

## AN ABSTRACT OF THE THESIS OF

Mary Alida Robarge for the degree of Master of Arts in Interdisciplinary Studies in Speech Communication, Adult Education, and Business Administration presented on July 20, 2000. Title: Beyond "Clear Transmission": Commercial Aviation, Communication, and Crew Resource Management.

Signature redacted for privacy.

Abstract approved: Signature redacted for privacy. \_\_\_\_\_

William M. Keith

This exploratory study looks at communication perspectives and applies them to the transcript of USAir Flight 427, a flight that crashed while attempting to land. Researchers calculate that 60% to 80% of the accidents can be traced to pilot error. Many of these errors occur through a single communication event or series of communication events. Human factor engineers developed crew resource management (CRM) to address communication, decision-making, and teamwork to proactive address these challenges. Often, human factors engineering studies recommend "better" or "clearer" communication to address the issue of pilot error. B. A. Fisher's perspectives (mechanistic, psychological, symbolic interactionist, and pragmatic) provide researchers a way to talk about communication by explaining the strengths and weaknesses associated with various approaches to communication phenomena. The application of Coordinated Management of Meaning and Conversation Analysis offers some insight and support to CRM that need further research. More research needs to be conducted solely focusing on communication's role in aviation.

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Beyond "Clear Transmission":  
Commercial Aviation, Communication, and Crew Resource Management.

by

Mary Alida Robarge

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APPROVED:

Signature redacted for privacy.

Signature redacted for privacy.

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Major Professor, representing Speech Communication

Signature redacted for privacy.

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Committee Member, representing Business Administration

Signature redacted for privacy.

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Committee Member, representing Education

Signature redacted for privacy.

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Chair of the Department of Speech Communication

Signature redacted for privacy.

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Dean of the Graduate School

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Mary Alida Robarge, Author

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## TABLE OF CONTENTS

CHAPTER ONE: COMMERCIAL AVIATION AND CRM.....	1
Overview.....	1
Agencies Involved in Aviation Accidents .....	5
Human Factors Engineering.....	14
How pervasive is pilot error? .....	16
U.S. Commercial Pilot Training.....	19
Crew Resource Management .....	20
Impacts of Automating the Aircraft System .....	27
CHAPTER TWO: APPROACHES TO UNDERSTANDING COMMUNICATION.....	33
Mechanistic Perspective.....	35
Psychological Perspective.....	43
Symbolic Interactionism Perspective .....	48
Pragmatic Perspective.....	54
CHAPTER THREE: COMMUNICATION PERSPECTIVES AND APPLICATIONS .	76
Overview.....	76
Mechanistic Perspective's Applications .....	85
Psychological Perspective's Applications .....	89

**TABLE OF CONTENTS (Continued)**

Symbolic interactionism Perspective's Applications ..... 92

Pragmatic Perspective's Applications ..... 95

CHAPTER FOUR: CONCLUSIONS AND FUTURE RESEARCH..... 103

    Overview ..... 103

    Systems Thinking: Education and Communication ..... 105

    Final Comments ..... 112

WORKS CITED ..... 114

## LIST OF TABLES

1. U.S. Carrier Fatal Accidents.....16-17
2. Cockpit Voice Recorder Transcript Legend.....80

# BEYOND "CLEAR TRANSMISSION": COMMERCIAL AVIATION, COMMUNICATION, AND CREW RESOURCE MANAGEMENT

## CHAPTER ONE:

### COMMERCIAL AVIATION AND CRM

#### *Overview*

Aviation disasters command newspaper headlines when they occur because, recently, the numbers of fatalities seemed to increase dramatically. In 1994, six commercial aviation accidents claimed the lives of more than 250 people. In 1995, the number of fatalities climbed to 422 passengers and crew. In 1996, the airline industry's safety record received several severe jolts as the fatalities number increased even higher from just three major crashes: ValuJet, Trans World Airlines Flight 800, and the flight near New Delhi, India (*The Economist*, 1997). The ValuJet crashed into the Florida Everglades and claimed the lives of all those on board, totaling 110 (*NTSB*, 1999). Trans World Airlines Flight 800 off the coast of Long Island claimed the lives of all on board, totaling 230 passengers and crew (*New York Times*, 1998). A mid-air collision near New Delhi killed 349 people (*NTSB*, 1999). Aviation accidents such as these appear to be increasing since the early part of this decade.

The number of flights increased but the number of fatalities decreased into the later part of the 1990s. However, several high profile accidents did result in fatalities from 1997 to 2000. In 1997, Korean Air flight 801, a regularly scheduled, international passenger service flight, crashed at Nimitz Hill, Guam. Of the 254 persons on board, 228 were killed (23 passengers and 3 flight attendants survived the accident with serious injuries). Impact forces and a post-crash fire destroyed the airplane. In the summer of 1999, American Airlines flight 1420, carrying a crew of 6 and 139 passengers on board, crashed after landing at Little Rock, Arkansas. The airplane went over the end of runway, slid down an embankment, and collided with some light structures. This accident claimed the lives of eleven people on board, including the captain. Public fears surfaced again in October of 1999 as Egypt Air flight 990 crashed in the Atlantic Ocean, killing all 217 passengers and crew on board the plane. Then in January of 2000, Alaska Airlines flight 261, a scheduled international passenger flight from Puerto Vallarta, Mexico to San Francisco, California, crashed into the Pacific Ocean near Point Mugu, California with 88 people aboard. There were no survivors. These accidents evoke a high level of fear in many people and cause a public outcry about aviation safety. With so many high profile accidents, journalists and the public scrutinized air safety and forced it into the spotlight.

As more people turn to air travel and flights increase to meet the consumer's demands, it appears that these tragedies will continue. An amazing number of people travel on passenger liners: in 1998, the world's commercial jet airlines carried approximately over a billion people on 18 million flights. According to Boeing and the International Air Transport Association (IATA), the airlines' trade organization, more than three million people from across the world fly safely on commercial aircraft every day in 1999. The Federal Aviation Administration (FAA) projects that by the year 2005 the number of flights in the US will have increased by nearly one-third (*Newsweek*, April 24, 1995). Given the large volume of flights and vast number of passengers, it seems miraculous that so few flights conclude in tragedy.

The United States airline's safety record is incredible because they move millions of passengers and pounds of cargo every day; most of them go off virtually without a hitch (*Newsweek*, April 24, 1995). Approximately 5 to 10 US commercial aviation accidents occur annually, these numbers exclude small commuter planes and delivery aircraft service such as: Federal Express, United Postal Service, and the United States Post Office (Boeing Commercial Airline Group, 1995). Internationally the rate doubles to 10 to 20 accidents annually. However, in the United States, it is 22 times safer to fly in a commercial jet than traveling by car (U.S. National Safety Council, 1997).

Aircraft designers envisioned and created planes built to carry even greater numbers of passengers than ever before but this could compound the problems. In a market driven industry, aircraft designed to carry 1000 passengers could become common place (*The New York Times*, 1997). As flight numbers increase, the public can expect to see more fatal accidents (Nader and Smith, 1994). A recent report by aircraft manufacturer, Boeing, states that, "there could be a big air crash once a week by 2010" (*The Economist*, 1997). Knowing that only a few will end tragically, why not write it off as any other business would predict some percentage of loss? The answer is simple; the loss of human lives is too great a price to pay. U.S. Vice President Al Gore, Transportation Secretary Rodney E. Slater, and Federal Aviation Administrator Jane F. Garvey announced a new safety program, *Safer Skies* in 1998. The program focuses on targeting and preventing the leading causes of fatalities and injuries. *Safer Skies* responsibilities include identifying the causes of aircraft accidents. The Department of Transportation specified that the FAA's goal will be zero accidents (*The New York Times*, 1997). To avoid these accidents in the future, researchers should expand their knowledge and understanding to uncover the "how" and "why."

## ***Agencies Involved in Aviation Accidents***

The Department of Transportation and the Federal Aviation Administration

The task of researching and investigating an airline crash provides a daunting challenge. First, who governs the airlines and reports on these mishaps? The Department of Transportation (DOT) oversees the various the governmental transportation agencies: Federal Railroad Administration, Maritime Administration, Federal Highway Administration, U.S. Coast Guard and the Federal Aviation Administration (Nader and Smith, 1994). The Federal Aviation Administration oversees the safe business practices of aircraft transportation and DOT has direct responsibility over the financial fitness of airlines. The FAA responsibilities include:

1. Operating the air traffic control system.
2. Promoting safety regulations, ranging from establishing maximum pilot duty-hours to mandating minimum aircraft maintenance standards.
3. Enforcing safety regulations when the regulations become effective.
4. Conducting safety inspections.
5. Establishing minimum standards for the design, materials, workmanship, construction, and performance of aircraft, aircraft engines, and related equipment.
6. Certification (licensing) of pilots, airports, aircraft, airlines, mechanics, and flight schools.
7. Establishing minimum standards for aviation security.

8. Establishing airport noise abatement standards.
9. Administrating the Airport Improvement Program, this helps fund local airport construction and safety improvements.
10. Conducting research and development of new aviation technologies.
11. Enforcing safety standards overseas where U.S. air carriers operate.
12. Working with the International Civil Aviation Organization (ICAO) to establish and maintain worldwide aviation safety standards.

The FAA's responsibilities include a great number of items; they regulate the safety in aeronautics and simultaneously promote the growth of the aviation industry. This is an incredible challenge. With over 460 million flight hours to track and 304 million departures, the FAA truly has its hands full. Some researchers and interested parties see the FAA's multiple responsibilities as too much for one agency to handle well (Nader and Smith, 1994). The FAA must answer to the Department of Transportation. DOT maintains responsibility over the airline's financial wellness. Usually this works well but an airline carrier's bottom line creates an occasional conflict of interest for the DOT and FAA concerning safety violations. The airline company's profits may decrease for a number of reasons thereby causing the airline to cut corners in a multitude of ways. For example, the company may not have funds to employ experienced pilots and mechanics. This situation could cause the company to develop substandard safety practices and continue to fly with unsafe aircraft or in unsafe conditions. The FAA regulates these unsafe practices, but at the same time promotes airline carrier. This does have serious

implications for safety. If the FAA serves as the promoter and primary regulator of the airline industry at the same time, some see this as a bipolarization of duties (Nader and Smith, 1994). One must wonder if this is the best possible system for aviation safety.

### National Transportation Safety Board

The National Transportation Safety Board (NTSB) acts as an accident investigation agency and produces definitive analyses of individual transportation accidents. The NTSB investigates accidents that take place on the highways, railroads, pipelines, waterways, and in the air. Public Law 93-633 obligates the National Transportation Safety Board to investigate and determine the probable cause of all civil aviation accidents in the United States. The reports must be available to the public upon request and in writing. The NTSB also provides an annual report to the Congress containing a statistical and analytic summary of its investigations. The NTSB drafted a strategic plan that emphasizes restoring and maintaining the public's confidence in the safety of the nation's transportation systems following accidents and serious incidents. The criteria of the plan is as follows:

1. To prevent future transportation accidents from occurring
2. Tasked with investigating transportation accidents, determining probable cause and making recommendations to prevent them from happening again.
3. Use accident investigations to identify trends or issues that may be overlooked

The NTSB must address safety deficiencies immediately, even if the deficiencies did not contribute to the cause of an accident (NTSB, 2000). After an accident or incident occurs, the NTSB forms an investigative group to compile data for an "Aircraft Accident Report." These reports are public record and listed on the NTSB's web site. The National Transportation Safety Board employees write the "Aircraft Accident Report" which solely states the NTSB's analyses of the causes of the accident. The NTSB encourages other involved parties such as the commercial airline company whose plane had crashed, Boeing, or the FAA to write and submit their own data which will become part of the public docket. These reports contain detailed accounts of what happened immediately prior to an accident based on transcripts from the cockpit voice recorder, aircraft instruments, witness or participants accounts, and much more information (Orasanu, 1995). Often the NTSB releases its recommendations from the investigation before the conclusion of the accident investigation. The NTSB lists its accident reports on its web site and each report is marked as "Prel, Fact, or Final." "Prel" is the synopsis based on the preliminary accident report and subject to change. "Fact" is the synopsis that contains information from the factual report. "Final" marks the synopsis that

contains information from the final report and includes the probable cause. NTSB Researchers and other officials deliberate over the findings in public meeting in Washington, D.C.

The NTSB investigates approximately 2,000 aviation accidents and incidents per year (NTSB, 2000). On one hand, NTSB is completely independent of any other department or agency in government and therefore subjected less to political pressure. On the other hand, the NTSB has no power to enforce its recommendations (Nader and Smith, 1994); without regulatory or enforcement powers, the reports the NTSB issues cannot be entered as evidence in a court of law. So the NTSB must collaborate with another group that does wield power and authority, such as the Federal Bureau of Investigations, that prosecutes criminal activity. Federal law designates the FAA as the designated party to the National Transportation Safety Board's investigative processes for aviation accidents. The NTSB can legally collaborate with any other agency to assist in the investigative process as well. The NTSB chooses its partners for their area of expertise and other agencies or countries chose the NTSB for their expertise. A recent example is the investigation of Egypt Air 990. Under the International Civil Aviation Organization treaty, the investigation of a plane crash in international waters is under the jurisdiction of the country or registry of the aircraft. At the request of the Egyptian government, the NTSB has taken the lead in this investigation. The Egypt Air 990 accident investigation will be supported by: the Federal Aviation Administration, the

Federal Bureau of Investigation, the United States Coast Guard, the Department of Defense, National Oceanic and Atmospheric Administration, Boeing Commercial Airplanes, Egypt Air, and Pratt & Whitney Aircraft Engines. The FAA and NTSB are not the only agencies interested in the prevention of aviation accidents, NASA is also involved. NASA acts as another partner in uncovering unsafe flying habits or conditions that contribute to aviation accidents.

#### National Aeronautics and Space Administration

The National Aeronautics and Space Administration (NASA) is a leader in scientific research especially in space and aviation. The Administration's responsibilities include promoting the public interest in aerospace exploration, as well as energizing scientific and technological advances. In order to study patterns that may lead to aviation accidents, NASA developed a preventative way to look at "near mishaps." NASA has a no-jeopardy reporting system for pilots to report incidents that have safety implications called the *Aviation Safety Reporting System* (ASRS). The ASRS benefits include uncovering certain issues such as: workload management, task delegation, situation awareness, interpersonal communications, and the process of building and maintaining an effective team relationship on the flight deck (Helmreich and Foushee, 1993). One

example includes the unwillingness of junior members to speak up in critical situations because of the established hierarchical nature of the flight deck. This does lead to unbelievable challenges during an emergency. The ASRS reports read like mini-dramas but provide a wealth of information as to why certain accidents were avoided (Nader and Smith, 1994). This valuable tool helps uncover some of the pieces that contribute to aviation accidents.

What do aircraft accidents and fingerprints have in common? No two are exactly alike. From years of studying errors, researchers discovered that a rare combination of complex circumstances contribute to every airplane crash (*The New York Times*, 1997). Researchers generally cite many causes for accidents, because most have several contributing factors (Oster, Strong, and Zorn, 1992). Operating an aircraft involves numerous simultaneous detailed steps that pilots carry out concurrently. Why do pilots err? Is error reduction possible with all of the simultaneous sequences of flying an aircraft? What exactly goes wrong on the flight deck? Just identifying errors can pose many challenges. The field of *human factors engineering* continues to probe into the details of aviation accidents by devoting a great deal of time and effort to study the nature of errors.

## Airline Manufacturers and Commercial Airline Companies

Many other parties serve as stakeholders in the outcome of the accident investigations: the manufacturers of the aircraft, aviation regulatory agencies, and the commercial airliners themselves. In 1995, worldwide commercial jet operations were comprised of nine manufacturers, 32 significant types of aircraft, with more than twelve thousand aircraft in service (Commercial Airline Group, 1995). Airbus and Boeing's planes dominate the industry with Boeing manufacturing two out of every three jetliners (*The Economist*, 1997). Boeing Commercial Airplane Group is the world's largest producer of commercial jetliners. Through the month of February 2000, Boeing recorded orders for 14,603 jetliners (more than all other manufacturers combined) and had delivered 13,136 airplanes. Boeing offers 23 airplane models to serve every passenger market from 100 seats to nearly 600 seats and cargo freighters as well. The Boeing Commercial Airplanes include the MD-11, MD-80, MD-90, 717, 737, 747, 757, 767, and 777. Boeing takes an active role in accident investigation by conducting its own tests on Boeing planes. When the NTSB makes recommendations about a design feature, they respond in writing.

