TECHNICAL AND SOCIAL CONFLICTS OF AVIATION ACCIDENT INVESTIGATIONS

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PREFACE

Man's fascination with flight has been well recorded in art, myths, and religious writings for well over 3,500 years. Modern aviation began with the flights of the Wright Brothers in the early 1900s. Unfortunately, there were many accidents as the art and science of flight developed. Public concern about accidents and their causes is very strong. This concern has created a process of aviation accident investigation and the teaching of the skills required to carry out this process.

Aviation accident investigation is a very technical undertaking. Finding the probable cause of aviation accidents has been an important part of the development of a safe air transportation system. However, there is also a social need of finding fault associated with the investigation process. Finding fault is a necessary element of litigation which is often associated with accidents.

This social need created the requirement for higher quality and clearer factual presentation of the events surrounding accidents. It also created conflicts during the investigation process when the technical probable cause seekers hindered the social, fault finding process. Laws, regulations, and the aviation accident investigation school curriculums did not address these conflicts.

By restricting the scope of this study to the US, the content and recommendations have application to the aviation accident investigation system in America. Addressed is the legal system's use of aviation accident investigation reports. The research confirmed the need for changes in the teaching, execution and government regulation of the aviation accident investigation process.

It was only through the cooperation of the academic community and organizations which taught accident investigation subjects that much of this material was accumulated.

Aviation accident investigators, both current and retired, were sources of many technical aspects of this study. Members of the government, military, FAA and NTSB, plus the legal community, offered input to the social aspects of the study. These three groups were furnished draft copies of this reset as it progressed, and reviewed its Summary, Conclusions, and Recommendations. Their comments and suggestions were incorporated into the research.

I wish to express my sincere appreciation to the members of my committee: Dr. Steven Marks, thesis advisor, whose suggestions as to content and format were critical; Dr. Kenneth Wiggins for his guidance and support as his knowledge in the field of aviation education was very helpful; Dr. Cecil Dugger provided assistance in the early stages of this effort and in the design of the research; Dr. Deke Johnson who provided guidance from a non-aviation viewpoint; and Dr. David Webster, his experience as a writer and educator was very helpful. These people worked as a team to guide me through this research which covered several disciplines.

There are many others to whom I owe special thanks, such as the faculty and staff of the Department of Educational Administration and Higher Education, the Department of Aviation and Space Education, and the OSU administrative staff with whom I have had contact. Their help and encouragement have been of great assistance.

My past professors at Polk Community College, Western Oklahoma State College, Thomas Edison State College, the University of Oklahoma and Oklahoma State University have all played a role in my education over the past 40 years. Their analysis of my efforts and encouragement to continue my studies have been factors in helping me set and meet my professional and personal goals.

Also to be thanked are my family, especially my wife, Jane. She, and my six children, have been great supporters of my efforts. They have assisted me as proof readers, typists and critics. Each one, in their own special way, have used their talents to help me in the pursuit of my academic, professional and personal goals.

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CHAPTER I

INTRODUCTION

Background of the Study

This research is a study of the conflicts that existed between the technical and social aspects of the aviation accident investigation process. The act of "flying" is an unusual combination of physical and physiological sciences which must be understood and followed to maintain an acceptable level of safety. Since the days of the first flights, aircraft accident investigation has played an important role in the development of the art, science, and mechanics of aviation (Dorman, 1976).

In the early years of aviation, 1903 through the mid 1930s, aircraft crashes were fairly common and seemed to be an acceptable and necessary part of the development of aviation (Walsh, 1975). When crashes occurred, the early inventors were anxious to learn what had happened, so that their next efforts at flying might not end in a similar fashion. Material failures were the most common causes of accidents, but the human factor, the pilot very often

played a critical role in determining the likelihood of accomplishing a successful flight (Josephy, 1962).

The early flights of the Wright Brothers and others were measured in seconds. The altitudes they reached were eight to ten feet and their speeds were usually less than 20 miles per hour (Vivan, 1921). Under these circumstances, most crashes did not result in any broken bones, only broken aircraft, broken hopes, and sometimes broken pride. It was not until 1908, when Selfridge was killed at Ft. Myer, VA, that a death occurred due to a powered aircraft accident. This event resulted in the first formal aviation accident investigation in the United States (US). The investigation process took only about six hours to complete (Squier, 1908). Because these early aviation accidents did not involve "the public," there was little interest in accident investigation outside the immediate aviation community.

As time went by, aviation in America grew, and the barnstorming age brought the magic of flight to thousands of people (Ward, 1953). Unfortunately, some of these flights ended in tragic accidents, with innocent non-aviators being injured or killed. These accidents resulted in public demand for safer aircraft, pilots and some form of control over all aviation activities.

Also required were changes to America's justice system in order to resolve the many new legal issues that aviation activities created. For example, when aviation accidents took place and the public sought compensation for its losses, they found a void in the laws that should have been protecting them from this new science of flight (McNair, 1930). This was the foundation for the support of new laws (Forlow, Hotchkiss, Knauth, and Miles, 1929) to govern these magnificent men and their flying machines.

