native English speakers into the mix can compound the problem. Prinzo, Hendrix, and Hendrix (2006) note that issues related to English language proficiency in the aviation safety system need to be addressed. Again, the ASRS database provides numerous examples of the impact and problems associated with English as the language of aviation. Here are two, both of which include the ASRS analyst's comments that illustrate the communication issues involved.

> U.S. flight crews must exercise extra vigilance when operating internationally into airports where accented English, and the use of native languages by air traffic controllers, can create confusion and uncertainty about ATC instructions. A recent ASRS report describes how an alert flight crew relied on "gut instincts" and prior experience to avoid a ground collision:
>
> We begin with the First Officer's concise account:
>
> > We were cleared for an immediate departure on Runway 09L, but we had to do a low-speed abort because the prior aircraft that landed took an excessively long time to clear the runway. We also had a hard time clarifying our clearance because Tower was having a long conversation in [non-English language]. When we were finally able to inform them of our actions, they told us to taxi clear of the runway and to contact Ground. We elected to stop immediately after leaving Runway 09L because taxiing well clear of Runway 09L would have placed us on [a] taxiway which also doubles as Runway 09R. We wanted to make sure that it was safe to proceed any further. [It is] fortunate we did because Tower had cleared another aircraft to land on Runway 09R/taxiway and following their instructions could have resulted in a collision.
>
> The Captain's report added this clarifying information
>
> > ...To clear Runway 09L conservatively would take us on to taxiway/Runway 09R. Taxiway/Runway 09R had not been used as a runway since we had been in the vicinity [but]...I decided to stay on Tower frequency wait and look first aware that our tail might be in close

> proximity to Runway 09L. We felt that due to the limited English speaking capability of the controller, it would be unlikely that we could get any kind of clarification from him. Also, at the time he was blocking the channel with some lengthy [non-English] dialog. Unknown to me, perhaps because all this occurred on the radio in [another language], the aircraft in close landing proximity now off to our right and slightly behind had been recleared. At about the time the aircraft touched down [on Runway 09R] right in front of us, the Tower controller told us to hold short of Runway 09R. Yet he had previously handed us off to Ground...

Even this crew's commendable caution could not avoid a ground conflict with the landing aircraft on the parallel runway (*Callback*, 2001, August, p. 2).

The language-related problems cited by ASRS reporters in foreign airspace operations include unfamiliar controller phraseology, a controller's unclear English or heavy accent, and readback/hearback issues. A Captain's report of a near runway incursion provides a glimpse of the language barrier sometimes experienced:

> During taxi, Tower issued instructions in a very heavy [European] accent that sounded like, "Cleared into position and wait." The First Officer, employing a phraseology that is common in the U.S., asked in a very clear and enunciated fashion, "Did you clear us into position and hold?" The Tower's answer was "Yes." I proceeded beyond the ILS [critical area] hold line. The Tower shouted, "Stop!" We spotted an airliner breaking out of the clouds. Although we never penetrated the area of the runway, the sudden stop, the proximity to the runway, and the sight and sound of the landing aircraft scared all of us.
>
> It is clear that we misunderstood each other. In all probability, he said, "Cleared to the hold line and wait." Perhaps if we had asked him, "Do you want us to go on the runway?" he would have responded with a strong "No!" (*Callback*, 1996, November, p. 1)

Even when only native English speakers are involved in a communication interaction, English language problems can arise as is seen in the following example that took place on an Air New Zealand flight.

> On March 31, 1985, a young man boarded an Air New Zealand flight in London for his home in Oakland, California. The plane stopped in Los Angeles, where U.S. bound passengers were to deplane and board other flights for their domestic destinations, then boarded new passengers and reboarded transiting passengers for the onward flight to Auckland. He became convinced that the Air New Zealand crew was directing Oakland-bound passengers into a transit area, where he headed, then later reboarded with the rest of the New Zealand bound passengers. Airline personnel claim that he was asked twice if he was going to Auckland, and

> twice answered in the affirmative. His explanation was that the New Zealand-accented crew didn't say Auckland, but rather, they said Oakland. It was not until sometime after takeoff that he realized his error, but it was too late, and he found himself in New Zealand's largest city at the end of his flight. The next day the airline flew him home—to Oakland—from Auckland at no charge (Baker, 1985, April 11).

As we can see, information transfer—and attendant hazards—can occur in any facet of the aviation environment, not just in the cockpit or between the cockpit and ATC or cabin. The cabin is an area where information transfer is also important. One of the basic information functions of the cabin crew is sending messages to keep passengers informed about safety issues. The messages that flight attendants convey to passengers may take the form of information about on-board services, connection gate data, required safety briefings, and information passengers need to cope with and survive emergency situations, including evacuations. For the airline passenger this type of information transfer may be vital to survival in an emergency. For a thorough treatment of preflight safety briefing and other aspects of information transfer in the cabin—and the potential communication problems that may occur in that environment, see Parker (2006), Barkow and Rutenberg (2002), Darby (2006), and Krivonos (2005).