International Air Transport Association (IATA) began in 1919 and serves as the world's international airline industry trade association. The IATA's mission is to "represent and serve the airline industry." Nearly 270 airlines group together through the

efforts of the IATA including the world's largest airlines whose planes fly over 95 percent of all international scheduled air traffic. The IATA works to ensure that people, freight, and mail move around the world easily. They also work to establish clear, defined, and understood rules. Therefore, the IATA members' aircraft can operate safely, securely, efficiently, and economically.

Many commercial airline companies exist in the United States. Alaska, American Airlines, American West, Continental, Delta, Northwest, Southwest, TWA, US Airways, and United just to name a few of the larger companies. *The Oregonian* printed the airline fatality rates following the crash of Alaska Airlines flight 261 in California. As a result of the Alaska Airlines flight 261 crash, Alaska joined TWA with the highest fatality rates even though Alaska had not experienced a crash in 29 years. Aviation researchers determine the fatality rates by totaling the number of fatal flight events and dividing it by the number of estimated number of commercial flights. These numbers do not tell the whole story though because so much more information needs to be uncovered. What about the number of mishaps and narrow escapes that pilots do not even report? What information has been learned from examining the accidents themselves?

## ***Human Factors Engineering***

The field of *Human Factors Engineering* has two major objectives: 1) to design systems in the most optimum way to take advantage of the characteristics and abilities of the people who are expected to operate them and 2) to select and train the operators of these system (Jensen, 1996). Human factors engineers specializing in aviation seek to optimize the relationship between aviation machines and the people who operate them (Wiener, Kanki, and Helmreich, 1993), by systematically applying human sciences within the framework of systems engineering (Jensen, 1996). The Federal Aviation Administration's definition of human factors is:

A multidisciplinary effort to **generate** and **compile** information about human capabilities and limitations and **apply** that information to equipment, systems, facilities, procedures, jobs, environments, training, staffing, and personnel management for safe, comfortable, effective human performance.

This definition presupposes a multidisciplinary study involving such fields as psychology, cognitive science, sociology, science, computer science, engineering, and communication. In order to train or help improve the pilot's job performances, human factors engineers delve into questions about behavioral and cognitive processes. Human factor engineers study aviation accidents through a variety of diverse topics including:

individual personality differences, high performance vs. lower performance teams, flight deck decision making, situation awareness, hierarchy in groups, and crew resource management. These researchers need to analyze all possible variables that contribute to an aircraft flight ending in disaster. These aviation experts ask questions such as: "Why might a flight have ended badly?" or "Why the mishap occurred in the first place?"

Human factor engineers specializing in aviation continue to look for how humans interface with their environment and the role of the machinery in these accidents.

As airline companies upgrade their airplane systems, they expect their pilots to keep up with the changes. Many researchers agree that some of these improvements do help the pilot perform better but the changes bring about newer errors or challenges. Studies of human reliability, generally, have been directed at improving people's reliability, and not at understanding why they were unpredictable in the first place (Senders and Moray, 1991). If systems continue to improve without the pilot fully understanding the process, it makes them less in control of flying the aircraft. Some researchers state that pilots are merely monitors of a system and not in charge of flying the aircraft. Yet, in times of crisis, airline companies expect their pilots to be in total control of the airplane. Just identifying the ways in which accidents occur; practical application of error theory should take place. How do we begin this process? What determines the boundaries of human errors if human error causes so many accidents?

The following section addresses pilot error, the extensiveness of pilot training, crew resource management, decision-making processes, and the impact of automation.

### ***How pervasive is pilot error?***

The NTSB overwhelmingly cites the flight crew's actions as the primary factor for aircraft accidents (NTSB, 1998). An industry wide analysis has shown that over 70% of aviation accidents result from crew coordination or communication problems, as opposed to lack of individual technical skills (Lautman and Gallimore, 1987; Boeing Aircraft Company, 1999). *Pilot or human errors* include the accidents that involve the flight crew's actions. "Human error" covers just about anything except for weather and clear mechanical failures. The following table shows the leading cause of fatal accidents involving U.S. Carriers from 1987 through 1996.

**Table 1: U.S. Carrier Fatal Accidents**

<b>U.S. Carrier Fatal Accidents</b>	<b>#</b>	<b>%</b>
1. Loss of Control	11	32
2. Other/Unknown	6	18
3. Controlled flight into terrain (CFIT)	4	12
4. Runway incursions	4	12

**Table 1 (Continued)**

5. Ice/snow	3	9
6. In-flight fire	2	6
7. Wind shear	1	3
8. Landing	1	3
9. Sabotage	1	3
10. Highjack	1	3
11. Mid-air collision	0	0
12. Fuel exhaustion	0	0
13. Rejected take-off	0	0

In comparing the data from Table 1, it is apparent that the largest number of accidents occurs from loss of control (FAA News, 1998). When the crew no longer can manipulate the aircraft, researchers consider it as a loss of control. Loss of control implies “human error” which is the largest contributor to accidents. Pilots are responsible for being in control of the aircraft at all times. The focus remains on pilots because they are the most likely catalysts for a chain reaction of errors that contribute to the tragedies we hear so much about from the media. Error is human actions that fail to meet an implicit or explicit standard. An error occurs when a planned series of actions fails to achieve its desired outcome, and when this failure can not be attributed to the intervention of some chance occurrence (Senders and Moray, 1991). If the crew had behaved or reacted differently, the crash would not have taken place (*The Economist*, 1997).

Misunderstanding the machine modes or system, misentering data, overconfidence in their flying ability, not depending upon the technology available, or inappropriate reliance on machine controls are just some of the factors that contribute to human errors (Adams, Tenny, and Pew, 1991). *Human errors* are often predictable and follow a pattern of well-established and well-practiced cognitive routines (Senders and Moray, 1991). Emphasizing the elimination of one error may lead to an increase or additional of new errors when the pattern of behavior is altered, and these changes could be unpredictable. Training people to perform better may not necessarily prompt them to make fewer errors. Error is a necessary part of learning (Senders and Moray, 1991). As technology improves the aviation systems, one might expect pilots to continue learning but also making mistakes in that process.

When human factor engineering first began the field followed the U.S. Government's training and focused on the behavioral outcomes. The ways to eliminate error emerged from behavioral methods in pilot training. Then came a shift in the behavioral studies in the research to cognitive processes. Cognitive processes encompass "metacognition" processes such as decision making and problem solving. Cognitive processes are much more difficult to define and measure (Seamster, Redding, and Kaempf, 1997). In the last decade, researchers recognize knowledge deficiencies and attitudinal problems as primary sources of pilot performance breakdown (Orlady and

Foushee, 1987). Undesirable personality traits, indecisive or unreceptive leadership, lack of discipline, complacency are not the real reasons why aviation accidents take place, they are merely descriptors (Besco, 1988). Human factor engineers need to examine knowledge deficiencies further. What exactly is the pilot expected to know? Everything an engineer or mechanic knows? Researchers often cite training as a means to improve pilot performance. As we can see from the next section, pilots spend a great deal of time in training.

### ***U.S. Commercial Pilot Training***

Pilots must maintain their licenses throughout their careers. The federal government legally requires that every U.S. commercial pilot pass a battery of tests on a regular schedule. Some of the exams include: medical (every six months), instrument rating (13 months), aircraft type rating and competence check (six months), safety equipment and procedures check (13 months), route check (13 months), technical questionnaire (13 months), and many other checks. No other profession is more thoroughly checked (Stewart, 1992). If that is true, and pilots are highly trained professionals that must complete the strictest of tests in order to fly, where do things go wrong? Many researchers continually seek ways to minimize pilot errors by finding

explanations for why accidents take place (Chou et al., 1991; Orasanu, 1995; Kanki et al., 1989; Predmore 1991; and Wiener, 1993).

### ***Crew Resource Management***

Human factor engineers developed a field called *Crew Resource Management* (CRM) in order to assist pilots to perform better under non-routine situations while flying. CRM is the effective management of all resources available to operators (Jensen, 1996). The concept of CRM encompasses the aircrew's behaviors within the context and environment of all the work that goes into preparing and actually flying the airplane (FAA Advisory Circular, AC 120-51, 1991). CRM concentrates on effectively using all available resources. Jensen (1996) says that CRM training includes interpersonal communication, group processes, team decision-making, leadership, situation awareness, conflict resolution, recognition of one's own behavioral styles, and recognition of other's behavioral styles. CRM attempts to address: 1) communications process and decision behavior, 2) team building and maintenance, and 3) workload management and situational awareness (FAA Advisory Circular, AC 120-51, 1991). Crew management, coordination, and communication should be the focus of CRM training (Santiago, 1996). When airline companies first introduced CRM training to pilots, they referred to it as "charm school." CRM implementation began in the 1980s and its concepts continue to

undergo scrutiny (Wise, 1996).

Communication and decision making are important sub-fields in CRM. Crew Resource Management concentrates on quickly assessing the available resources and using communication to accomplish tasks; CRM focuses on teamwork to complete its objectives. Decision-making requires taking stock of the situation and resources available and then processing these through a mental model. Crew decision-making requires personnel to enlist help from other crewmembers. Since decisions happen across individuals and teams, members need to communicate to each other how they understand the situation (Orasanu and Fischer, 1992). This requires pilots to quickly assess available resources and communicate their decisions about the use of those resources. Both areas overlap in identifying assessing available resources and using communication to complete tasks, especially within the constraints of time. This is important because both assume communication is a significant part of accomplishing tasks but never define it or go into detail as to how communication will improve the process to eliminate errors.

### The Role of Decision-making on the flight deck

Decision-making is understood by researchers as a mental model that includes a system of assumptions and beliefs about the status of the current situation, plans, and problem solving strategies (Hark, Krems, and Severin, 1995). Researchers typically

describe decision-making as an individual cognition. Human factor engineers extend the study of individual decision making to that of its crew and it is termed “crew or cockpit decision making.” Naturalistic Cockpit Decision-making is the choice of actions in response to situational cues that signal abnormal or emergency conditions (Orasanu, Fischer, and Tarrel. 1993).

The taxonomy of decision-making involves four major components: 1) situation awareness, 2) choice of a response option, 3) time assessment, and 4) risk assessment (Orasanu, Fischer, and Tarrel. 1993). The choice of response option depends upon the pilot or crew’s awareness of the available resources. If time is limited, the range of options or ability to think clearly narrow, opening the possibility for an accident to happen. Orasanu (1995) concluded “...good decisions are made in well managed cockpits; thus, it is important to develop the task management and communication strategies that support effective decision making skills.” Yet, to foreshadow later questions, what does “communication” mean here? It is difficult to tell, since these studies take communication for granted and do not define the term (rather like building a house with beautiful brick but no mortar to keep the whole structure together).

Acknowledging, even partially, the social factors in decision-making and crew resource management, researchers should be specific about what constitutes communication-or risk creating new errors. Time management and accurate risk assessment come from experience of following procedures and quickly recognizing viable solutions to particular

flying challenges.

A pilot's decision-making is always important but becomes crucial during particular phases of flight where errors are more likely to occur. Flights are separated into the following 12 sequential phases: load, taxi, unload, takeoff, initial climb, climb, cruise, descent, initial approach, final approach, and landing. Researchers (Funk et al., 1991; Predmore, 1991) have discovered that typically many more accidents occur in the initial approach and final landing. During this time the pilot may be engaging or disengaging the automation used to fly the aircraft. Every time an aircraft takes off and lands; the probability of problems occurring increases and is compounded by the limitation of time. Pilot's errors are mainly related to a lack in the decision-making process. Over 50% of military and civil aviation accidents involving human errors from 1987 to 1989 were decisional errors (Diehl, 1991). Performance under stressful conditions causes a tendency for an individual's perpetual focus to narrow, resulting in a decreased ability to process multiple tasks (Predmore, 1991). On the other hand, in extreme cases some pilots make random choices or avoid the process altogether (Payne, Bettman, and Johnson, 1993). Crews must interact with the aircraft and interact with each other to coordinate activities (Segal, 1993). Pilots cannot put their aircraft on hold, park, or stop while errors, anomalies, and unexpected events are resolved (Besco, 1991). Time is limited when making decisions on the flight deck (Wright, 1974; Wickens, Stokes, Barnett, and Hyman, 1991; Stokes, Kemper, and Marsh, 1992). During flight

training, the steps to decision-making appear simple but the conditions are vastly different when flying an airplane (Seamster, Redding, and Kaempf, 1997).

An important goal for error reduction is to identify what an error is and then create ways to decrease the non-optimal results (Wiener and Negel, 1988). The demand on pilots to think creatively when they are under stress contributes to more errors. In order to offset non-optimal human decisions, researchers have begun automating systems with standard procedures, and moved to creating checklists to cover anticipated failures or emergencies (Billings, 1991; Wiener, 1988). Certain systems lend themselves easily to checklists and other situations, but no play book will come in handy for all situations because diverse problems contribute to aviation accidents. Therefore, researchers continue to search for the best ways to understand what items might be combined into a checklist and what types of scenarios can be tested in a simulator. The simulator allows aircraft operations to prepare their pilots for a number of challenging situations that will require them to exercise their decision-making skills.

### Situation awareness

Crews must go beyond merely noticing the presence of cues; they must appreciate their significance, and significance is relative to the model they have of the relevant situations. Situation awareness involves interpreting situational cues to recognize that a

problem exists that may require a decision or action (Wiener, Kanki, and Helmreich, 1993). Thus, situation awareness is the detection of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status in the near future (Endley, 1988).

Pilots must observe and interpret the environment (flight deck or airplane) in order to make decisions. A number of crucial systems in the total flying situation command the pilot's attention. If a flight does not reach its destination on time, the passengers may miss their next flight, etc. and eventually this affects the airline's bottom line. At the same time, the pilot may be receiving information from the flight crew about a number of issues that do not directly relate to flying the aircraft. In the midst of all this, the pilots remain responsible for flying the aircraft safely and efficiently.

### Task Initiation and Checklists

Researchers began critiquing the current methods for making generalized assumptions from "simulated" research and applying it to real world problems (Klein and Klinger, 1991). As mentioned earlier, a large percentage of human error can be contributed task initiation. By using research findings along with the direct information from the pilots, more useful task management checklists emerged. Along with creating

checklists, a reformulation of workload problems has been suggested so that pilots can better handle tasks (Hart, 1989). This includes broadening the researcher's approach to study multiple task performance (Wickens, Larish, and Contorer, 1989). Researchers have studied task performance using the name of Task Management. Task Management functions as a supersystem or umbrella overseeing many other aviation categories (Funk, 1991). Task initiation is part of the task management functions. Forty-two percent of human error can be attributed to task initiation (Funk, 1997). If a pilot fails to initiate a task because they are unsure of the steps or have no idea that a task should have begun, this creates real life dramas! If task initiation contributes to such a large percentage of aviation accidents, why are these highly trained pilots not initiating the tasks? Are the pilots making poor or reactive decisions? Are airline companies motivated to uncover why this is a problem? What practices might eliminate these problems without creating new challenges?

While creating checklists will be useful, they are just a tool in the overall task of flying the airplane. The pilots must constantly assess and prioritize the tasks (with or without checklists) (Adams, Tenny, and Pew, 1991). There is relatively little literature on how people cope with more than two concurrent tasks. The study of multi-tasking may lead to promising human factor engineering efforts in the areas of system design and training (Adams, Tenny, and Pew, 1991). In addition, handling interruptions of tasks

adds high stress when trying to fly the aircraft (Latorella, 1996). The systemic approach of trying to be all-inclusive with checklists might contribute to the stress as well. It is reasonable to project an increase in the number of CRM error-induced accidents as traffic density and cockpit complexity grow, unless appropriate countermeasures are introduced (Funk, 1991). Researchers may disagree on the ways pilots should handle high stress workloads but everyone suggests new ways to look at minimizing the possibilities of aircraft accidents. The multiple views may help realize all the facets. Is this a case of man vs. machine? Researchers must examine automation's role in accidents to suggest ways to eliminate errors.