Jargon, the use of language in a profession, trade, or in a specialized situation (as in aviation), provides a shorthand means for communicating well—when everyone understands the jargon. The aviation safety environment is loaded with jargon that often makes communication more efficient and effective. However, when others don't understand the jargon or use it incorrectly, then problems of misunderstanding and misinterpretation can easily occur.

The following example from the ASRS database provided by Matchette (1995) illustrates how such difficulties can arise with the misuse of jargon, as it did for one unfortunate pilot:

> The Pilot-Controller Glossary defines squawk as "activate specific mode/code/function on the aircraft transponder." Therefore, "squawk your altitude" is a controller's instruction to activate the altitude function of a Mode 3/A transponder.
>
> Squawking 7500 is the international code to indicate a hijacking. The AIM instructs pilots of hijacked aircraft to set 7500 into the aircraft transponder, which triggers a flashing "HIJK" in the aircraft's data block on the Controller's radar screen. The Controller will then ask the pilot to "verify squawking 7500." If the pilot verifies the code or makes no response at all, the Controller will not ask further questions, but will continue to flight-follow, respond to pilot requests, and notify appropriate authorities. These procedures are exactly the ones that occurred, as this reporter can testify:
>
> > "Burbank assigned me a squawk code. Several minutes later the Controller

> asked me my altitude and I responded 7,500 feet. He told me to squawk my altitude. I replied, 'Squawking 7500', and the Controller confirmed my code...After landing, Ground directed me to a specific parking area, and I was immediately surrounded by three police cars with a number of officers pointing their weapons at me...They frisked me and handcuffed me. They really roughed me up...I would suggest that Controllers never use the terminology 'squawk your altitude.' "
>
> This poor pilot forgot to review his AIM, which would have informed him that: "Code 7500 will never be assigned by ATC without prior notification from the pilot that his aircraft is being subjected to unlawful interference [hijacking]. The pilot should refuse the assignment of Code 7500 in any other situation and inform the controller accordingly" (p. 20).

One of the problems with the use of jargon is that if someone isn't familiar with the jargon, you might as well be speaking a foreign language. Using jargon when others don't know what it means is an example of what I term the COIK principle—Clear Only If Known. Again, if we know what the jargon means, it is a handy way to help in the information transfer process. If we do not know what the jargon means, then the information is seldom, if ever, transferred effectively.

Majoros (1990) offers a personal example that effectively captures the essence of the COIK principle:

> I would like to relate an incident that happened as I was boarding a plane in Orange County to come to Washington. At this time the John Wayne Airport is undergoing a major building program and does not have jetways or other motorized conveniences for planing and deplaning, Planes must line up on the apron or tarmac or gate area one-by-one and passengers have to walk to the aircraft. Just before I boarded the flight, the boarding agent said over the public address system, "Flight 1256 is in final boarding. Passengers should proceed through Gate C. The plane is in the middle of the runway, it is facing south, and it is a Boeing." Other than the experienced traveler, who would know where to go with these instructions? How much of our communication in maintenance could take on similar tones because the communication is not clear and the maintainer does not know where to go with the instructions? (p.44)

While there are a number of communication and information transfer issues and problems that are apparent in the above discussion, there are some effective communication principles that can lead to greater safety and less risk and error in the system. Although more effective listening skills would be generally helpful, two specific communication skills that can be applied to create more effective information transfer in the aviation environment are using feedback and asking questions. Given that a substantial number of ASRS reports involve readback/hearback problems (*Callback*, 2001, March), these skills are especially important.

With regard to feedback both Ruffell Smith (1979) and Foushee and Manos (1981) note that feedback in the form of acknowledgement, monitoring, and cross-checking are important aspects of communication for effective flight operations. The following example from the ASRS data base, including the analyst's comments, illustrates the importance of feedback.

> Mandatory readback of certain parts of clearances provides a mechanism to reduce misunderstandings between ATC and flight crews. An ATC supervisor reports on a readback error that slipped by both him and an ATC trainee, with a potentially hazardous result.
>
> > Aircraft A was given a descent from 8,000 feet to only 7,000 feet (6,000 feet would be the norm on this route). Pilot read back 6,000 feet, which was not caught by either of us. We tried to get him back to 7,000 feet, but he went to 6,500 before he climbed back. Aircraft B was one mile in trail at 6,000 feet, same speed.
> >
> > A contributing factor was my over-reliance on the trainee, who is fairly well along in training. I was assuming he would catch the problem, so I was not listening as intently. Also, the [typical] descent from 8,000 to 6,000 feet probably had the pilot expecting to hear 6,000. Only goes to prove the importance of readbacks being heard and understood (*Callback*, 1997, October, p. 1).

The following comment by an ASRS analyst about the example provided above concerning the misinterpretation of "position and hold" provides an excellent justification for asking questions:

> The reporter realized after the fact that the crew either misheard or misinterpreted the Controller's clearance. Regardless, the reporter's suggestion is a good one: seek clarification by rephrasing the clearance in plain, simple words, different from those used by the controller. Although some foreign controllers may not have a broad command of English, they often will understand the crew's restated questions and be able to provide clarification (*Callback*, 1996, November, p. 1).

These reports certainly underscore the need for feedback to clear up unchecked assumptions and expectations. For a full treatment of readback/ hearback issues in aviation safety see Monan (1988, 1991).

Asking questions is another effective communication skill that can help reduce information transfer problems in the aviation safety environment, thus minimizing risk. Krifka, *et al*. (2003) found that questions were slightly more frequent in good crews and that good crews also answered a considerably higher number of questions; in contrast to good crews, commands were more frequent in poor crews. Flight Safety Foundation (2000) indicates that the failure to request clarification or to question ATC instructions is an ineffective aspect of pilots' communication. Following are an ASRS report and then

accident report from the FAA that clearly illustrate the importance of asking questions for clarification:

> After completing our run-up, we taxied to the hold short line of Runway 16. My student was at the controls in the left seat. He called the tower saying "Skyhawk holding short Runway 16, ready for takeoff." The tower replied, "Skyhawk, taxi up and hold." I thought the tower meant taxi into position and hold...and we crossed the hold short line. Tower then told us to stop and clear the runway. We complied immediately, but the inbound plane elected to go around. Factors contributing to this incident were the use of non-standard phraseology by the tower, and my failure to verify whether he meant "hold short" or "taxi into position and hold." To avoid this type of situation in the future, **I will always ask if I am not sure of a clearance**, especially before entering the active runway (*Callback*, 2004, April, p. 2; emphasis added):

> . . . a lack of communication between the crew and air traffic controllers during a landing in a severe thunderstorm contributed to the accident, according to the NTSB report. **The crew did not request clarification** about the weather conditions or change its course of action to take these conditions into account. The winds associated with the storm forced the plane down precipitously, causing an emergency landing without the landing gear's being fully extended. The plane skidded off the runway, causing serious damage to the aircraft and an emergency evacuation of the passengers (Federal Aviation Administration, 1997, p.11; emphasis added).

Monan (1991) effectively sums up the importance of asking questions when he states: "Ask for verification of any ATC instruction about which there is doubt" (p. 4). This suggestion goes for any communication interaction in the aviation safety environment, not just between pilot and ATC. It is useful advice within the cockpit or cabin, between cockpit and cabin, or for any aspect of the aviation safety system.

COMMUNICATION ESTABLISHES INTERPERSONAL RELATIONSHIPS

A large part of interaction among flight crew, among cabin crew, and between flight and cabin crew involves communication functioning to establish interpersonal relationships.

Davis (interviewed by Schultz, 2002) notes the importance of communication relationships in aviation when he states that:

> In virtually every organization, the ability to create effective relationships is essential. . . The same is true in the cockpit of an airplane. During critical moments, effective communication can mean the difference between life and death. You can avoid accidents most of the time if you have a flight crew whose members can talk to one another and whose voices are listened to (p. 3).

One aspect of communication relationships is how people interact with one another, especially in a hierarchical setting, as is the case in operation of an airplane. Linde (1988) found that suggestions by crew members to captains are more likely to fail if they are more polite and indirect than if they are direct, and notes the dangers of excessive mitigation (politeness and indirectness) in the cockpit. Thomas (2004a, 2004b, 2005) and Thomas and Petrilli (2004) associate poor communication between and among crew members with a lack of assertiveness, especially on the part of First Officers, and that this type of relational interaction could lead to poor crew coordination and performance.

Linde (1988) does note, however, results in her study which found that crews classified as high in safety performance have higher rates of mitigation that those classified as poor in safety performance. Her explanation is that mitigation is a "kind of social oil, which can help to prevent the development of interpersonal and relational misunderstandings and animosity" (p. 396). Merritt, (1995) echoes Linde's notion that mitigation and indirectness are not necessarily a problem for aviation safety:

> I think we need to acknowledge that indirect communication will always be present in aviation, and that it is not automatically a bad thing. Indirect communication can facilitate teamwork, it can promote non-defensiveness in training and debrief situations, and in high face-threat situations it may be the only form of communication that less experienced or lower status crewmembers can articulate (p. 2).

Clearly there is disagreement about the value of assertiveness or mitigation in the aviation environment, especially the cockpit. Perhaps most important in this discussion of assertiveness versus indirectness (or mitigation) is the need to take a situational perspective on communication interaction and not try to apply a one-size-fits-all solution to every situation. It is probably that neither the assertiveness perspective nor the mitigation perspective is completely correct or incorrect. Rather it is most likely that each is appropriate in different communication situations. One example might be evident in an emergency situation which would most likely call for greater assertiveness.

COMMUNICATION ESTABLISHES PREDICTABLE BEHAVIOR PATTERNS

Functioning as predictable patterns of behavior, communication can help us coordinate human activities including the teamwork necessary for the effective operation of aircraft and thus have an impact on aviation safety. Ruffell Smith (1979) conducted in a flight simulator study from which he found that most of the "flying" difficulties were related to crew coordination problems, not poor technical skills or lack of knowledge. Because effective crew coordination is mainly accomplished through effective communication, it follows then that effective crew performance is more closely associated with effective crew communication than with any individual pilot's flying proficiency.