### ***Impacts of Automating the Aircraft System***

Pilots originally just flew the craft, just as people drive their cars, but now they have become managers of an elaborate technical system that responds to various inputs. The automation features duplicate and could take the place of nearly every pilot task, including takeoffs, maintaining flight, and landing. Allerton (1996) reviewed avionics developments from the past seventy years and concentrated on the impact of computer technology during the last ten years. He expects aircraft to be more reliable due to technology. Technology provides more information to the automated aircraft flying

system through sensors than a human pilot could. While various forms of automation have been in place since 1962, recently most commercial aircraft come equipped with elaborate technology (Allerton, 1996). Rapid development of solid-state electronics led to the production of powerful microprocessors. This remarkable technological leap resulted in innovations in cockpit automation with the most visible part being the cathode ray tube (CRT). Electronic flight instrument system (EFIS) present traditional displays electronically with one CRT, also known as the primary flight display (PFD). This modern and clean appearance in contrast to endless rows of gauges has given rise to the common term *glass cockpit* (Wise et al., 1993). These advances in technology are feeding more information to pilots, which can enhance their ability to fly or at times be confusing or distracting from the overall mission.

Automation is replacing human (crew) functioning with machine functioning (Wiener, 1989b). The technology exists to have machines completely fly the aircraft. Researchers continue to debate whether or not machines will replace humans on the flight deck. Some researchers believe increased automation allows pilots to fly more efficiently and not waste resources. Many engineers hope automation will be the wave of the future and an absolute solution to human errors. "Do not herald automation as the savior of the aviation industry" warn some researchers (Nader and Smith, 1994). Machines might generate other mistakes than human make, which can be equally fatal. Yet, automation is no longer optional, since commercial aircraft are now heavily equipped with newer

technologies. Three factors alter the pilot's role from active participant to passive manager: 1) technology, 2) safety, and 3) economics (Wiener and Curry, 1980), and technology is a response to the other two factors. Some reasons for aviation automation development include: available technology, concerns for safety, economics of operations, workload reduction and the crew complement issue, more precise flight maneuvers and navigation, display flexibility, economy of cockpit space and special requirements of military missions (Wiener, 1988a). The technology and desire to decrease the business bottom line to create more profit plays a major role as well. In the field of aviation, automation naturally became the next step but researchers are beginning to take a closer look at the impact of automation.

### Research Support for Automation

Automation did bring about notable improvements in safety, reliability, and economy to the operator (Wiener, 1985). The use of automation will likely continue to grow because of it has superior reliability, improved performance, and reduced costs for the performance of many functions over the ability of the "stick and rudder" technology of earlier aircraft (Ensley, 1988). The accident rate for crew caused errors has been decreasing since the introduction of automation (Abbott and Rogers, 1993). Increased automation has been associated with increased communication (Bowers et al., 1993;

Veinott and Irwin, 1993). Yes, computers perform flawlessly, but if the pilots are not communicating effectively and clearly, confusion can increase. High performance teams tend to communicate with each other more while lower performance teams communicate less. Researchers clearly show that communication plays a major role in the pilot's interaction with automation but its not entirely clear how or to what extent.

### Negative Impacts of Automation

An increased trend toward large catastrophic failures often accompanies the incorporation of automation (Wickens, 1992). Technological failures, such as the 1986 NASA Space Shuttle explosion, forced a reexamination of technologies. To a significant degree, organized technology is trial and error approach. Failures, experienced or observed elsewhere, force disruptions so that organizational systems settle into new arrangements. Testing and experimentation are deliberate steps to promote such disruptions before catastrophic outcomes.

A critic of automation, Billings (1997) states "pilots either do not understand what the automation is doing or do not receive adequate feedback from the automated systems." In other words, pilot-machine communication is poor, since it is in competition with pilot-crew communication. Which receives greater priority and at what time? With the extensive use of automation in the flight deck, the pilot's relationship

with the aircraft has expanded from direct hands on control management to a more passive system monitoring (Petridis et al., 1995). Technology seems to have converted nearly every airline trip into a relatively simple operation. Arousal levels are becoming too low and even when flying half way round the globe, it is easy to forget that you are in an aircraft hurtling through space (Brooks, 1992). The technology of self-contained inertial guidance systems (not reliant on external radio signals) used in civil aircraft have reached a point of "extreme reliability," which may cause pilots to become overly dependent on technology (MacKenzie, 1996). There is concern that pilots will not have sufficient knowledge of complex system interactions to be able to respond to developing problems on the flight deck (As in Allerton, 1996). Operators should understand what the machine is doing and why in order to fly the aircraft (Adams, Tenny, and Pew, 1991).

### Aviation Automation Implications

Wiener (1985) states that pilots simply act as monitors of these flight systems. He also says that it takes people longer to recognize a problem and then take the time to correct it when the autopilot is in control of the aircraft. Examples of this include: the 1987 crash of a Northwest Airlines MD-80, an 1989 crash of a Boeing 737 at New York's LaGuardia Airport, and the 1983 Korean Airlines flight that was shot down over

the USSR. Aviation experts believe the Russian military shot down the Korean flight because the plane was flying on the incorrect coordinates and did not respond to the military's radio communication.

How safe are computers, specifically, computer automated aircraft? MacKenzie (1996) states that researchers need to collect more data on levels of exposure to potentially hazardous situations that may have resulted in death or injury due to problems which arise from human interaction with an automated system. Example of an A320 which crashed into mountainous terrain where "an analysis of the cockpit voice recorder suggests that 'there was limited verbal communication, coordination, and cross checking between the two pilots'" (As in Wiener, Kanki, and Helmreich, 1993). Increased automation has been associated with increased communication (Veinott and Irwin, 1993). Communication appears to play a huge role in the pilot's interaction with automation. Aviation experts should examine the concepts of communication very closely. Research is needed in the areas of human-to-machine communication, person-to-person among peers, and person-to-person communication from worker to supervisor to management (Senders and Moray, 1991).

## CHAPTER TWO:

### APPROACHES TO UNDERSTANDING COMMUNICATION

Both aviation safety precautions and failures involve a complex interaction between people and machines. Some researchers describe the interactions (person-to-person and person-to-machine) as “communication.” Researchers use communication to explain safe operations (the crew had good communication) and mishaps (there was a communication breakdown). However, communication itself is not so cut and dry. What exactly defines communication? The definition depends upon the phenomena.

Communication scholars often separate communication into contexts: intrapersonal, interpersonal, small group, organizational, public, intercultural, mass communication and others (Devito, 1991). The Functions of Human Communication: A Theoretical Approach even includes a list of 126 different definitions of communication (Dance and Larson, 1976). Researchers may not view a single definition of communication as desirable because of the severe limitations placed on research possibilities. However, defining communication remains significant because research recommendations depend on a clear definition. Researchers should further explore communication complexities because it plays an integral role in aviation accidents. Understanding communication seems simple enough and researchers use the term commonly across disciplines.

However, no single definition addresses all aviation challenges and this acknowledgment circumscribe its complexity.

As mentioned previously, many researchers study communication without defining the term. If a researcher recommends remedies based on an inappropriate or no definition, what could happen? Researchers need to be aware of the full range of its possibilities. Sometimes scholars focus only on certain parts of the concept (for example, engineers tend to focus on the means and media of communication, and ignore purpose and evaluation). In some cases, the methodology inclines people towards a conception of communication that has little going for it but convenience, habit, or tradition. This particular approach only serves to protect the status quo methodology. What good will this do? No one single definition holistically encompasses every aspect of communication, even within the field of communication itself. So, what possibilities exist for defining and understanding communication?

Fisher's (1978) four communication paradigms show many possibilities for understanding commercial pilot communication and alternatives in ways not been done before. The four paradigms are *mechanistic*, *psychological*, *interactionist*, and *pragmatic*. The mechanistic paradigm focuses on the transference of messages from point A to point B. The psychological paradigm extends the mechanistic perspective emphasizing the selective impact of stimuli on human perception. The interactional

perspective focuses on the roles humans play in each other's versions of reality, since an individual comes to know the world through interaction with others. The pragmatic perspective focuses on relationships and patterns of interaction, holding that communication and behavior as virtually synonymous (Fisher, 1978). By addressing each separate paradigm, we can assess how assumptions about communication have implications for improvement of communication on the flight deck. Researchers can expand their definitions of communication thereby deepening their understanding of flight deck dynamics. Human factor engineers must consider how they have chosen to conceptualize communication in order to determine human errors. Can better communication solve aviation safety challenges? What would "improving" communication mean and how would we go about doing it? Fisher's four separate approaches expand the possibilities to answer these questions.

### ***Mechanistic Perspective***

Human communication's mechanistic perspective focuses on the physical transmission and reception of messages (Fisher, 1978). Senders, receivers, and the channels through which information passes comprise the basic components. Fisher metaphorically describes the mechanistic perspective as a conveyor belt. Senders create

messages, sending the messages along a channel (conveyor belt) where the receiver awaits the delivery. Several theories fall within the framework of this concept: mathematical, information, and transmission theories. The accurate transfer of information remains paramount through each perspective.

The mechanistic perspective defines communication as “the process or act of transmitting a message from a sender to a receiver, through a channel and with the interference of noise; the actual message sent and received; the study of the processes involved in the sending and receiving of messages” (Devito, 1985). And Littlejohn (1989) defines it as the “the transmission and reception of messages.” The mechanistic perspective outlines the importance of message encoding, the presence of noise, a channel’s capacity, and how accurately sources transmit messages. Optimal transmission of signals depends on the probability of receiving the information accurately. The mathematical model aims to reduce uncertainty about which signals have been sent by identifying patterns that compensate for predictable errors of transmission (entropy). Entropy is the degree of uncertainty that results from randomness in a message (Heath and Bryant, 1992). Noise in the channel, like static on a telephone line, causes high entropy that makes a message more difficult to decode. Senders rely on some type of previously established pattern to decode and understand messages. However, the mechanistic perspective examples focus on message transmission with little or no concern for the meaning of the message although great potential exists in the meaning of

the message. This potential allows for a deeper understanding of why humans communicate and what they try to accomplish by using communication. It allows humans to select information and to actually “do” something with it, perhaps problem solve.

Studies of human factors in aviation assume that the transfer of information is purely about getting the most accurate information from a source to a receiver. The technology (predominately radio) is the channel, which the messages (containing information) pass through. Kanki and Palmer, in Crew Resource Management, point out that communication is clearly a means by which crews accomplish tasks. Anything that interferes with the accurate transfer of the message can be a detriment whether it is the source (humans) or the technology (radios). However, this perspective focuses on how the message is sent and received.

People commonly refer to information as knowledge or content acquired in any manner: data, facts, etc. As Ritchie (1991) points out, “information” is a concept appropriated from electronic engineering. Surprisingly, the “information” in information theory has nothing to do with content, facts, or news. In the mathematical/information theory of communication, the term refers to the predictability of the word or signals (its physical form), not its meaning as a message. Information should *not* be confused with meaning. Information is measured in binary digits (commonly abbreviated as *bits*). A bit is the basic binary opposition that is expressible as 0/1. Messages are formed by binary

choices from the code set, and so they have patterns (as do the code sets from which they are formed). Ritchie (1991) defines coding as “a set of rules for mapping one code set to another.” An example of this theory in practice is Morse code. A sender generates the message then encodes it into a device which sends it across a wire (the channel) to a person on the other end (the receiver). The Morse code consists of taps and pauses arranged in a pattern for decoding. The process of decoding patterns is usually straightforward unless some type of interference is present. A television set provides an excellent example of the mechanistic perspective. The television receives signals forming a picture from the picture elements (or pixels) which are thousands of tiny dots that make up the image produced by a television set. The goal is an accurate message on the receiving end; if noise or entropy is present, the viewer sees snow (interference) on the screen. Information theory, however, has nothing to say about the content or meaning of the image formed by the pixels, only an explanation of accurate transmission. In other words, this theory does not explain what television program someone may want to watch or what the program means to them. The mechanistic perspective wants to know if the picture seen on the television screen accurately depicts the picture sent from the studio. Unlike a perfect replication or facsimile, our intuitive idea of communication usually involves meaning and context.

Communication's mechanistic perspective provides researchers a way to talk about communication and an understanding of communication phenomena. Human factor engineers usually include the mechanistic perspective's basic framework: source, message, and receivers. The information transfer perspective may appeal to engineers and scientists because it involves discrete mechanical, sequential steps to accomplish communication. The pilots and air traffic controllers become sources and receivers of messages through radio signals (channel), and perhaps clear patterns and steps exist to reduce the probability of an accident. If human factors engineering studies rely on the information transfer model, what strengths and weaknesses does it have and what might those reveal?

In aviation, Billings and Cheaney (1981) state that human attributes and system factors contribute to information transfer deficiencies. Good communication would be messages that are clearly constructed, transferred, and understood by the intended receiver. Cushing (1994) points out in his book Fatal Words, examples of challenges and he describes them in terms of the information transfer perspective. Aviation talk has morphed into nearly its own dialect. Often, common uses of terms have a very different meaning within the context of the flying environment. This is common in many fields but aviation's stakes can be much higher. Miscommunication takes place quite frequently in human communication; in aviation, the challenges are no different.

Cushing also claims that *code switching* or various uses of a particular word contribute to some accidents. “Hold” in a landing situation means to stop what you are doing and go around. In everyday conversation, “hold” can mean continue what you are doing. This slipping or moving between meanings or common uses can cause serious implications for an aircraft that is seeking to land on a busy runway so fixing the coding scheme would solve this problem. Human behavior is highly subjective and is not so easily squeezed into a mathematical model. “Codes in human communication are not on-off buttons and are difficult to fit into a mathematical paradigm” (Littlejohn, 1989). Humans’ ability to contribute and shape their own social contexts is very important to understanding how the communities are created and maintained through language.

Radio technology plays a large part in aviation communication and this method introduces certain communication problems. Sometimes the radio transmissions do not work or the person using the technology is using it improperly (or not to the best of its design features). For example, pilots sometimes push the button to talk too slowly and the air traffic controllers cannot hear the first part of a word or two. This sort of challenge leads to repetitions of the same message throughout the highly crucial times of flight, takeoff, and landing. Therefore, technology renders verbal communication vulnerable during crucial times of flight. Sometimes, the technology garbles messages (due to static), senders send the messages but no one receives the message, and senders do not send expected messages. In addition, according to Nader and Smith (1994) “much

of the current equipment on-line in air traffic control facilities is increasingly subject to breakdown and malfunction.” So there are some serious concerns about safety that involve communication technology. The element that also deserves attention is the human interaction with the technology.

In the mechanistic perspective, the communication process itself acts much like the workings of a machine. Once the dialogue begins, messages are lobbed back and forth; the perspective does not ask, “what does the ball mean?” but only “was it caught?” The encoding and decoding serve only to enable the message to move along through the channel. The entire process hinges on the transmission. A “breakdown” occurs when the receivers receive garbled, partial, incorrect, or no message. In a dialogue exchange, people make small corrections and adjustments to achieve getting the message to where it needs to go with some degree of predictability. According to the mechanistic model, of communication problems only occur when the transfer of messages is inaccurate or incomplete. Therefore, if the receiver does not receive the sender’s message, the communication failed. Could the current technology simply replace the “weak link?” Is the assessment of pilot error an accurate assumption? What would that help? Some researchers propose that perhaps fewer aviation crashes would occur because they assume the technology will address all the challenges. For example the ground warning system now installed dramatically decreased the controlled flights into terrain but what other challenges arose? The ground warning system is another part added to the system

that could potentially break down or distract the pilot from monitoring the entire system.

With such a large percentage of aviation accidents attributed to human factors,

miscommunication and misunderstandings seem to be prime culprits. Even if people are

the weak link, they are always going to be a part of the system. The mechanistic

perspective provides a baseline to begin dialogue about communication and how it

transpires which is highly important to begin understanding how communication occurs

and what elements researchers may chose to single out for further study.