In a follow up study to that of Ruffell Smith (1970), Foushee and Manos (1981) analyzed the cockpit voice recording utilizing Ruffell Smith's data from his study. Foushee and

Manos (1981) found a positive relationship between communication and good flight performance: “Overall, there was a tendency for crews who did not perform as well to communicate less, suggesting that as expected, poor crew coordination tends to result in more marginal performance (p. 66).

They also found that it was not simply the amount of communication that was important for effective crew coordination, but more importantly the type of information that was share. They found that the greater the information about flight status that was shared, the fewer errors there were in the operation of the flight. In addition the type of communication ulilized also played a role: more inquiries, observations, and acknowledgements were also related to fewer operational errors, while poor communication, lack of understanding, and such specific communication behaviors as frustration, anger, uncertainty, and embarrassment were related to higher operational errors (Foushee & Manos, 1981).

Federal Aviation Administration (1997) notes that a lack of coordination among members of the cockpit crew can lead to problems and emphasizes the importance of effective communication to accomplish effective coordination. Taneja (2002) notes that lack of effective communication by aircrew continues to be the most causal factor in aviation accidents. In his review of human factors in aircraft accident and incident investigations, Adams (2006) points to communication as one of the key factors leading to errors that transpired because of poor crew coordination.

Again, the cockpit crew is but one aspect of the aviation system. While critically important for the safety of any flight, they are not the only source of communication for providing predicable behavior patterns or coordinating activity. The cabin crew is also charged with that task, especially when it comes to cabin safety. Burian, Kismukes, and Barshi (2003) posit the importance of communication and coordination during emergency situations and as an example note that communication problems between the cabin and cockpit had negative consequences the evacuation of a flight into LaGuardia in 2003.

Flight Safety Foundation (2003) indicates that poor communication can contribute to problems during evacuation procedures. Transportation Safety Board of Canada (1995) reports several evacuations in which ineffective cabin crew communication jeopardized the chances of successful evacuations in several incidents:

> Effective crew coordination is crucial to a successful evacuation, but ineffective crew communication leads to ineffective crew coordination. As evidenced by the occurrence data, poor crew communication may result in unnecessary injuries or fatalities and unnecessary exposure to risk for passengers and aircrew alike (p. 20).

Effective coordination between cabin crew and flight deck crew is also essential for the safe operation of an aircraft. Since 9/11, effective communication from the cabin crew to the flight crew is even more important. “The ‘sealed’ cockpit environment has increased the reliance on Flight Attendants for the transfer of vital information” (*Callback*, 2003,

March). The FAA clearly states that effective communication between all crewmembers is a prerequisite for such coordination (Federal Aviation Administration, 1988). ASRS reinforces this point: "Flight attendants are an integral part of the aircraft crew and their primary responsibilities are safety related" (Callback, 2003). Rice (2001, May-June) suggests that better communication between cabin crew and flight crew have resulted in fewer fatalities. Chute and Wiener (1995) make the tie between communication and safety even more explicit:

> There are two critical safety obligations for the flight attendant. The first is to prevent accidents, primarily by means of conveyance of information regarding hazardous conditions to the flight deck. If the accident cannot be prevented, the second is to maximize survivability. Both roles require effective communication between the two cultures (p. 15).

There are a large number of reports that confirm the success with regard to safety of effective communication in the cabin-cockpit interaction (see, for example, *Callback* 1999, August; 2003, March; 2004, February). Yet, the working and relationship and communication interaction between cabin crew and flight crew continues to be a vexing one. "Communication and coordination problems between cockpit crewmembers and flight attendants continue to challenge air carriers and the FAA" (Federal Aviation Administration, 2004, p. 15).

Helmreich, Wiener, and Kanki (1993) and Kayten (1993) cite numerous examples where crew coordination problems and poor communication were contributing factors in several accident reports. Murphy (2001) conveys stories from flight attendants who felt that vital information they tried to pass along to the cockpit was ignored. In their study of flight attendants and pilots, Chute & Wiener (1996) found cabin-cockpit communication to be ineffective. Chute (2001) also maintains that cabin-cockpit communication is not always necessarily effective.

In a report on evacuation procedures, the Transportation Safety Board of Canada (1995) indicated that poor communication between flight and cabin crew possibly jeopardized safe evacuations in several instances. Regarding one specific incident, the report states that:

> Inadequate communication between the cabin and the flight deck resulted in a significant delay before the flight crew was aware of the existence and seriousness of the fire and contributed to the fact that the evacuation was not initiated until one minute 55 seconds following the rejected take-off (Transportation Safety Board of Canada, 1995, p. 19).

Perhaps the two most dramatic examples, however, of safety problems due to poor cabin-cockpit coordination and communication are the crash of the Air Ontario flight while taking off from Dryden, Canada on March 10, 1989 (Baker & Frost, 1994; Chute & Wiener, 1996; Merritt, 1995; Moshansky, 1992; Murphy, 2001) and the crash of the British Midlands flight on January 8, 1989 at Kegworth after taking off from London's

Heathrow Airport (Baker & Frost, 1994; Department for Transport, 1990).

In the Dryden crash, the pilots of a Fokker F-28 tried to take off, even though the upper surface of the wings were covered with snow; the plane clipped the treetops and came to rest in a heavily wooded area, with the loss of twenty-four lives (Baker & Frost, 1994). A flight attendant, one of the few (and only crew member) to survive, saw that the wings were not properly de-iced, but did not convey that information to the pilots:

> Moments before takeoff, the F28 was taking out for the final takeoff with significant amounts of snow visible on the wings, and while a flight attendant and two airline captains traveling as passengers notices, this was never communicated to the pilots. The flight attendant, who was the only crew member to survive, testified later that she had concerns over the snow, but because she had been rebuffed by company pilots over a similar situation in the past, it influenced her decision no [sic] to go to the cockpit (Aviation Safety Letter, 2004, p. 2).

Similarly, the Kegworth crash provides another example of cabin crew not providing crucial information to the flight crew. The British Midlands Boeing 737-400 experienced an engine fire in the left engine, a fact that several cabin staff and passengers noticed, but this information was not conveyed to the flight crew, who reduced power to one engine, then when vibrations and smoke ceased, mistakenly shut down the wrong engine and crashed into an embankment of the M1 Motorway, with the loss of forty-seven lives (Department for Transport, 1990).

Another area where communication plays a coordinating role between flight and cabin crew is in pre-flight briefings. While a greater amount of time for the briefing would be advisable (Chute & Wiener, 1995; Murphy, 2001), this is not always possible. With appropriate communication, even a short period of time can help to establish positive relationships between the cabin crew and flight crew. Zunin and Zunin (1974) feel that the first four minutes of any relationship are critical in establishing rapport. The FAA has suggested a number of simple behaviors that can enhance the working relationship between flight attendants and flight crewmembers to establish a positive climate for good communication and effective crew coordination; seemingly, one of the easiest ways to do so is through courteous mutual introductions (Federal Aviation Administration, 1988). Chute and Wiener (1994), however, found that flight attendants were almost universal in their complaint that pilots, especially captains, failed to introduce themselves. Pilots also expressed a desire that flight attendants take the initiative to introduce themselves (Chute & Wiener, 1995).

Surprisingly, even pilot-to-cabin briefings themselves seem to be the exception rather than the rule. Pilots perceived that such briefings occurred at a much higher frequency than did flight attendants (Chute & Wiener, 1995) and both pilots and flight attendants complain about how often such briefings are omitted and disregarded (Chidester & Vaugn, 1994). Thus, even "before the crew board the aircraft, the stage is set for poor communication" (Chute & Wiener, 1996, p. 3).

COMMUNICATION MAINTAINS ATTENTION TO TASK AND MONITORING

Another problem with information transfer is that while information is important to make good decisions, too much information—information overload—can lead to tension and errors, and communication or information overload often occurs in the aviation environment. Prinzo & Morrow (2002) found that: "Communication problems arise in part because of complex air traffic control (ATC) messages sometimes overload pilot memory (p 1);" especially with that longer messages which increased demands on pilots' memories. Majoros (1990) notes that excess information can lead to communication overload and that the challenge is to communicate essential information. Prinzo, *et al*. (2006) posit that controllers should be encouraged to transmit shorter and less complex messages that limit the occurrence of communication problems and misunderstandings. Wever, Ven Es, and Verbeek (2006) found that pilots suggested reducing the amount information in the voice communication and observed that shorter messages may help to reduce misunderstandings.

Along with other factors, such as poor listening skills, information overload can lead to lack of attention and distraction. Billings and Cheaney (1981) "conclude that distraction is a serious problem that inhibits effective performance, both in the cockpit and in air traffic control" (p. 92). Dismukes, Young, and Sumwalt (1998) examined 107 ASRS reports in which flight crew paid inadequate attention to one task while performing another task. Their examination revealed a wide range of activities that distracted or preoccupied the pilots, most of which were communication related. A number of recent incidents and accidents, including the near miss at LAX between a SkyWest flight and that of a business jet in September 2006 and the crash of Comair Flight 5191 in Lexington, Kentucky in August 2006, can be attributed to lack of attention and distraction.

The following reports from the ASRS database illustrate the effects of distraction on safety.

> After landing I began to think about the [clearance] the controller had given me.... I think he may have said that he needed me at 500 feet while enroute for passing under the Runway 33 approach course. If that was true, I should have descended to 500 feet and then proceeded on course. The bottom line is, I should have known exactly what he wanted, but I did not. I believe that I made a mistake in not giving 100% attention to the ATC instructions. When flying a multi-task job, i.e. [media], EMS, power line [patrol], lift work, etc., there can be many distractions from the customer that have little or nothing to do with the immediate job of flying the aircraft. In the future, I will lock out the [company] radios while receiving a clearance or ATC instructions.... I am going back to the basics- first the aircraft and ATC, then I'll take care of any company business (*Callback*, 2005, May, p. 2.).

The second report has both the Captain and the first Officer's perspective on the incident.