While many scholars presume the mechanistic perspective is obvious and true, it limits the possibilities for explaining human communication. The mechanistic perspective oversimplifies the process of *human* communication. Human communication does not lend itself so easily to a machine perspective whether it is a telephone or computer system. The mechanistic perspective omits the significance of the human ability to create meaning and context via communication. Meaning is the *interpretation* of the information contained within a message (Heath and Bryant, 1992). In many cases, meaning is part of a communication problem that leads to an accident, and information theory cannot account for this. In one dramatic case, a plane headed for New York circled the area for over an hour and ran out of fuel. The pilot had requested priority handling and stated that they could only hold on for five more minutes. The ATC was probably preoccupied with the great volume of flights and the pilots never specially stated that the landing was an emergency (Nader and Smith, 1994). The pilots knew the

situation would be an emergency but stated it as a priority instead but added the “can only hang on for five more minutes” later. Therefore, meaning becomes very important in aviation.

### ***Psychological Perspective***

The psychological approach moves just one step beyond the mechanistic approach according to Fisher (1978). The psychological perspective provides additional terms to talk about communication but does not venture into the meaning behind the communication. Psychology has been described as the “black box” theory because direct observation of the brain functioning is nearly impossible so researchers observe external behaviors (Fisher, 1978). People’s filters shape their perception and meaning in the psychological perspective. Perception is the processing of sensory information from receptors or the process of knowing objects and objective events through the senses (Chaplin, 1985). Everyone selectively filter in and out information. Perception at its best is an approximation to reality and, at worst, an outright illusion (Viney, 1993). However, what does this have to do with communication? First, pilots could overload on stimuli during crucial times of a flight with disastrous result. People create and modify their perceptions using communication. Pilots do not respond to the fuel being low-they respond to their perception that the fuel is low.

The psychological perspective recognizes those different responses to different stimuli results in a variety of personalities. Personality predicts what a person will do in a given situation. How individuals responds to their environment has been studied by many scholars: Alfred Alder, Gordon Allport, Viktor Frankl, Sigmund Freud, Carl Gustav Jung, Kurt Lewin, Abraham Maslow, and others. Recent studies focus more on the humanistic and complex nature of people rather than only seeing humans as reacting to “shock treatment” or the stimuli in their environment. The psychological approach to communication provides researchers with “tools” to begin talking about how communication occurs. The behaviors exhibited by pilots can have a tremendous impact upon a flight. For example, drinking alcohol impairs a person’s judgement or decision-making skills, and the poor decision making can cause harm to themselves or others. The same applies to pilots; the choices they make affect the flight.

The discipline of Human Factors has roots in cognitive psychology. As discussed earlier, human factors seeks to optimize the relationship between workers and their environment. This can range from selection of ergonomic factors (such as the placement of visual displays) to personnel selection (Salvendy, 1987). Human factor engineers trying to understand how humans operate in order to create a safer flying record rely upon attention, memory, sensation, and perception. What is the psychological profile of an outstanding commercial pilot? Is it not in the best interest of the public who fly, that airline companies want to hire only the “best and brightest?” Is there an assumption that

the “best and brightest” will not be prone to attitude problems or not want to work well with the team? What kinds of people fly airplanes? Are they risk-takers? Do the airline companies value risk takers or someone to baby sit the controls for a few hours? Airline companies need to know if the pilots hired are going to do their job when it is required of them. Psychological studies are responsible for attempting to measure the successfulness that one who need to fit into high or low stress environments, what does it take? Specifically what personality traits contribute to a pilot’s success? Ability to operate under pressure? To speak up at crucial moments?

The link between personality and performance of flight crews has been studied by many (Chidster, 1990; Chidster et al., 1990; Gregorich, Helmreich, Wilhelm, and Chidster, 1989; Helmreich, Foushee, Benson and Russini, 1986; Helmreich and Wilhelm, 1989). Some research shows a strong correlation between “bad” communications (frustration, anger, uncertainty, and embarrassment) and pilot error (Chidster, Kanki, Foushee, Dickinson, and Bowles, 1990; Kanki, Palmer, and Vernott, 1991). Knowledge deficiencies and attitude problems are the primary source of less than optimal pilot performance (Besco, 1992). These obvious signs affect the safety of all flight personnel and passengers with a pilot who shows theses types of behaviors. Another outcome from this behavior might impact a pilot’s decision making processes especially in a stressful situation where they need to pay close attention to a variety of things going on with and within the aircraft.

Communication and decision making do not occur in a vacuum, so we must briefly address the implications and influence of situation awareness. Situation awareness is the "detection of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status in the near future" (Endley, 1988). Situation awareness involves interpreting situational cues to recognize that a problem exists, which may require a decision or action. Recognizing cues and clues occurs through a decision-making process. Decision-making is the process of choosing a preferred option or course of action from among a set of alternatives. Decision-making permeates all aspects of life. Decisions often involve uncertainty about the external world (e.g., What will the weather be like?), as well as conflict regarding one's own preferences (should I opt for a higher salary or for vacation time?). The decision-making process often begins at the information gathering stage. Then proceeds through likelihood estimation and deliberation before reaching the final act of choosing. Pilot's attention to detail and readiness to make decisions during a flight can have far reaching consequences. Therefore, human factor engineers look to weed out any variables (negative personalities or poor decision making skills) that would negatively affect the aircraft operations. Personality, situation awareness, decision making are just some of the variables that have been studied in order to improve the safety of flying commercially.

Selecting “optimal performers” from a testing situation may not actually reproduce those optimal results in the field. Little or no part of the psychological perspective accounts for the pilot’s interaction with others. In earlier years airline companies expected pilots who would exhibit autocratic leadership styles. Airlines today expect pilots to exhibit a skill set that involves seeking input from other crewmembers before rendering important decisions. While that situation is ideal on paper, the captain is still ultimately in charge or responsible for what happens on the flight. If only one person is held responsible for the decision making process, people who might be outstanding consensus takers/maker may not, in the aviation company’s standards, have what it takes to command a flight operation.

We can see how many mishaps occur in communication when we focus on the receiver. By attempting to understand the impact of messages upon the receiver or how the receiver interprets messages researchers can propose techniques to assist pilots with situation awareness and decision-making. An excellent example is the story of a flight instructor working diligently to have the student pilots remember the thirteen steps of what to do in an extreme emergency. One brave student spoke up and asked, “How do you expect me to remember this information when I’m afraid?” Most people will experience a lag in situational awareness under stressful situations. Perception errors (situation awareness) and errors in communication (from people and things) are built into systems. The technology commonly used in aviation today screening for possible

candidates for the stressfulness of flying the big jets may influence the airline carrier's safety record and eventually their bottom line.

This perspective also limits addressing the roles and the impact that culture plays in creating our relationships with others. These forces also affect decision-making. In addition, it does not address the integration into a particular culture which impacts how humans choose to express themselves from moment to moment or even conduct business. Some psychological researchers treat people as if they were black boxes; others have no idea what someone else thinks. Psychology is not reducible to physical, physics, or any other point of view that does not reveal structure of meanings existing in the lives of humans (Harre and Gillett, 1994). Therefore the psychological perspective is an excellent stepping stone for explaining some components in why humans may make the decisions they do. However to move closer to understanding more about communication and the incredible number of variables, the social environment requires a closer look.

### ***Symbolic Interactionism Perspective***

Symbolic interactionism perspective represents social psychological approach and crosses boundaries into the field communication. The symbolic interactionist perspective seeks to explain individual human behavior through societal interactions. Humans create

meaning as they come to share and use the same significant symbols guided by the rules and norms of the culture. Significant symbols evoke the same meaning for many people.

Sociology can be defined as “the scientific study of human society and social behavior” (Robertson, 1987). Sociologists typically study society as a whole.

Sociological research generally does not focus on an individual’s actions but views the individual as a product of society. Many sociological studies address the societal roles people play in such constructs as marriage and families. The symbolic interactionist perspective embodies the sociological view of the influence of society upon individuals, unlike the psychological perspective, which focuses solely on the individual.

Psychologist’s research strives to explain the behaviors and motives that define individual behavior. Symbolic interactionist research explains psychological concepts about social cognition. For example, self-concept emerges through an internal version of an external dialogue (thinking). Thinking allows humans to converse with themselves and acts as the spark for use of language so that they may interact with others. Through interacting with others, humans they come to know themselves and develop a sense of self. The self develops through socialization. It provides the basis for operating in society. Each individual is continually involved in a succession of interactions with others, which shape the mind and self and affect society.

Humans come to know themselves through language and interaction with others. These types of interactions shape personal identity and sense of self. They serve as the

basis of human interaction, which creates a social reality. The social reality guides the roles we play. Role taking from the symbolic interactionist perspective is a process whereby an individual identifies them in another person's position. Roles serve a purpose of letting people understand that they are doing. Researchers derive meaning from people's behaviors while playing a particular role or symbolic symbol like status (police uniform or physician's white lab coat). There can be the same action but the meaning can be different. If someone is directing traffic without wearing a uniform in the middle of a busy city road most likely, people will respond by ignoring, disregarding, or even saying something rude to that person. However, if that person is wearing a police uniform they would most likely respond differently if that person is really a law enforcement officer or not. What is salient is that people's behavior stems from their perception of symbols. Humans don't just react to stimuli as in the psychological perspective but to the symbols by which they understand the stimuli, and by making decisions based on their own rules and experiences within society.

Mead (1934) said that humans come to know themselves through their interaction with others and through their interaction with others adopt certain roles. "There can be neither mind nor self without society" (Mead, 1934). Role, rule, power, socialization, group membership, conformity, motivation, prejudice, and perceptions are important concepts for understanding the symbolic interactionism perspective. Roles are "socially defined positions and patterns of behavior which are characterized by specific sets of

rules, norms, and expectations which serve to orientates and regulates the interaction, conduct and practices of individuals in social situations. Societal expectations dictate the relationships between man and women, parents and children, managers and subordinates. When it comes to role expectations in society, we begin to see that there are differences between what is expected from a female versus a male, siblings versus non-siblings, older to younger, and the list continues. Traditionally, women in this society take on a nurturing/caring role despite their age or status. Generally, men as a group benefit from this female role expectation. For example, society expects siblings to help other siblings in time of need. Usually the older has more resources in order to assist the younger member regardless of gender. These examples show the nature of social action and human interaction is inherently strategic. Rules are the means by which all social and cultural relations along with non-verbal communication, language and code are in varying degrees constituted, guided, and regulated (O'Sullivan, 1994). Humans project themselves into what they experience so humans take an active role in creating knowledge and the world around them (Littlejohn, 1989). Knowledge does not arise from discovery but from the interaction between knower and known.

Human factor engineers have spent a great deal of effort looking at ways to decrease the troubles with human error that plague the field of aviation. The technology exists that could replace the pilot (Boeing, 1998). Some engineers assume that the new technology removes all the problems the human operators create. The technology exists

for flight sans the pilot but that brings about its own unique challenges. Most importantly though, is the flying public ready to trust their lives with the automation that would take off, fly, and land the aircraft? Probably not at this time. So, other avenues must be explored, one of the major field of study has been crew resource management or CRM (previously discussed in chapter two). The goal of CRM is to use all available resources to “achieve safe and efficient flight operations” (NTSB). Some CRM principles focus on creating and maintaining teams that exhibit predictable positive behavior. Establishing predictable behavior occurs through standard operating procedures (SOP) and communication of role expectations.

Roles are the pattern of expectations based on the characteristics of a certain position. Role taking in the symbolic interactionism perspective gives people the ability to symbolically place oneself in another person (real or imagined). CRM researchers recognize the tangible and symbolic (=meaningful) elements that help to define roles. The tangible element for aircraft pilots is the physical space of the flight deck. For example, the Boeing 727 contains seats for three flight deck crewmembers. The symbols are the roles that people play. Roles according to CRM researchers can be defined as “a set of expected behaviors associated with a particular position (not a person) in a group or team” (Ginnett, 1993). Aviation crews have clear cut roles and boundaries. Federal Aviation Regulation 91.3 outlines that the captain is the leader and ultimately responsible for the operation of the aircraft. The first and then second officer follows the captain.

The next person would be the senior flight attendant. These expectations, if violated or ambiguous, can have some undesired results. One example is the "10,000 rule." This rule states that the flight attendants will not communicate with the flight crew below 10,000 feet unless it is an emergency. Role deviations could have serious implications for changing how and when crewmembers fly together. Some researchers have stated that crews that had recently flown together had higher levels of performance (Hark, Krems and Severin, 1995; Orasanu 1990). Other studies compared high-performing crews vs. low-performing crews with the variable of a list of problem solving talk and the high-performing crews had less challenges (Foushee, et al., 1986; Chidster, 1990). Another study defined the difference between high vs. low performing crews by the amount of pre-planning that occurred because it lead to less problems during the flight.

The symbolic interactionist perspective rests on an assumption that we perceive our worlds differently depending upon the significant others humans could be interacting with at any particular time. However, the perspective does not address the emotional or cultural reactions to symbols. The extremely broad approach does not explain specially how the individual is shaped. Yet, it does provide a great deal of information about an individual, probably more information than is needed for routine communicative acts. While these seem to be routine criticisms, the implications could have an impact upon using it to study pilot communication in highly stressful situations.

### ***Pragmatic Perspective***

Communication, especially language, is probably the most important instrument of socialization that exists in all-human culture. Humans use communication predominately to pass along and continue their beliefs, laws, and customs from one generation to the next. Children come to know and use language to understand the structure of the society into which they are born and their own place in that society. As a social force, communication promotes the bond between the members of the same group but it also differentiates the group members from others. In every situation, what one says and how one says it depends upon the nature of that situation, the social role being played at the time, the status of the person or persons involved, attitudes, and so on. Fisher (1978) compares the pragmatic perspective to ballroom dancing because people learn some basic steps to follow, have different partners, and each dance is something new between the participants. The combination of nonverbal behavior and language work together to reinforce the various roles and relationships important in a particular culture. Pearce (1989) described communication as odorless, colorless, tasteless vehicle of thought and expression. Communication transcends being the glue that holds society together; it is what makes us who we are within the social context.

The pragmatic perspective of communication concentrates on the behavior of the communicator which is the essential component of human communication (Fisher, 1978).

The pragmatic perspective operates like a metatheory which basic components comprise a number of theories. Pragmatics derives from a distinction from three dimensions of language: semantic, syntactic, and pragmatics (Morris, 1938). Semantics explains how meanings are expressed in language; for example the word “cool” because “cool” has different meanings to different people. Syntax categorizes words into sentences by rules and patterns. For example, when native English speakers learn to speak Spanish (after developing an elementary grasp of common words) the next challenge is to begin to string words together as sentences. The sentence structures in Spanish are different from English structures so the native English speakers must grasp a new syntax. Pragmatics is “the study of the interpretation of utterances and more specifically how the context of situation influences their meaning” (O’Sullivan et al., 1994). Pragmatics studies how symbols relate to people or symbol to user relationships (Morris, 1938). The purpose of the pragmatic perspective is to “explain how language users actually make sense of each other’s utterances in the face of the various kinds of indeterminacy and ambiguity...” (O’Sullivan, 1994). These definitions show how important the context is to the pragmatic perspective. If someone states “I’d like to see you,” it could mean a variety of different things depending upon who issued the statement and who the intended receivers may have been. If it came from a supervisor to a subordinate, it could mean the subordinate did something wrong. If it came from an admirer, then it would mean

something entirely. The participants create meaning by their interaction and it depends upon the context of the situation.

The pragmatic perspective focuses on a system perspective so there must be a minimum of two people involved. The perspective has been used in a number of research venues. In studies that involved analyzing the communication between native and nonnative speakers, expectations that go along with the culture one is reared within, and that has an impact upon the way we choose to speak and human's external behaviors.

Some awkward situations surfaced when researchers expected Japanese speakers (communicating in English) to use face threatening speech acts, refusals, chastisement, disagreement, and embarrassing announcements. The Japanese speakers would not have used these tactics in their own culture (Coupland, 1991). This perspective is interested in describing the rich context in which humans operate and stresses individual subjective response. Individuals are important to study because it goes beyond the symbolic interactionism perspective in explaining human behavior. Researchers can begin to explain why situations may turn out the way they do by looking at the holistic picture and taking into account all that goes in to trying to "simply" intentionally communicate with another human being.