> [A captain’s report about an incident]
>
> While we were in level cruise at FL330, Center cleared us to FL290, "pilot's discretion" to 11,000 feet (or so I thought). I dialed in 11,000 feet in the altitude window, and the First Officer [FO] acknowledged. The first clue I had that something was amiss was when I noticed another aircraft...we were approaching FL270, and the FO told me we were only cleared to FL290.
>
> [The First Officer’s report about the incident]
>
> During the conversation with the controller, a conversation was going on within the cockpit with a deadheading crew member, which may have contributed to the FO and Captain not verifying the altitude assignment with each other. The crew had several tasks in progress, with briefing, receiving ATIS, and making "in range" calls (*Callback*, 1998, September, p. 2).

One possible remedy (which will be explored in the discussion of communication training) is effective listening which can help provide greater focus and attention. The nature of distraction in the cockpit and problems that occur because of it is treated in excellent fashion by Australian Transportation Bureau (2005).

COMMUNICATION IS A MANAGEMENT TOOL

While much of the communication functions noted in relationships and coordinating activities could also be classified as a management tool, perhaps the most important aspect of communication in this regard is to create and maintain a safety culture in any aviation organization. It is through leadership and messages about the importance of safety (and the effective transfer of information, teamwork, and attention to task)—and behaviors and resources to back up those messages—that a safety culture can be built and nourished.

LESSONS REQUIRED

This paper has outlined several areas where lessons have been learned with regard to communication in aviation safety with regard to how communication functions to provide information, establish interpersonal relationships, coordinate activity, monitor conditions, and as a management tool. A number of suggestions for possible future research and proposals for training for improving aviation safety will be offered. While there are certainly a large number of important subjects that would provide valuable insight into safety, this paper will focus only on communication-related issues.

NEED FOR FUTURE RESEARCH ABOUT COMMUNICATION

Several areas of potential study stand out as needing future research to find their impact on aviation safety, including communication during emergency and evacuation situations, interpersonal variables that affect communication in an aircraft, particularly communication between flight crews and flight attendants, language and meaning differences within the cockpit and between the cockpit and cabin crew and between cockpit and ATC (especially those leading to ambiguity and distortion), and how to create greater clarity in such communication interactions.

In the team and organizational setting roles play a critical part in communication interactions. Research concerning the communication implications of roles and role relationships would provide an important advance in knowledge about communication interactions in the cockpit, between the cockpit and the cabin, and from a management and organizational perspective concerning aviation safety and a culture of safety. Nevile (2006) provides several valuable directions such research about roles in the aviation safety environment could take.

Allied with the concept of roles is that of crew member's communication style based on those roles; for example the use of assertiveness versus indirectness in communicating information. Because there is disagreement as to the efficacy of assertiveness versus indirectness, there is definitely a need for greater research to clear up the nature of politeness and indirectness in communication in the aviation environment, including looking at the issue from a situational perspective. More research into this seeming contradiction is needed to clarify and explicate this important area of team interaction, both in the cockpit and between flight crew and cabin crew. Also, given the perceived need for assertive communication behavior on the part of cabin crew members in an emergency, either directed toward passengers or to overcome the reticence inherent in the flight attendant's dilemma (to not convey needed information to the flight deck), research into the effects of such assertive behavior on the part of flight attendants and how that behavior is perceived by passengers and pilots would prove to be worthwhile.

Because the safety of any flight depends on effective team interaction, research into interpersonal communication variables in the cockpit and in cabin-flight crew interaction is essential, but is also a difficult proposition. The transitory nature of the relationships that are established—and then quickly broken—among aircraft crews make for challenging communication and communication research. It is probably most fruitful to research the types of communication that flight attendants and pilots perceive as establishing rapport, trust, and credibility in such teams. A survey of pilot and flight attendant preferences for certain types of communication, particularly during briefings, might be a first step in discovering how a positive, supportive communication climate can be established in the momentary aircraft crew relationship. Chute and Wiener (1995) allude to the need for this type of research when they note that: "Further research needs to be done to measure the quantity and quality of interaction that occurs with greater familiarity and the impact on aviation safety" (p. 13).

Very little has been written about communication issues in aviation maintenance and inspection. The FAA did sponsor a two day meeting in December 1989 which focused on information exchange and communication in the maintenance area (Parker & Shepherd, 1990). Latorella and Prabhu (2000) note that communication is a contributing factor to error in aviation maintenance. Some research regarding communication in the maintenance arena would be worthwhile, especially into the effectiveness of written documents which Piotrowski (1990) amd Majoros (1990) maintain is an important part of maintenance communication. Aviation maintenance is an area where jargon and acronyms abound (Taylor, 1990). It would be important to investigate how the use jargon and acronyms impacts aviation safety within maintenance itself and from a wider perspective.

These suggestions are but a few that might be important to investigate regarding the effects of communication in aviation safety. Given the critical nature of communication many other research areas within the cockpit, the cabin, and interactions between airline crew and other parts of the aviation system are ripe for research study.

THE NEED FOR COMMUNICATION TRAINING

There have been numerous calls for communication training, both as an independent effort and as part of Crew Resource Management (CRM) for flight crews and for flight attendants (Baker & Frost; 1994; Butler, 1993; Chidester & Vaughn, 1994; Chute & Wiener, 1996; Edwards, 1992; Federal Aviation Administration, 1988, 2004; Grommes and Dietrich, 2002; Helmreich, 2000; Sexton & Helmreich, 2000; Young, 1994). Perhaps, more important have been the calls for joint pilot-flight attendant training (Baker & Frost, 1994; Butler, 1993; Chidester & Vaughn, 1994; Chute & Wiener, 1995, 1996; ETSC, 1996; Federal Aviation Administration, 2004; Helmreich, Wiener, & Kanki, 1993; Kayten, 1993; Murphy, 2001; Moshansky, 1994, NTSB, 2000). “We must teach crews that communication and cooperation are safety issues” (Chute, Wiener, Dunbar, & Hoang, 1996, p. 17).

Flight and cabin crew, while a critical part of the aviation environment, should not be the only focus of communication training as part of an aviation safety training program. Flight Safety Foundation (2000) notes that training programs should include special emphasis on pilot controller communication. Thomas (2005b) and Thomas and Petrilli (2004) argue for communication training as part of error management. Latorella and Prabhu (2000) and Petrowski (1990) note that the importance of communication in aviation maintenance training. Baron (2002) emphasizes the importance of providing training about runway incursions for pilots, controllers, and ground vehicle operators. Etem & Patten (1998) suggest the need for communication training in flight instruction.

However, such calls for training generally do not often include or indicate which communication topics are needed, especially when it comes to interpersonal communication training; nor are the specific subtopics needed to help increase communication effectiveness generally explicated. The Federal Aviation Administration

(2004) offers some general communication topics, which this paper will expand upon with regard to communication training, including interpersonal communication, listening skills, decision-making skills, and conflict management, though they did indicate, as noted above that cockpit-cabin crew communication coordination continues to challenge the aviation system (Federal Aviation Administration, 2004). The Federal Aviation Administration (2004) also offers some specific areas where joint cabin-cockpit communication training can focus, including pre-flight briefings, post incident and accident procedures, sterile cockpit procedures, notifications and pre-flight, pre-landing, and turbulence passenger-handling issues.

In addition, the Federal Aviation Administration (2004) notes that the "importance of clear and unambiguous communication must be stressed in all training activities involving pilots, flight attendants, and aircraft dispatchers" (p. 10). As noted previously communication is a two-way transaction, not a one-way transfer. Thus the concepts of perception and meaning are important to include in any communication training. We communicate about the world in the way we perceive it, therefore, everyone in the aviation safety system needs to understand how perception operates and how people differ, sometimes radically, in the ways they perceive a situation.

Layered upon differing perceptions is the concept that when we communicate about the world, we do so in symbolically, so that we give meaning to our perceptions. As we have seen, people will interpret messages in such a way that makes sense to them and makes sense of the world around them. George (1993) and Matchette (1995) provide several suggestions, some including the use or misuse of jargon, for improving communication between pilots and controllers that can be incorporated into any communication training for aviation safety. Thus, the areas of perception, language (including meaning and jargon) need to be part of any communication training for aviation safety. As we indicated earlier, feedback and asking questions are critical to greater success and effectiveness in our communication interactions. Majoros (1990) reinforces the need for feedback as one method to improve communication effectiveness.

In addition to the exploration of the effects of meaning and jargon on communication, two other related concepts need to be included: message distortion and information overload—and how to minimize them. As much as we understand and desire to have clear and unambiguous communication, especially regarding aviation safety issues, given the nature of language and human interaction, we can only hope to minimize message distortion and information overload. Understanding these important communication barriers and how to deal with them effectively are needed in cabin safety training. As far as interpersonal communication training is concerned, more in depth treatment of such areas as establishing a positive, supportive communication climate, understanding how trust and credibility are achieved, conflict management skills, and active listening is required.

The process of conflict, underlying reasons for conflict, and effective communication behaviors during conflict are also crucial topics in this area of aviation safety training. For example cabin crew assertiveness—with respect to evacuations, poor passenger

behavior and air rage, and reticence to convey important safety information to the cockpit—is an integral aspect of the conflict management portion of communication training. Like any other communication behavior, conflict management requires a situational perspective. The conflict management and assertiveness portions of the training will take this concept into account, for example, when to be assertive, when to be accommodative, and when other communication behaviors might be appropriate. This situational nature of conflict management will also provide a thought provoking opportunity for when flight and cabin crew need to be assertive and when indirectness or mitigation is a more effect method of communicating.

Training with regard to establishing a positive supportive climate needs to explore such topics as defensive communication and disconfirming messages. Gibb (1961) notes that a defensive communication climate is extremely disruptive to the interpersonal communication process. In fact a negative climate can make effective team communication very difficult, if not impossible. Communication training for cockpit and cabin crew should include the understanding of defensive communication, disconfirming messages, and the practice of supportive and confirming messages. Defensive and disconfirming messages are basically ones that ignore others and treats them as if thy do not exist or do not matter. Supportive and confirming messages let others know that they—and their ideas—are worthwhile and valuable. Trust, too, is an important aspect of a positive, supportive climate, one that can lead to much greater rapport, cohesion, and team coordination for the flight crew as a whole unit. Thus, understanding trust behaviors and messages needs to be an integral part of this aspect of training.