From the pragmatic standpoint, the locus is on *behavior* as the fundamental component of human communication. The sequences and patterns in communication dictate the pace of the "ballroom dancing." Therefore, "communication and behavior are

virtually synonymous.” There is interdependence among the participants or there would be no relationship at all. Two people just passing each other on the street do not fall into in this category of communication. People depend on the patterns in language to understand one another. If moved about, it could create misunderstandings though. What if a writer decided to use no punctuation in a novel? This shows how by taking the rules and applying them differently, the author is actually trying to communicate something. The patterns can be intentional. Fisher (1978) states that relationships are much like contexts in the pragmatic perspective because both are subject to the “same interpretations of patterning, punctuation, and sequencing.” Each of the influences how the relationship is created and maintained. Two important pragmatic theories are the Coordinated Management of Meaning and Conversation analysis. Looking at these theories in detail provides a deeper understanding of how communication and reality transpire.

### Coordinated Management of Meaning

The Coordinated Management of Meaning (CMM) theory explains how humans use language to coordinate meaning and to construct reality. Primarily, CMM focuses on the content (semantic) and the contextual (pragmatic) nature of communication. The content is the actual dialogue or conversation and the context is the social information

embedded in the message to understand the content (Branham and Pearce, 1985). CMM represents the pragmatic perspective because the theory focuses on the parts of communication that goes beyond semantics. Humans co-create reality by interacting with one another; objective reality may or may be important to a given interaction. The pragmatic perspective shows that people use communication to elicit some sort of response from others. The action is interpreted and defined within a contextual which can lead to confusion at times or uncoordinated communication events. A controversial issue that illustrates this perspective is the Egypt Air Flight 990 crash. Egypt Air Flight 990, a scheduled international flight from New York to Cairo, crashed in the Atlantic Ocean about 60 miles south of Nantucket Island, Massachusetts on October 31, 1999 killing all 217 passengers and crew on the aircraft. As the NTSB and FAA seek answers to what may have caused this tragedy, one of the main places to seek answers are the black boxes (the flight data recorder and cockpit voice recorders). The cockpit voice recorder was recovered from the wreck and was translated by an international team of specialists. The translated transcripts released stated that the co-pilot was recorded uttering the words "Tawakilt ala Allah" or the translated version "May God help us" repeatedly. There was speculation as to other words that might have been uttered or even the interpretations of those words, which lead Jim Hall, the Chairman of the NTSB to seek additional assistance. He asked Egypt Air to supply someone who knew the pilots to review the tape, not just to translate the Arabic but to *interpret* the nuances of tone,

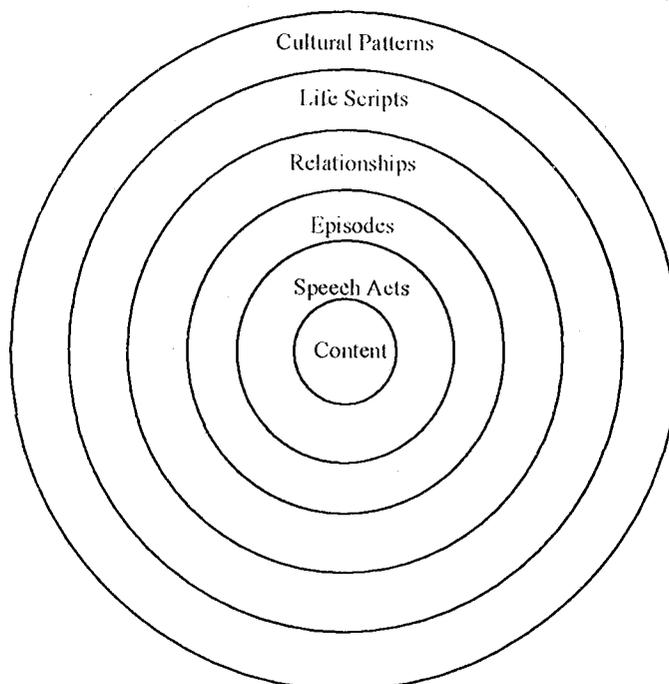
timbre and tension in the crew's voices. The words themselves are purely content, but in order to understand the terrible events that took place lead up to the crash, investigators needed to examine the contextual nature of the comments. The investigation is ongoing but it does illustrate the importance of seeking answers beyond the simple delivery of words.

CMM shows that communication is so much more than a vehicle for transferring messages; it explains how humans use communication to create a social reality (West and Turner, 2000). This theory rejects the psychological notions that communication is merely a way for people to express their inner attitudes, purposes, or feelings (Neuliep, 1996). In order to move beyond the mechanistic, psychological, and symbolic interactionism perspectives of communication, CMM's pragmatic approach stresses the importance of the communication process in creating and maintaining relationships. To accomplish this objective, CMM theorists focus on two people engaging in conversation. Pearce and Cronen (1980) illustrated the overall concepts by stating that life is an undirected play; there is no script, humans learn as they go along. According to CMM, people tend to produce order out of chaos. People lean towards organizing things hierarchically. People create their own meanings based on their own experiences so their interpretations differ widely from one another (Cronen, Pearce, and Harris, 1982). In analyzing exactly how people achieve this organization, CMM shows how

communication transpires on several levels. The hierarchy of meaning describes six levels of organized meaning: content, speech acts, episodes, relationships, life scripts, and cultural patterns.

Content is the most basic step or in the schema in the hierarchy of meaning.

People take in raw data at this point and begin to organize it in some manner that would make sense to them. This is the lowest level in the coordinated management of meaning system. Take the phrase "Oh, you are a bright one." These are six simple words from the English language. The dictionary meaning of each word is understandable, but that does not clarify what the person means by the words. If these words are spoken within a conversation, there is an assumption that they do have meaning, but that comes from moving up in the hierarchy of meaning system to find out more.



The next level is the speech act. Speech acts are the things that people do to one another because it signifies how humans use information. Often, speech is action. People seek action by: pleading, insulting, asserting, praising, joking, threatening, complimenting, questioning, demanding, and the list continues. If a grandfather says to his granddaughter "Oh, you are a bright one," he may be praising her for something she has done well. The speech act acts praise in this particular case. The exact same phrase used between friends as they tell one another jokes especially if one is a bit slow in understanding the punch line. However, in a social situation, where relative strangers are conversing the comment "Oh, you are a bright one" might have a myriad of explanations. These interpretations are not always clear. Looking at the next level should provide more clues as to how to act upon the particular information.

Reoccurring interactional routines represent episodes. Episodes are like templates or cookie cutters, the data entered (the dough) may change, but it takes familiar shapes. These communicative collections have a clear beginning, middle, and end. A set routine marks the episodes. Episodes act as frames, dividing what part of the conversation is included or excluded from a conversation. Examples are friendly banter between friends, greetings that co-workers exchange, or meetings that take place in an organization. In the field of aviation, checklists are episodes. The content and speech acts are predictable in these interactions. Episodes are dependent on collaboration. The captain usually reads

the items from the checklist aloud while the less senior officer check the gauges and responds with very precise information. The junior officers repeat back an altitude or just to say: "check," "yes," "okay," or "k." Examples of various violations of the episode rules by the junior officer would be to: begin by telling a story, ignoring the captain, or unexpectedly stating "Oh, you are a bright one." The coordination failures amount to a breakdown of communication.

The next level is relationships. People set the guidelines and boundaries for their relationships. Implicit agreements takes place between people that establish the boundaries of the relationship. The word relationship seems formal but it is more about the boundaries of the interactions. The relationship can be on many different levels, ranging from informal to formal. This is a flexible dynamic because people define their relationship together. Western culture (with some exceptions) recognizes the relationship of marriage as a bond between two people. How those two people chose to define their relationship is up to them. They might decide to maintain separate house holds, see each other only on the weekends because they work in separate cities or take a more traditional approach of living together and interacting nearly everyday of their lives etc. Shailor (1994) defines relationships as including certain rights, exclusions, freedoms, and responsibilities. A spouse or significant other may have certain demands to time or joking around that others may not such as co-workers or neighbors. The phrase "Oh, you

are a bright one” could possibly be a personal joke between people in a friendship. If someone outside of that friendship overheard the phrase and attempted to use it within a separate encounter, it might be met with hostility or some other negative response. This would occur because the communication was not appropriate within the confines of that particular relationship. This level allows for widen the perspective on communicative frames so we have a better understanding of what transpired.

Life scripts represent the collection of experiences that shape a person. This makes up the person’s self-concept and determines how someone may act in a given situation. This prediction forms from the clusters of patterns of episodes that a person experiences. However, being in a relationship can alter it with someone who has an influence upon a person’s life. More than a year ago, I worked for a vocational school that taught computer skills and professional behavior. Many of the students who came to the school had incredibly low self-esteem. Throughout their lives, certain family members, teachers, and supervisors had interacted with them in such a way that they personally felt worthless. Their life scripts were marked with not finishing high school, job hopping, and moving from town to town to stay with a variety of friends and family members. Often, the student’s communicative patterns would emerge as they often spoke about how stupid they were, how they could never type fast enough, or understand the concepts of word processing. Thus they did not have the usual responses to praise, since

it was not consistent with their life scripts. Researchers describe the life as a person's autobiography because this is how they choose to define their life. Culture heavily influences how people define their lives.

Cultural patterns are the experiences that help humans relate to a larger group. This level creates a clearer understanding of all the other levels. It contributes to understanding why something was said and the context that contributes to understanding the statement. Social groups play a large role in distinguishing and interpreting experiences. This is because social groups have particular group norms that help them maintain an identity and boundary lines of groups (Forsyth, 1990). Often Western society places a great emphasis on individualism (Samovar and Porter, 1995). Native English speakers use single person references regularly in conversation. This cultural pattern is different from that of many Eastern cultures. Eastern cultures place a larger value on the collectivism (Ferrante, 1995). There have been an increasing number of studies of cross-cultural communication. It becomes readily apparent in a global market just how important understanding the influence of culture when a multi-million dollar business agreement does not materialize because of an uncoordinated management of meaning.

CMM was first used to explain interpersonal communication through looking at dialogue to understand how humans relate within their given societies. CMM now offers

an expansive view of human action. Human communication leans more towards awkwardness than elegance. It is amazing that communication even takes place sometimes given the complicated nature of coordinating content, speech acts, episodes, relationships, life scripts, and cultural patterns. The coordination takes a great deal of effort but this theory shows how people coordinate their activities by managing the ways their messages have meaning to reach their goals (Heath and Bryant, 1992). This theory contributes to the pragmatic perspective by explaining the use of language in communication. Researchers use CMM, a relatively new theory, in a number of ways. Recently CMM has been used to explain uncoordinated communication between spouses in dispute mediation (Shailor, 1994) and lack of coordination of communication between people of different cultures (Cronen, Chen, and Pearce, 1988). The application of this theory is moving beyond just interpersonal to intercultural, therapeutic, and even organizational (Woods, 1997).

### Conversation Analysis

Conversation analysis is the study of recorded, naturally occurring talk-in-interaction (Hutchby and Wooffitt, 1998). Researchers examine recorded conversations looking for details of patterned regularities in conversational behavior. Researchers note

the patterned regularities through turn taking and sequential pairs of comments. Conversation analysis focuses on the orderliness of turn taking and the signals of such patterns in conversation because it manages the structure. Conversation analysis searches for interactional organization of social activities (Hutchby and Wooffitt, 1998). The structure of the conversation provides clues to the relationship and the social activities of the participants. Ethnomethodological studies from sociology influenced conversational analysis, as well as linguistics and social psychology. However, conversation analysis is a large departure from most linguistically studies because it is only marginally interested in language itself. Conversational analysis reflects the orderly properties of talk as oriented to the accomplishments of the participants and this takes place by looking at conversations. Why do people even listen to each other? They listen because they need to be able to respond to the other participant's comments. If they both spoke at once then they would have difficulty hearing the other person. Conversation analysis provides details of how the sequentially patterns of turn taking mark conversations.

One part of the local management system of conversation is turn taking. Turn taking is not a series of random acts. Each participant focuses on a goal and works through the conversation to achieve that goal or action. Synchronicity and regulated sequences characterize turn taking. The participants must attend the actions of the other so that they will be able to anticipate their response. The outcomes can be mutually beneficial for all participants but it depends on the participant's intrinsic motivation to

listen to one another and process the messages. People coordinate and synchronize their actions and conversation through the local management system. Rules guide the order of whom and when a participant speak, this is part of turn taking. The process of dialoging is something many take for granted, yet if we slowed it down into slow motion this is what we might find.

- Rule 1
- (a) If the current speaker has identified, or selected, a particular next speaker, then that speaker should take a turn at that place.
  - (b) If no such selection has been made, then any next speaker may (but not need to) self-select at that point. If self-selection occurs, then first speaker has the right to the turn.
  - (c) If no speaker has been selected, then alternatively the current speaker may, but need not, continue talking with another turn-constructional unit, unless another speaker has self-selected, in which case that speaker gains the right to the turn.
- Rule 2      Whichever option has operated, then rules 1 a-c comes into play again for the next transition-relevance place.

These rules are flexible. The word “rule” itself seems to imply lawfulness but Schegloff suggests that the word “practice” or “usage” might be more accurate. They describe the practices and orientation that participants use in actual turn taking scenarios. The pool of people talking to one another can vary (Sacks, Schegloff, and Jefferson, 1974, 1978).

However, native English speakers tends to follow this pattern: A talks, A stops talking, B talks, B stops talking, and then A talks then stops and then the pattern is repeated. The

length and content vary greatly but regulators serve to let someone else know when it is their turn to speak. Regulators serve to coordinate the flow of conversation with gestures and facial expressions (Ekman and Friesen, 1975). Gaze direction raised eyebrows, pointing gestures, and facing the other person serve as regulators in face to face conversation.

Ideally, one speaker should talk at a time and turns should be taken with little gap or overlap between them (Hutchby and Wooffitt, 1998). Realistically, conversations are much more fluid and dynamic with frequent gaps and overlaps. The overlaps initially seem to violate the rules of conversation analysis. There are varied meanings and effects of overlapping in conversations (Tannen, 1990). A listener may start talking to show mutual support or to change the topic of conversation. Jefferson (1986) states that people frequently overlap with each other in conversation, the overlap serves as a signal to transition to the next speaker. For instance, if a child could not seem to eat enough of Baskin-Robbins' ice cream and knew that when a certain aunt would visit the likelihood of going out for ice cream was high. When the aunt would visit before she was even able to finishing asking, "Would you girls..." a resounding "Yes" was heard from the little girl. On the other hand, if you are standing in the grocery store checkout line and do not know the cashier, you would probably wait to be prompted to answer the questions: "Cash, check, debit, or credit?" "Paper or plastic?" Often times, if people have been in a very close or a long-term relationship, the "ideal" is relaxed and there is greater gaps and

overlaps. Tannen (1990) states that style difference of the speakers relative to one another plays a part in the degree of overlap as well. Turn taking is very structured but there is flexibility within the framework. This flexibility and degree of overlap depends upon the relationship and interpretation of the participants. Units make up the actual turns that can be a sentence, clause, a single word, or even an utterance such as (“Uh,” “Hmmm” or “Oh”). Now that there is a basic overview of turn taking, the next area that is important is how do people appear to make conversations flow so smoothly.

“Repairs” are the corrections made in conversation. Communication contains many slips of the tongue, incorrect word selection, mispronunciations, mishearings, misunderstandings, and the list continues (it is amazing that we can even coordinate meaning at all sometimes). People achieve meaning by making communicative repairs quite often through a conversation. Schegloff, Jefferson, and Sacks (1977) describe four types of repairs: self-initiated self-repair, other-initiated self-repair, self-initiated other-repair, and other-initiated other-repair. “Self-initiated self-repair” refers to repairs both initiated and carried out by the speaker. An example of this occurs when someone mispronounces a name, recognizes they made a mistake, and then follows up with the correct pronunciation. Other-initiated self-repair refers to repairs made by the speaker but initiated by the listener. Same example as before but if the listener interjects with a quizzical look and says ‘huh?’ or ‘what?’ then the speaker makes the correction. Self-

initiated other-repair refers to the speaker who creates the trouble source, trying to get the other to help correct the problem.

An example of self- initiated other-repair could be an ongoing conversation between spouses at a party where one cannot remember the other guests names and the other spouse corrects and fills in the blanks for the spouse who cannot remember. Other-initiated other-repair refers to the speaker of the trouble source both initiating and correcting the repair. This occurs in conversations where the first speaker has made an error and the second speaker may or may not provide correcting information but the first speaker repairs the following utterance after the second speaker's comments. The actual pattern of conversation is synchronized though despite some of these challenges.

In conversations, there is often a structural preference for one of the *second pair parts* over others. Adjacency pairs define the preferences. Adjacency pairs serve as the fundamental functional unit of conversation, for which turn taking provides the framework of conversations. Turn taking and adjacency pairs work together; each adjacency pair incorporates two parts of a paired action sequence. The adjacency pairs must be: nearby each other, produced by different speakers, ordered as a first part and a second part, and classified so that a particular first part requires a particular second (or range of second parts). The first pair part (FPP) engages the listener in the conversation (Littlejohn, 1989). The second pair part (SPP) requires the listener to contribute. Some examples of adjacency pairs are summons+answer, question+answer, greeting+greeting,

offer+acceptance, apology+minimization, and invitation+acceptance or invitation+declinations. People achieve mutual understanding through talking. Two utterances, produced by different speakers do what a single utterance cannot do, show the levels of understanding (Schegloff and Sacks, 1973). Participants reach understanding by to the first utterance. The participant has a number of ways in which to respond to the message. If a co-worker states "How are you?" every time they pass their co-workers in the hall and one particular person rarely answers the question, people make inferences based on their behavior. The first one that comes to mind is that the cheery coworker is being snubbed. There are alternatives such as the person may be hard of hearing, heavily distracted by other thoughts, or perhaps they are grumpy and do not care for idle chitchat. The first pair part as a question stipulates that an answer be made. Usually people respond with an answer such as "Fine" and/or ask, "How are you?" So typically, a participant would offer the greeting "How are you?" to which the second participant would respond "Fine and how are you?" If they answered "One flew over the cuckoo's nest," we might wonder if there was a personal joke or a violation. In addition, a part of understanding adjacency pairs comes from presequences and insertions.

Presequences are adjacency pairs whose meanings depend on another pair that has not been uttered. They set up what is to come.

A: Are you hungry

B: Yeah, sort of...

A: Wanna go to lunch?

B: Sure.

The first adjacency pair has no relevance beyond a question+answer. It takes the second adjacency pair to put the comments in perspective. Insertions are embedded expansions within an adjacency pair. This means that they interrupt the original adjacency pair but provide more information. The following example shows the interruption:

A: Can I get a beer?

B: Are you twenty one?

A: No.

B: No.

Insertions happen quite frequently as the speakers sort out what is relevant to the particular conversational goals. There is the expectation that the answer will be forthcoming soon. Preference organization also shows patterns. Preference organization refers to the interpretation of a respondent. How the first pair part is delivered usually requires a preferred response (Schegloff, 1988). An example is invitations. People can decline or accept invitations but the default response is acceptance. "Will you marry me?" expects the preferred response of "Yes." The dispreferred response would be "No." If the person truly wanted a different answer then they could have phrased the first part in a different manner. If the answer to the question had been "Uh, well, okay, I guess so," that would most likely be a dispreferred response as well. The dispreferred responses is

something marked by the very short gap as the person attempts to respond or present a reason why they cannot do something. The premise of preference does not refer to the psychological motives of the individual, but to the structural designs of turns associated with particular activities. People usually deliver preferred answers right away and the dispreferred after a slight hesitancy or with a marker of “well.” The preference simply marks what is being said.

In conclusion, the pragmatic perspective addresses mistakes people make in the *use* of language not the language itself. An example would be: “he is a fine friend.” The pattern is understandable. However, what is the meaning of this sentence? Is it simply a genuine statement? Depending upon the context, it could be sarcasm. Even without emphasizing the words vocally, there could be alternative meanings assigned to this statement. Is the statement an attempt of faint praise? What does conversational analysis offer? It provides an opportunity to look closer at something most people take for granted; the ability to see the emerging patterns that contributes to each participant achieving communication. People create reality through these patterned interactions. Communication is far greater than the sum of its parts.

## Pragmatic Perspective and Human Factors

Currently there are no studies in human factors that incorporate the principles of the pragmatic perspective. The pragmatic perspective concentrates on the behavior of the communicator (not as an outcome) but implying communication and behavior are virtually synonymous, (Levinson 1983). By breaking, it into smaller pieces for analysis allows researchers to recognize the strengths of human communication and its incredible resilience combined with their decision-making skills may make humans a better choice to fly planes. Therefore, we must envision useful conceptual tools, which is pragmatics.

Where do we go from here?

All these communication perspectives can help us understand why studying pilot communication is important in a number of ways. All the perspectives focused on patterns or loci that address outcomes and the consequences of communication acts. Sigman (1995) states that “consequentiality leads to a consideration of the procedures, dynamics, and structures of communication, not the effects (the supposed end results).” To understand another is not a matter of looking inside them and considering other patterns of interaction in which they engage. Thus, individual uniqueness is a social creation, not the dualistic opposite of sociality. The meaning of behavior is always

subject to negotiation and revision. This is what we are attempting to bring to light with this study of pilot communication and their interaction with the aircraft automation.

However, more questions remain. The initial question centers on how U.S. commercial pilots manage multiple tasks in the face of the new advanced technology. By studying the effects of automation on the pilot's ability to communicate during situations where human error has been cited, will we learn anything significant by defining communication differently? What points might be inherent in the communication that would lead to a breakdown in the ability to accomplish the goal of safely flying and landing the aircraft? It is highly unlikely that pilots will be totally replaced by the machines and because this is true, human error cannot be ever entirely ruled out. How can human errors be reduced to potentially curb the loss of lives if all accidents are preventable? So from a communication standpoint, is that even possible? In order to focus on the information exchange, the attention to tasks, and how communication is used as a management tool, the transcripts of hull loss commercial aircraft will be scrutinized but first we must look at how this is accomplished.

## CHAPTER THREE:

# COMMUNICATION PERSPECTIVES AND APPLICATIONS

### *Overview*

The goal of this research seeks to describe and identify common threads that may lead to problems in human interaction and thus to performance errors. Vice President Al Gore and the FAA stand behind the *Safer Skies* program. The *Safer Skies* program seeks to identify the leading causes of aviation fatalities and incorporate preventative measures. Researchers diligently search for realistic ways to meet the *Safer Skies* objectives and many begin by looking closely at human errors. Human error contributes to many aviation accidents and those errors usually begin with single communication event. These communicative events deserve more attention in the research.

Some researchers speculate that as technology improves, the difficulty of the pilot's job increases because more components need attention. If the automation influences the types of human errors that occur then its impact should be more thoroughly examined. MacKenzie (1996) states that accidents caused by failures in the interaction between human beings and a computer system are typically 'messier' in research terms because the operators blame the machine and the systems designers blame the operators.

The NTSB states a growing concern that automation overloads the pilot and that this overload could lead to the loss of more human lives. None of the involved agencies wants to see more accidents becoming commonplace. Aviation experts must examine safety performance to assess what areas need attention. Researchers need to focus on the pilots as humans and adult learners. New training methods need to address the needs of all pilots. Not everyone wants or can be the “top gun” or the “James Bond of pilots” able to always bail themselves out of a terrible situation.

This chapter emphasizes and describes communicative events that involve human and computer interactions that lead up to shortly before the USAir Flight 427 crashed. The USAir Flight 427 transcript taken from the cockpit voice recorder (CVR) contains the last 30 minutes and 56 seconds of the flight. A mechanical failure led to the crash, but human error contributed. A great deal can be learned from taking a closer look at what transpired communicatively before the accident. Using the theoretical resources from chapter 2 to analyze portions of the USAir transcript, I want to show that new possibilities exist by going beyond the mechanistic paradigm. This research descriptively explores a USAir Flight 427 excerpt. Through the mechanistic, psychological, symbolic interactionist and pragmatic perspectives we will look for patterns of communication and seek to provide some explanations of the implications of these alternatives on current research.

## Background of USAir 427 transcript

USAir Flight 427, a Boeing 737-300, departed from Chicago-O'Hare International Airport heading for Pittsburgh International Airport and crashed near Aliquippa, Pennsylvania on September 8, 1994. The same flight crew performing duties flew together over the course of a three-day trip. The scheduled flight departed with 5 crewmembers (2 pilots and 3 flight attendants) and 127 passengers on board. All 132 people on board died when the airplane entered an uncontrolled descent and impacted terrain. Impact forces and fire destroyed the plane. The accident occurred on the third day of the trip and the captain and first officer never flew together before. The NTSB determined the probable cause to be the loss of control of the aircraft, because the rudder surface most likely deflected in the opposite direction commanded by the pilots. In turn, this may have caused the main rudder power controls unit servo valve to jam. The cockpit voice recorder showed that the captain acted as the pilot-not-flying (PNF) which includes performing the radio transmissions. The first officer executed the pilot-flying (PF) duties with the auto-flight system (AFS) engaged.

According to the NTSB Report, the crew did what they could under the circumstances to control the plane and are not to blame in this accident. Both the captain and first officer were experienced pilots with many hours of flying time. The NTSB Report stated that the flight crew was properly certified, qualified, and trained according

to the guidelines set by Federal regulations. The crew took the off-duty time prescribed by the regulations and the NTSB found no evidence of any preexisting medical or behavioral conditions. The crew noticed the problem right away when the plane rolled. They took immediate action but did not regain control of the plane. USAir did not train the crew how to recover from an uncommanded rudder reversal movement because that type of training did not exist at that time. In the years following the accident, some airline companies began offering this training to address this challenge per the NTSB recommendations. However, not all airlines choose to offer training on recovering from unusual upset maneuvers (NTSB, 1999). Therefore, the NTSB did not expect the USAir 427 pilots to correct the rudder problem under these particular circumstances.

#### Action sequence in the USAir Flight 427 transcript

USAir 427 departed from Chicago-O'Hare International Airport (ORD) shortly after 6 p.m. and headed for Pittsburgh. Shortly after 6:45 p.m., the ATC at Cleveland cleared USAir Flight 427 to descend from the altitude of 29,000 (msl) to 24,000.

Approximately five minutes later the Cleveland ATC advised USAir to cross CUTTA (intersection) to prepare for descent. Every major city has a predetermined flight path for its runways to guide the air traffic. The USAir 427 Captain acknowledged the statement. Next, the CVR picked up the sound of the cockpit door opening and closing. The flight

attendant asks the captain and first officer if they would like anything to drink. After the flight attendant leaves the cockpit, the following piece of the communication transpires.

In order to understand the NTSB USAir transcript, Table 2 outlines some of the terminology represented:

**Table 2: Cockpit Voice Recorder Transcript Legend**

<b>Abbreviation</b>	<b>Association</b>
RDO	Radio transmission from accident aircraft
CAM	Voice or sound source recorded through cockpit area microphone
HOT	Voice or sound source recorded through cockpit hot microphone
PA	Voice or sound source recorded through public address system
JSAP	Voice or sound source recorded through jump seat audio panel
-1	Voice identified as captain
-2	Voice identified as first officer
-3	Voice identified as female flight attendant
-4	Voice identified as male flight attendant
CTR-?	Radio transmission from unidentified Center controller
CLE1	Radio transmission from 1 <sup>st</sup> Cleveland Center controller
CLE2	Radio transmission from 2 <sup>nd</sup> Cleveland Center controller
CLE3	Radio transmission from 3 <sup>rd</sup> Cleveland Center controller
CLE4	Radio transmission from 4 <sup>th</sup> Cleveland Center controller
DL1083	Radio transmission from Delta flight 1083
*	Unintelligible word
@	Nonpertinent word
#	Expletive
%	Break in continuity
()	Questionable insertion
....	Pause
	Editorial insertion

The NTSB investigative group works diligently to transcribe the CVR tapes but cautions readers because the transcript or parts thereof, if taken out of context, could be misleading. The CVR transcript works as an accident investigation tool in conjunction with other evidence gathered during the investigation. Readers or investigator's conclusions or interpretations should include more than the transcript. All large commercial planes come equipped with flight data recorders (FDRs) and cockpit voice recorders (CVR). Investigators refer to both devices as the "black boxes." The flight data recorders record a number of flight parameters throughout the flight such as air speed, altitude, elapsed time between events, etc. The FDR are located in the strongest part of the aircraft, the tail section that can withstand a great deal of pressure and temperatures. The cockpit voice recorders record the flight deck conversations on a continuous 30-minute loop. Federal regulations state that all large commercial must carry black boxes. Federal law prohibits the release of certain the audio versions of an aviation accident to the public. However, the NTSB releases the written transcript to the public as soon after the researchers decipher the tape.

The USAir 427 excerpt covers a dialogue between the captain, first officer, and radio communications with the ATC. According to the US Department of Transportation's Radio Communications Phraseology and Techniques, pilots must acknowledge every direct radio communication with the air traffic controllers (ATC) by responding with the appropriate call sign. In the excerpt below, another plane attempts to

land before the USAir flight. The Radio Communications Phraseology and Technique outlines how to state figures, directions, speed, time, altitudes and flight levels. For example the altitudes and flight levels must be stated as separate digits of the thousands, plus the hundreds if appropriate (up to but not including 18,000 feet MSL). Therefore, pilots would state 12,000 as "ONE TWO THOUSAND" and 12,500 as "ONE TWO THOUSAND FIVE HUNDRED." The pilots must keep track of many different numbers.

#### USAir Flight 427 transcript excerpt from the NTSB Report

...

1854:19

CLE4 Delta ten eighty three, reduce speed to two ten. Contact Pit approach one two one point two five

1854:24

DL1083 twenty one twenty five, good day.

1854:27

CLE4 USAir four twenty seven cross CUTTA one zero thousand two five zero knots now.

1854:36

HOT-2 This thing is going to scream and holler. I can't do that.

1854:42

HOT-1 Thirty eleven.

1854:43

HOT-2 Thirty eleven set.

1854:44

HOT-1 You can't make it?

1854:45

HOT-2 Its gonna say I can't.

1854:49

HOT-2 Because its....it it uh, it'll do it. I'll make it do it.

1854:53

CAM (Cockpit area microphone)

[sound of unidentified click]

1854:55

HOT-2 see, it's calling me names like it did to you.

1856:16

CLE4 USAir four twenty seven reduce speed to two one zero now that's at the request of Pit approach I'll take the speed first.

1856:22

RDO-1 OK speed back to two ten USAir four twenty seven. Uh, we'll do our best to make the restriction.

1856:27

CLE4 don't have to now. just uh, speed first uh, pd [pilot discretion] to ten.

1856:31

RDO-1 you got it.

1856:32

CLE4 USAir four twenty seven contact Pit approach one two one point two five.

1856:36

RDO-1 twenty one twenty five, USAir four twenty seven, good day.

1856:43

HOT-1 Two ten, he said.

1856:45

HOT-2 Two ten? Oh, I heard two fifty, #.

1856:49

HOT-1 I may have misunderstood him.

The flight attendant returns to the cockpit and the remainder of the flight (not analyzed here) follows as the captain receives further landing instructions for the Pittsburgh International Airport. Shortly before 6 p.m., the ATC advises Delta flight 1083 to descend to 6,000 feet MSL. Inside the USAir 427 cockpit, an aural tone sounds and the flight attendant returns to the aircraft cabin. The Flight Data Recorder shows the plane's altitude at 10,818 feet MSL. The first officer thanked the passengers for traveling with USAir and at the same time, the captain clarified information from the ATC. The ATC asked the Delta flight to switch to another frequency to avoid confusion. At 7:02 p.m., USAir 427 encountered Delta 1083's jet stream and just a few seconds later began to roll to the right. The CVR recorded that captain saying "whoa" and then the plane began to roll to the left again. At three minutes after the hour, one of the pilots disconnected the autopilot. The CVR records the captain stating "what the hell is this?" Next, the collision avoidance system sounds and a mechanical voice repeats "traffic, traffic." The ATC advises USAir to maintain 6,000 feet MSL but the plane was at 5,300 feet MSL. The captain repeatedly states "pull, pull, pull" and the plane crashes into the hilly, wooded terrain.