The briefing process offers an ideal opportunity for joint cabin-cockpit communication training to integrate the concepts of trust, supportiveness, teamwork, and a positive communication climate in training. It is in this aspect of communication between cabin and cockpit crews that many problems occur, potentially setting a negative tone for the rest of the flight. Likewise, understanding and utilizing communication that engenders a positive climate during the briefing process can create a collaborative and productive atmosphere for the flight.

Active listening comprises the final part of communication in aviation safety training. This aspect of the training could cover the importance of listening, the cost of poor listening, the process of listening, barriers to effective listening, and steps to better listening. Barriers to effective listening covers such topics as lack of concentration, prejudging messages, making unchecked assumptions, rehearsing a response, focusing on style and delivery, unconscious projection, and a win/lose perspective on listening. Steps to better listening covers such topics as a win/win perspective to listening, focus, patience, and asking questions. The training would include practice in such important listening skills as paraphrasing, responding, and feedback. Active, effective listening skills are crucial in creating the best possible communication environment for the exchange of accurate, unambiguous messages that minimize distortion and overload. Such a communication environment also contributes to a positive, supportive climate where rapport and trust can develop and thrive.

As important as specific topics needed for training for effective aviation safety communication are, the methodologies required for delivering such training are also critical. As with most communication training, there should be limited didactic presentation. Rather, there needs to be a great deal of interaction, practice, and introspection. The best methods for this type of training would include experiential exercises, practicing communication skills, role playing, small group and team building exercises and discussion, case study scenarios, and self-assessment tools (for example, the Thomas-Kilman Conflict Mode Instrument)—all centered around communication in aviation safety, with particular emphasis on communication specific, applicable situation, such as in the cockpit, the cabin, and between cabin and flight deck crews.

ASRS publications, especially *Callback* and *Directline,* afford abundant examples of both poor and good communication in the aviation system that can be used to create case studies and scenarios which can be used to gain insight into effective communication skills. These actual communication occurrences in the aviation safety environment need to be integrated into cabin safety communication training. Young (1994) and Flight Safety Foundation (1994), in addition to numerous ASRS reports, provide incidents in which cockpit crew, flight attendants, ATCs, and maintenance personnel were able to use their good sense in emergency or potentially unsafe situations in order to prevent possible tragedies. While examples of poor communication can provide excellent examples for scenarios that would be useful for training, so too should such examples of good communication be used for training purposes.

LESSONS FOR AIR SAFETY INVESTIGATORS

Much of the discussion in this presentation has focused on the aviation safety milieu in general, especially on communication in the cockpit and between the cockpit and other aspects of the system. There are lessons to be learned for air safety investigators in this conversation.

Harle (1995) argues that it is essential for air safety investigators to integrate human factors information. Given that communication is an critical aspect of human factors, then communication issues need also be integrated into aviation safety investigations as one possible, if not at times, key aspect of the possible causes of accidents and incidents. Sexton and Helmreich (2000) discuss the relationship between language use and flight outcome measures. While their discussion was not directly investigation related, one outcome measure important to investigators is an accident and any potential underlying factors.

Von Thaden and Steelman (2005) posit that the purpose of accident investigation is to identify the process through which interacting and underlying factors lead to an accident; they argue that ". . .if accident investigators lack a cohesive definition of human factors issues, the investigation into human performance may be unsystematic, incomplete, or leave significant points unresolved" (p. 1). As we have seen, communication is not only a critical part of human factors, but is in and of itself a crucial aspect of aviation accidents

due to poor communication. Thus, it is essential for accident investigators to have an understanding of the effects of communication in the aviation safety environment to be able to fully investigate the causes of an accident, whether primary or secondary.

CONCLUSION

This paper examined the status of communication as a crucial aspect of aviation safety. Effective communication is essential for aviation safety, whether within the cockpit, the cabin, maintenance, or between flight deck and other parts of the aviation system. Effective crew coordination is fundamentally dependent upon effective communication. Teaching effective communication is an essential requirement for aviation safety training for all involved in this enterprise. Short of grounding all aircraft, it is probably impossible to eliminate the risk of ineffective communication leading to incidents and accidents. However, it is possible to minimize such risk by creating an awareness of the importance of effective communication, integrating such awareness into our thinking, and applying this integration into a proactive approach to communicating by incorporating effective communication behaviors into all aspects of the aviation safety environment.

An article in the ASRA *Directline* perhaps said it best with regard to communication in aviation safety when noting that communication errors are the most frequently cited problems in the incidents that are reported to ASRS:

> Communication problems take a variety of forms. Equipment deficiencies, phraseology, similar call signs, speech rated, blocked transmission, and failure of the readback/hearback process are just a few types of communication problems. The subject is too broad to be covered by any degree in this article, but I do want to make the point that communication problems often lead to a “Flawed Information Transfer” (FIT), and if the flawed information transfer is not corrected soon enough, the result may be an “Occasional Semi-Hysterical Information Transfer” (acronym unknown) (George, 1993, June, p. 16).

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