### ***Mechanistic Perspective's Applications***

The mechanistic perspective provides a basic framework for analyzing the pilot communication but limits what researchers can use to define human error. The purpose converges on the pure transfer of information, the accuracy of that information, and the interference of noise. Remember "information" in this perspective is not the same thing as creating meaning or understanding, just the reduction of statistical uncertainty about the coding of the message. Senders, receivers, and channels comprise the basic components. Senders create messages, then send the information via a channel to the receiver. The USAir 427 major senders and receivers are the Captain, First Officer, and a Cleveland Center controller. The Boeing 737-300 only needs two pilots to control and fly the aircraft; during this leg of the USAir 427 Flight, the first officer is the pilot-flying (PF). Therefore, the captain's responsibility shifts to being the pilot-not-flying (PNF). One of the PNF's duties includes managing the radio transmission with the air traffic controllers; this is standard operating procedure. So there are two linked conversational streams going on but one conversation involves the captain and first officer and the other conversation involves the captain and the Cleveland Center Controller. The USAir Captain gathers and shares information with the controller and the controller provides information to the captain that he relays to the first officer although the first officer can hear the transmission.

The mechanistic perspective centers on the transmission of information. In the dialogue between the captain and first officer, pieces of information move to and from the captain as a sender and he offers information to the controller and the first officer, both who respond as receivers. The process continues with the first officer and controller sending information to each other. The first officer does not interrupt the exchanges between the captain and the controller so it is as if the captain is plays a single game of tennis with a pair on the other side of the net. The players volley one ball back and forth. The dialogue appears a bit artificial however; most daily conversations contain more overlaps and interruptions. Mechanistically, this small section of the USAir's crew interaction appears to go quite well. No major breakdowns occur as the participants clearly transmit the information. Just like an electrical system or reception of messages over telephone wires, this perspective seeks an ideal state that consists of discrete mechanical, sequential steps to accomplish communication. The dialogue includes plenty of aviation jargon and clipped phrases. Despite some seemingly unclear phrases and terminology, the participants continue communicating and the information moves along because the participants share a common language. Not all exchanges between the pilots contain this feature. The phrase spoken by the first officer "this thing's gonna scream and holler" and "I can't make it do that" provides no clear indication to what the pilot means. Researchers need more information than the mechanistic perspective to decipher the meaning and to understand the context. Yet, the mechanistic perspective does not

address meaning or contexts. This perspective only concentrates on the information that moving back and forth through a channel.

Cushing, in his book, Fatal Words suggested airlines incorporate a system to translate the pilot's voice to written text for controllers to read (the technology is not available at this time). The accuracy of information remains as another mechanistic goal and depends upon redundancy to overcome the interference of noise. However, senders must recognize that the recipient did not receive the information. Using a verbal and a computer text based program creates redundancy, but noise becomes amplified with multiple channels. What might arise if someone miscodes information? How would Cushing's proposed system clarify the first officer's "scream and holler" phrase or what would the ATC do with this information? What might happen if the information from one channel contradicts the message from the other channel? If someone says one thing and means something else then the technology may not be able to correct this type of error. For example during the USAir 427 flight, the air traffic controller informs the captain to slow the plane to 250 knots. Then in the next sentence where he speaks he asks for "USAir four twenty seven reduce speed to two one zero now that's at the request of the PIT approach I'll take the speed first." He is telling USAir to slow the speed to 210 knots instead of 250 knots. The air traffic controller issues a change of plans without pre-signaling it. Shortly after the captain tells the first officer "two ten he said." To which the first officer replies "two ten? oh, I heard two fifty, #" (the # marks represents

an expletive). If USAir continued to fly 250 knots, it would have overtaken the Delta aircraft. How do we know who was making the correct assumption? What if the air traffic controller had misspoken the knots he requested? Something seemingly mundane as this quick exchange could and does have catastrophic results for aviation. An extreme example occurred in 1983, when the Russian military shot down a Korean commercial airliner. The airliner had strayed into Russian air space. The NTSB believes that the crew erroneously entered data into the flight management system so they were flying on the incorrect coordinates. In order to know more about aviation accidents, researchers need to ask more questions. Who are the people involved? Why did they choose to say things they did? What is their working relationship like? People tend to take certain things for granted about communication like: thinking about the assigned roles or positions of the pilots, cultural impacts, and who is in charge of the flight. However, who the senders and receivers are has no bearing on this perspective. The mechanistic perspective does not address these points. Most human factor researchers do not recognize the importance of utterances or the ways participants state the words (tone, pitch, timbre, etc.).

Overall, the mechanistic perspective limits the range of possibilities for explaining communication phenomena. Researchers identify the participants as senders and receivers, which provides a simple understanding of the communication process. However, the mechanistic perspective limits researchers from delving deeper into the

“hows” and “whys” of communication. Researchers should explore more than communication’s basic components. The mechanistic perspective leaves out a great deal of richness that other perspectives possess.

### ***Psychological Perspective’s Applications***

Psychology has given people a way to begin to talk about types of behaviors and personality traits not commonly addressed a few years ago. The prediction of behavior is highly important to a system that heavily depends upon its operators. The psychological perspective metaphorically views humans as “black boxes.” Therefore, no one can truly know what goes on inside the minds of pilots. Humans interpret others behavior and then categorize them. The psychological perspective focuses on the prediction of behavior, based on the decision-making process as manifested in behavior and situation awareness.

Airlines spend a great deal of money to train and test the pilots. The commercial aviation positions require pilots with many hours of flying experience. Commercial pilots must be medically examined complete an aircraft type rating, and competence check every six months. Every 13 months the pilots complete exams for instrument, safety equipment and procedures check, route check, technical questionnaire, and many others. The other checks include the line-orientated flight training (LOFT). LOFT prepares and tests pilots for the unexpected as well as their routine decision-making skills

in a simulator. Pilots practice so they can engage in error detection because the airlines and passengers depend on the pilot's decision-making skills. All this testing appears to lead to less aviation accidents. However, researchers began critiquing the current methods for making generalized assumptions from "simulated" research and applying it to real world problems (Klein and Klinger, 1991).

From the psychological perspective, researchers need to uncover patterns of each pilot's behavior. The NTSB appointed a team to conduct this research. This team reviewed the captain and first officer's personnel and training records. They took part in interviews with participants who knew the USAir Flight 427 crew members. The wives provided written answers to the NTSB team's questions. The team searched for medical issues (including identification of the remains and toxicology testing). The researchers looked for any information that may have contributed to the accident.

The captain, a 45-year-old male, was married for 19 years with two young children. According to others and his wife, they had a happy relationship. The researchers found no financial, criminal, or medical challenges. The captain's wife reported that his overall health as "very good" and he rarely drank alcohol. The captain obtained his commercial pilot certificate in the summer of 1974. He received pilot training from the United States Air Force (USAF) training program. The captain previously worked for Braniff Airways and USAir hired him in the early part of 1981. He began as a flight engineer on the 727 and upgraded to flight officer in November of

1982. In September of 1987, he became a first officer for 737s and upgraded to captain in 1988. According to USAir's records, the captain successfully completed his initial, recurrent, CRM, and LOFT training for all airplanes and positions that he was qualified to fly. The report makes note of post-accident interviews with several people who worked with the captain. The responses were that the captain flew "by the book" and was professional and meticulous.

The first officer, a 38 year-old male, had only been married for two years with no children. The researchers found no financial, criminal, or medical challenges. The first officer's wife reported that his overall health as "excellent" and he moderately drank alcohol. The first officer, interested in flying as a teenager, obtained a private pilot's certificate in 1973 and his commercial pilot certificate in 1981. Piedmont Airlines hired the first officer in 1987 and USAir acquired Piedmont in 1989. In 1989, he transitioned to flying the Boeing 737s. The first officer satisfactorily completed his most recent proficiency check that included a refresher on CRM on May 12, 1994.

The USAir transcript does not reveal what the pilots were thinking. The NTSB Report confirms that the pilot's behaviors matched the expectations of a normal flight. Pilots presented with challenges may not respond in the most desired way. For this reason, such devices as checklists help manage some unexpected challenges. Checklists do not work for every situation though. The checklists themselves can potentially become a distraction. In these instances, the pilot's decision-making skills are

paramount. The psychological perspective only allows researchers to observe behaviors. This extends further than the mechanistic perspective but still lacks a holistic picture of communication.

### ***Symbolic interactionism Perspective's Applications***

The symbolic interactionism perspective focuses on the interaction between people. The impromptu play metaphorically represents this perspective. The actors (people) engage in dialogue (communicate) with one another to create the play (reality). No pre-determined ending or goal compels the actors towards the end. The play goes on and the creation of meaning occurs through each step of the interaction. Social expectations shape people and their perceptions. People perceptions determine how they plan react and interact with one another because every culture exists according to rules that govern the people who belong. People respond to others based on the parts they play. What does this tell us about the pilots of USAir 427? We know that both men were in the prime of their careers. Each pilot was married. The captain had been married significantly longer than the first officer and had children as well. The captain served in the military but the first officer had not. All of these roles and group memberships contributes to how they may have communicated or acted on the flight deck.

Effective communication involves the ability to create and share messages with others that do not have exactly the same culture, experience, knowledge, and background as you. Nobody shares all those things with anyone. Along with certain roles comes a perceived sense of power or authority over others. Authority grants people the right to use power and influence. In the situation of boss and employee or teacher and student, the boss and teacher hold formal power over the employee and student. Aviation regulations clearly define the flight crew's roles (Wiener, Kanki, Helmreich, 1993). According to Federal Aviation Regulation 91.3, the captain assumes total responsibility and control for the aircraft, its passengers, and the flight. The first officer assumes the next person in command responsibilities and then other flight crewmember (when applicable), followed by the most senior flight attendant. What kind of implications do the role expectations carry for people in aviation? Recently, airline companies forced pilots over the age of 60 to retire. Several of these pilots found positions as flight navigators or engineers. This causes some role challenges as the captain or first officer would defer to the flight engineer because of the pilot's former experience although the new position placed the former pilot third in command. The USAir 427 captain maintains the ultimate responsibility of the safety of the passengers, crew, and airplane so patterns of deference acknowledge the captain's experience and authority. However, the first officer is actually flying the plane during the excerpt, so others must support (through communication) him while he has the controls. Role confusion results from

these types of experiences. Hesitancy to hand over the controls or defiant attitudes present serious implications for aviation.

For the flight crew of USAir 427, it was the first time they had flown together as a group. The NTSB Report stated that it was one of the flight attendant's birthday and the group ate together before setting off on their flight together. Others remarked that the USAir 427 crew seemed to get along just fine. The roles determine what may or may not happen on the flight deck. From the taped conversation, it appeared that the crew worked well together. In some cases, the socialization process does not always go so smoothly. Chute (1995) recalled the story of a situation where the cabin crew asked the flight engineer to check on a non-operating lavatory. The flight engineer refused so the cabin crew withheld food from the pilots in retaliation. The USAir 427 group seemed to work well together with everyone contributing to their assigned roles this does not always have positive consequences.

From any socialization process, we know that most groups form or adhere to a set group of jargon and acronyms. The military, police officers, the medical field, the financial world, academia, and pilots converse using their own jargon. Norms define your belonging to that group. A noteworthy exchange transpired as the first officer seems to be fighting with the plane. Several comments refer to the plane as a participant in the play. The first officer gives the plane a voice by saying things such as it is going to "scream and holler" or saying something about the plane calling him names. How might

this impact how researchers view the machinery? Perhaps researchers should consider the role the plane plays instead of an entity that needs to be controlled. Where would the plane fall in the categories of socialization, conformity, group membership, roles, rules, and power?

### ***Pragmatic Perspective's Applications***

The pragmatic perspective looks to create a holistic picture. Practically speaking the pragmatic perspective looks at behaviors. Communication and behaviors establish relationships between people and act as the basic building block of relationships. This perspective accomplishes this by examining conversational patterns and looks for sequences in behavior. Researchers use these patterns and sequences to explain the importance of context in a given situation. Ballroom dancing is the metaphor for the pragmatic perspective. Participants possess the basic skills to interact with others and the actual experience changes every time. In the pragmatic perspective, each episode will be different even if it does involve the same people. Suchman (1987) in her book Plans and Situated Actions: The Problem of Human-Machine Communication recounts an article written by Thomas Gladwin in 1964 describing the differences between Trukese navigators and European navigators on the open sea. European navigators using universal principles, plots a course and follows it very closely. The European navigator

does not want to stray from the course. The Trukese navigators begin the journey with an objective, take into account all the elements along the way, and do not stop to re-adjust the plan. Suchman (1987) states that human communication should follow the path outlined by the Trukese navigator because “the circumstances of our actions are never fully anticipated and are continuously changing around us.” This summarizes the pragmatic perspective and this research. My objective centers on asking the questions not asked before. What exactly can the pragmatic perspective tell us about the communication, behaviors, and relationships in the transcript of USAir 427?

From the conversational analysis standpoint, the turn taking goes so well that it does appear to have an artificial quality to the conversation. By addressing only a small set of the dialogue, we see what appears to be a request (1854:42) followed by a confirmation (1854:43) and ending with an accusation or question (1854:44).

1854:42 HOT-1 Thirty eleven.

1854:43 HOT-2 Thirty eleven set.

1854:44 HOT-1 You can't make it?

The preferred response would be a statement, not a question. Expanding the excerpt to include the previous set of adjacency pairs provides a different picture. If we group 1854:36 and 1854:44 comments together as a pair, then that leaves the comments at 1854:42 and 1854:43 as an embedded sequence in the other adjacency pair. Aviation

checklists do not fit into any predefined adjacency pairs. I recommend for further research that the terms “statement+confirmation” be added. The checklist allows the pilots to stay focused on a sequential task and every statement requires a response. The preferred response would be a confirmation. As mentioned earlier, pilots often repeat back the statement and then add a word or say “check.” In this example, if 1854:42 and 1854:43 were part of a checklist, this could be a typical response.

1854:36 HOT-2 This thing is going to scream and holler. I can't do that.

1854:42 HOT-1 Thirty eleven.

1854:43 HOT-2 Thirty eleven set.

1854:44 HOT-1 You can't make it?

If we extend our focus even wider to include more of the dialogue, the analysis starts to become more complex. If we group the comments as mentioned in the previous example, we can see that leaves the addition of three more comments: 1854:45, 1854:49, 1854:53. The first officer utters the comments in 1854:45 and 1854:49. These comments appear to be a continuation of a thought even though they were divided up in the NTSB transcript. The comment following the first officer comes from the airplane's flight management system (automated features) in 1854:53.

1854:36 HOT-2 This thing is going to scream and holler. I can't do that.

1854:42 HOT-1 Thirty eleven.

- 1854:43 HOT-2 Thirty eleven set.  
1854:44 HOT-1 You can't make it?  
1854:45 HOT-2 Its gonna say I can't.  
1854:49 HOT-2 Because its....it it uh, it'll do it. I'll make it do it.  
1854:53 CAM (Cockpit area microphone) [sound of unidentified click]

Again, the machine becomes part of the communication process. We know the response was dispreferred because the first officer says "see, it's calling me names like it did to you." Suchman (1987) addresses this very issue as she drew on conversation analysis to offer a critique of the model of human communication which most systems designers and programmers tend to use. Conversation analysis's multidisciplinary approach allows researchers the opportunity to look at patterns but where no current explanations exist. Conversation analysis offers some valuable insights into how humans actually create reality through communication.

The Coordinated Management of Meaning (CMM) theory explains how humans use language to coordinate meaning and construct reality. Primarily, CMM focuses on communication's content (semantic) and the contextual (pragmatic) nature. CMM provides researchers an interdisciplinary communication approach with systems theory. This theory looks how all the CMM tenets: content, speech acts, episodes, relationships, life scripts, and cultural patterns contribute to the creation of meaning.

Content is the sum of all the things going on in the environment, noise, movements, and visual stimuli. The most basic step involves taking in raw data. Next, the pilots organize the information in a way that would make sense to them. With the communication between the pilots of USAir 427, the words are understandable in and of themselves. Of course, the jargon does need some decoding for those of us who are not pilots or do not frequently look over aviation transcripts. It does capture the quirks of naturally occurring communication. Most utterances in the transcript are phrases and the syntax arrangements do not necessarily flow smoothly.

Speech acts signify how the collected pieces of information should be responded to because they are directive in nature. From reading the USAir 427 excerpt, you can “sense” that there is a flow to the communication between the captain and the first officer. At this layer in CMM, it is clear that the participants are coordinating meaning. A sense of order presides and no one needs to apologize for beginning to talk when others are still talking. Tannen (1994) says that is a communicative pattern more often used by women. The first officer is the one actually flying the plane with the captain guiding and overseeing the process. Both pilots have information or control that the other is dependent upon so you can see how they each contribute to the pragmatic perspective of creating the communicative event as it occurs.

Episodes are communicative collections that have a clear beginning, middle, and end. This breaks the entire transcript into collections. After the excerpt used in this

chapter, the captain and first officer engage in friendly banter about the juice drinks brought in by the flight attendant. The flight attendant poses a question and one pilot responds with a humorous line then everyone laughs. The flight attendant then leaves the flight deck. Checklists comprise their own episodes. In the excerpt, the conversational episode focuses on radio communications with the Pittsburgh air traffic controller and adjusting to the assertions presented. At the same time there is an interesting episode with the first officer trying to make the plane do as he wants. As technology becomes more part of our lives, we probably find ourselves talking to our computers, cars, and copy machines. What implications does this have for communication?

The relationship forms the next layer in the coordinated management of meaning. The relationship can be on many different levels and focuses on the boundaries of the interaction. Behaviors establish relationships. Although these pilots had not flown together before this trip, they had been flying together for two days prior. During that time, they had to coordinate many episodes to get their job done. The close physical proximity of the flight deck may have contributed to developing quick rapport with one another.

Life scripts are the collection of experiences that shape a person, which determines how they will act in a given situation. This is a formation of the sense of self. However, being in a relationship also alters it with someone who has an influence upon

your life. We do not know a whole lot about the captain and first officer's life scripts. The positions of being a pilot for a major airline company must shape their perspectives. Compensation for this type of work with tenure does command a higher than average salary. Also, the fact that they are pilots. The airlines expect the pilots will travel a lot with this type of work and flying the big jets is a huge responsibility. What type of life scripts contributes to someone being a "good" pilot? How does it affect their ability to coordinate meaning?

Cultural patterns are the all-encompassing collection of experiences.

Understanding the role of cultural patterns help humans relate to the larger group. The USAir 427 pilots seemed to have some similar qualities that may have contributed to them working well together. Some of the similar qualities are: both were pilots, interesting in flying at a young age, were close in age, men, similar physical stature, drank alcohol occasionally, and were married. I would venture to say that 10 years ago that was probably the typical US commercial pilot. Those similar cultural patterns shaped the pilot's conversations though. Before the three-day trip together began, the pilots did not know one another and had not flown together before. However, they had some similar cultural reference points, which gave them the opportunity to feel comfortable working along side each other. Parts of the transcript (not in the thesis) show the pilots laughing and joking around with one another. Differences in cultural

patterns can bring up a continuum of challenges. What happens when international crews are flying together? The airline schedules their employees by putting names in the slots. Business dictates that they conduct scheduling this way. This happens because so many flights are dependant on weather and so many other factors. The airline companies work to create an extensive scheduled list of flights but there are many unscheduled flights and they need people to fly where ever and whenever sometimes. Furthermore, in the globalization of the economy, more and more travelers are flying from country to country. This creates a need that might be filled by a crew from several different cultures. Will this bring more problems? No, just like automation the diversity brings its own unique challenges (and strengths). What comes into play when people of two different cultures with different languages attempt to converse with one another? Some researchers have begun to ask this question. Japan Airlines conducted CRM training based on Blake and Mouton's (1982) Grid® theory. The theory provides a framework for understanding differences between people and an understanding as to an individual's behaviors. Will the CRM training incorporate a blend of cultural patterns and styles? Researchers based CRM on Western ideals and expectations about communication. How does that affect the implementation of an international CRM training? Human factor researchers need to be aware of how cultural patterns shape the communicative process.

## CHAPTER FOUR:

### CONCLUSIONS AND FUTURE RESEARCH

#### *Overview*

Despite common fears, commercial airline transportation is still the safest way to travel. The odds of an accident seemed to be decreasing until the 1990s, when there was a quick surge in large accidents. While it is the safest way to fly, passengers do not always hear about the near mishaps that occur. Having researched the statistics and causes of these accidents, I usually did not think of the lives that were devastated by such catastrophic accidents. It is partially for them that this thesis has been written; although I have never personally lost anyone to an aviation accident. Reading *Esquire* magazine (July 2000), an article that described the events following the Swissair Flight 111 struck me. The flight crashed on September 2, 1998 en route from New York to Geneva. The pilots were frantically following the checklist trying to dump fuel. In the pilot's haste, he reverted to his native language, German, and since the ATC did not understand him, he had to repeat the emergency call in English. Pilots must dump fuel if they suspect the plane might crash, because jet fuel is highly flammable. Jet fuel burns quickly and turns into a thick black smoke. People have survived the impact of a plane crash that slides off

or overshoots a runway only to die from smoke inhalation. Yet, the Swissair plane crashed and broke into a million pieces. Part of the aviation accident investigation requires the investigators to piece the plane back together. However, the parts were in such small pieces and spread out that the investigators will not be able to put it back together. This accident shattered hundreds of lives. All the people (229 passengers and crew) on board Swissair 111 were dead. The disaster recovery crew found nothing but parts of bodies and almost all had to be identified by DNA testing. Each story has its own sadness, such as the man waiting at the airport to propose to his girlfriend. The small fishing village nearby became a morgue and the families raised money for a memorial at the crash site. This is why this research is so important. The aviation industry and human factor researchers have been diligently working to uncover and eliminate errors at their root causes. The challenge is to keep up with the emerging technology, which with every new step brings its own unique triumphs and challenges. Wiener, Kanki, and Helmreich (1993) state that “graduate training in the behavioral sciences has become increasingly specialized and narrow” and they suggest that the field needs renaissance people to look at the challenges on a multitude of levels. On that note, there needs to be a more holistic integration of systems thinking into the study of aviation accidents. Aviation researchers have not fully tapped into the fields of Education and Communication. What might the fields of education and communication hold for human factors engineering and aviation?

### ***Systems Thinking: Education and Communication***

Within the field of education, human performance improvement (HPI) emerges into the spotlight. Education itself has a long history but Industrial education, as a formal program, only began somewhere in the early 1900s with the National Society for the Promotion of Industrial Education. So as a discipline it is quite young. Much like the field of communication, a number of fields have influenced the creation of this educational discipline. HPI includes behaviorism, diagnostic and analytical systems, organizational learning and instructional systems design, organization development and change management, systems theory, evaluation, and management sciences. Currently pilot training incorporates behaviorism and some strands of the other topics mentioned in CRM training. Remember, CRM training is not a mandatory training for pilots of all airline companies. Some companies can not afford the training or do not wish to provide the training in addition to the federally regulated training. Systems thinking addresses both education and communication and may be a great starting point for further discussions and research.

Behaviorism has been one of the cornerstones of human factors engineering research and education. An aviation example is LOFT training. LOFT training applies operant conditioning to prepare pilots for routine and emergency flying procedures. Behaviorism simply looks at the input and outputs and there is no reference to the

participants consciousness or mental constructs (Watson, 1925). The pilots learn to control the simulated environment through simulators and classroom training.

Researchers began critiquing the current methods for making generalized assumptions from “simulated” research and applying it to real world problems (Klein and Klinger, 1991).

Systems theory has begun to enjoy a more widespread application in education and many businesses. This theory helps people understand the complex world of systems. The theory was born from the field of system dynamics by MIT Professor Jay Forrester in 1956. Researchers call the application of systems theory “systems analysis.” One of the tools of systems analysis is systems thinking. Systems thinking is another way for people and organizations to view the world, from a broad perspective that includes structures, patterns and events, rather than just the events themselves. This broad view helps to identify the real causes of issues and know where to work to address them. The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization (1994) written by Peter Senge are influential works about systems thinking and its application to organizations. Senge uses systems thinking as an approach to developing a learning organization. Learning organizations are the “continuous testing of experience, and the transformation of that experience into knowledge-accessible to the whole organization, and relevant to its core purpose” (Senge, 1994). If businesses such as Harley-Davidson, General Electric, British Petroleum, Chrysler, Dupont, Ford,

Hewlett-Packard, Mitsubishi Electric, Shell Oil Company, Toyota, the United States Army, Xerox and others have been able to implement these ideas with success, what could that possibly mean for the aviation industry? First, we need to explore the basic premises of systems theory.

Very simply, a system is a collection of parts (or subsystems) integrated to accomplish an overall goal. A pile of sand is not a system because if one removes a sand particle, there remains a pile of sand. However, a functioning car is a system but remove the battery and the car does not work. Systems have input, processes, out puts and outcomes, with ongoing feed back among these various parts. If someone or thing discards one part of the system, that alters the nature of the system. Too often people think that they can break up a system and only have to deal with its parts or with various topics apart from other topics.

Systems range from very simple to very complex and there are numerous types of systems. For example, there are biological systems (the heart, etc.), mechanical systems (thermostat, etc.), human/mechanical systems (riding a bicycle, etc.), ecological systems (predator/prey, etc.), and social systems (groups, supply and demand, friendship, etc). The system's overall behavior depends on its entire structure and not the sum of its various parts. Complex systems, such as social systems, are comprised of numerous subsystems. People arrange subsystems into hierarchical categories. Each subsystem has

its own boundaries, and includes various inputs, processes, outputs and outcomes geared to accomplish an overall goal for the subsystem.

The approach of systems thinking is fundamentally different from that of traditional forms of analysis. Traditional analysis focuses on the separating the individual pieces of what is being studied; in fact, the word "analysis" actually comes from the root meaning, "to break into constituent parts." Systems thinking, in contrast, focus on how the thing being studied interacts with the other constituents of the system—a set of elements that interact to produce behavior—of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systems thinking works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied. This results in sometimes strikingly different conclusions than those generated by traditional forms of analysis, especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external.

The effect of systems theory for businesses has been another way to help managers to look at their organizations from a broader perspective. Systems theory has brought a new perspective for managers to interpret patterns and events in their organizations. In the past, managers typically took one part and focused on that. Then they moved all attention to another part. The problem was that an organization could have wonderful departments that operate well by themselves but do not integrate well

together. Consequently, the organization suffers as a whole. So many of the important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them. Dealing with such problems is notoriously difficult, and the results of conventional solutions are often poor enough to create discouragement about the prospects of ever effectively addressing them. One of the key benefits of systems thinking is its ability to deal effectively with just these types of problems. It raises our thinking to the level at which we create the results we want as individuals and organizations even in those difficult situations marked by complexity great numbers of interactions, and the absence or ineffectiveness of immediately apparent solutions. Systems thinking provides an extremely effective way to address the most difficult types of problems to solve. Examples of areas in which systems thinking has proven its value include: challenges that involve complex issues, challenges that depend a great deal on the past or on the actions of others, and challenges stemming from ineffective coordination among those involved. Complex problems that involve helping many participants see the "big picture" and not just their part of it. Perhaps this can have an effect for the field of aviation. From the communication field, CMM incorporates a systems perspective. Earlier I mentioned that CRM was meant to help pilots with teamwork but its does not end at the cockpit door, it must move beyond that.

There remain so many other avenues to explore the overlaps and gaps from education and human factors engineering. The work of Joe Harless, Malcolm Knowles,

Donald Kirkpatrick, and Robert Gagne contribute to education and training. Joe Harless coined the term *front-end analysis* in 1969. Harless believed that the actual identification of a performance problem usually came far too late in the process. This usually meant that the solutions were not well thought out. So, he devised *front-end analysis*, which is a rigorous diagnostic framework that needs to be done when addressing a solution to a problem. Much of the world today takes a reactive approach. A reactive strategy can be very costly to businesses. Some researchers refer to Malcolm Knowles as the “father of adult learning theory.” Knowles in his book, *The Adult Learner: A Neglected Species* (1984) stated that adult learners need to be self-directed when learning, need to know the purpose of what they are learning, and be able to practically apply that knowledge.

Donald Kirkpatrick (1967) clarified the importance of evaluations and outlined a four-level framework. The lowest level gauges the reactions of the participants; usually “smile sheets” accomplish this. Smile sheets are very short surveys asking if the participant was satisfied with the material and delivery of the material. The second level seeks to have the participant demonstrate the learning. The third level transference of skills learned in the classroom to real life settings. The fourth level looks for results that affect the greater community. Robert Gagne is best known for being a proponent of task analysis and suggesting five types of learning: psychomotor skills, verbal information, intellectual skills, cognitive strategies, and attitudes. Of course, all these researchers and their contributions only scratch the surface; many more theories could assist the aviation

human factor engineers. How much work do researchers devote to front-end analysis? The NTSB only responds to accidents so that approach tends to be reactive. Although the NTSB does look for patterns and makes strong recommendations for any item, the system as a whole needs attention. How much do the pilots contribute to the development of training programs that affect their jobs? When airline companies first introduced CRM training, pilots referred it as "charm school." I imagine at that point the buy in level was low but there seems to be more support for it now in the literature written by pilots. To what degree if any are the trainers and facilitators taking into account the various types of learners? Air safety investigators need this data on human performance as well. With Kirkpatrick's four level evaluations, to what degree are the airlines following up with the pilots to see how well they apply these skills and whether or not there is a direct impact on the number of accidents?

Where does communication fall in this whole process? What is the relationship between pilot communication and automation? Is the high number of pilot error y the result of pilot error? What can conversation analysis show about the relationship between crew communication and human error crashes? What about the relationship between crew communication and decision making? If communication itself is typically messy, how can we expect crew communication to be a sanitized version? What implications does that have? Could it bring about more errors because code switching can be a problem? Are humans just prone to error and we should accept the risk

associated with flying? Training intends to be a behavior modifier but people do revert to their former habits, how will this be kept track of? Does it matter? For now, the human element in aviation is not going away any time soon so we all need to figure out a way for this to work. There could be a checklist for every possible scenario. However, would pilots be able to find and access that information when they need it most? One of the challenges with automation is that the pilots do not know how the technology works. Current training methods emphasize algorithmic way of decision making. Perhaps those efforts could refocus on training the pilots and crew to apply "practical wisdom." No principle can fill the gap of what pilots need to know in today's environment because unexpected or new situations will present themselves. People should be prepared for the unexpected with creativity (Robinson and Stern, 1997).

### ***Final Comments***

U.S. Airline companies recognize the importance of CRM to help reduce the number of accidents. The training in the aviation industry is extensive but the implications of poor training are so devastating. As long as humans will be flying planes for commercial transport of passengers, the potential for these large accidents remains. So many disciplines are working from various angles to bring forth preventive, viable solutions to aviation accidents. When agencies cross functions and come together to try

to learn what caused an accident, powerful outcomes take place. We need to spend time on the front-end analysis, look at the whole system, include the entire crew in CRM training, and remember communication should be a prominent piece though out all studies. Perhaps, my four years in the US Air Force as a jet engine mechanic in the late 1980's spurred me to conduct research on this topic. I understand how one group's goals may not be in line with another's group. As a mechanic, we were trained in the "turn 'em and burn 'em" school of fix the critical items first and foremost so the plane was ready to go back on the line. This type of mentality did not always mean a safe flying machine. If we are to ascertain anything from the loss of lives on USAir Flight 427, Swissair 111, and all the others, the difficult questions need to be asked. The aviation field needs the renaissance people to look at the challenges on a multitude of levels.

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