In response to industry and public requests, the first aviation laws on a national level were enacted in 1926 (Air Commerce Act). Soon afterwards, official government investigations of non-military aviation accidents began to take place (Young, 1931). The initial and primary purpose of the aviation accident investigation process was to prevent future accidents by learning as much as possible about each accident that had occurred (Dorman).

By the late 1930s, aviation was beginning to mature, and the skill levels of aircraft accident investigators were also being perfected (Dorman). As stated in the Civil Aeronautics Administration's (CAA) 1953 manual, Aircraft Design Through Service Experience, much of the development of air travel, "is a result of the lessons learned by these investigators from previous accidents" (p. iii).

At the end of World War II, the aviation industry had reached a level of design and manufacturing that could produce the aircraft, supporting hardware and facilities needed for a modern air transportation system. With the advent of the jet age, the safety level of air travel reached a point far above what had previously taken place. Considering the high frequency rate at which aircraft took off and landed, air travel had certainly become a very safe means of transportation (Matthews, 1995). The basis for this level of safety was acquired from the lessons learned during government accident investigations conducted over the past 70 years (Miller, 1994).

Background of the Problem

As the aviation industry matured, its safety record reached a level where the public began to accept traveling in an airplane as a normal activity that had high national value (Truman, 1947). From the early 1960s, when less than 20 percent of the public had flown, (M.K. Hynes, 1967) to the mid 1990s, when over 75 percent of the American public had flown, millions of take offs and landings were being made without incident (Pena, 1995). Aviation accidents, at least those of major airlines, were so infrequent that they were considered "random events" by some government

officials and NTSB accident investigators (R. Scheedle, personal communication, June 19, 1992).

The technology of aviation became so well developed, that the reliability of the equipment being used reached a level where design defects or material failures were no longer considered the major causes of accidents. Much of this development was the result "of the lessons learned from investigating accidents," (Copeland, 1937, p. 2). This trend had been taking place for 30 years, and had been fairly stable for eight years (Taylor, 1990). The human factor was now accounting for approximately 60 to 80 percent of all aviation accidents (Reingold, 1994).

Unless a major or politically sensitive accident was being investigated, the investigation process had become a routine activity (Waldock, 1992). This expectation, on the part of government investigators, resulted in work activities that detracted from the quality of their reports (Wolk, 1993). The question could be raised, Are aviation accident investigators becoming conditioned by these statistics and trends? Were government and private computer data bases on accident factors becoming distorted because of the input of incorrect information?

A social concept, common in the US but rooted in old English law, was the undertaking of "tort litigation." This was the legal remedy available to someone who had

suffered because of the acts (or failure to act) by another party (Black, 1991). When an aircraft accident happened, a "loss" to someone, called a plaintiff, usually occurred. Personal injury, death and/or loss or damage to property are characteristics of all aviation accidents. Under the legal concept of res ipsa loquitur, (the thing speaks for itself,) claims for damages could be made when accidents took place. To obtain justice within all legal systems, a plaintiff must be able to prove their claim against the alleged party responsible for the loss, called a defendant. This must be accomplished before the law will allow a plaintiff to receive compensation from the "wrongdoer" defendant (Madole, 1987).

"Proving the claim" invariably required factual evidence concerning the accident. Under the government controlled system of aviation accident investigation, only the NTSB, and the parties that the NTSB designated to join in the investigation, were allowed access to accident sites (49 CFR, Part 800, 1994). Theoretically, all of the factual evidence collected during the investigation process would be made public. This usually occurred about 14 months after the accident when the National Transportation Safety Board (NTSB) released it's Form 6120.4, "Factual Report of Aviation Accident/ Incident."

Questions had been raised by M.K. Hynes (1990), Waldock (1992), Wolk (1993), and others about the timeliness and the quality, (accuracy and content) of NTSB reports. These writers had shown that the biases of the investigators who conducted the investigation, and the influence of the parties whom the NTSB utilized during its factual investigation process, created quality problems and conflicts in the preparation of NTSB accident reports.

If by oversight or on purpose, the data collected or used by the NTSB contained errors, when the public was given access to this data, it did not serve the needs of the interested parties (Shipman 1992, Wolk). To add to this problem, in the early 1990s, additional steps were taken to restrict public access to government acquired factual data on aviation accidents. Such a restriction resulted from the Iowa District Court ruling during the Air Crash at Sioux City litigation (Re., 1991). The passage by Congress of other restrictive legislation in 1992 expanded this limitation concept into the area of military accident investigations (Public Law 102-396).

The policies and procedures which impacted aviation accident investigations, seemed to reflect the teachings of aviation accident investigation schools and appeared to follow a very narrow tradition. This tradition was based on seeking technical information to determine "probable

cause", the final objective of all publicly released, government aviation accident reports (NTSB, 1992). However, by the early 1990s, the major use of these reports was to fulfill the requirement to prove "fault" when seeking relief under the US legal system of torts (Miller, 1993). The terms, probable cause and fault, have very different meanings in a court of law (Black). Thus, conflicts existed between the technical motivation (finding probable cause) and the social motivation (finding fault) of the aviation accident investigation process. These conflicts resulted in a diminishing of the quality of aviation accident investigation efforts and reports.

Most instructors of aviation accident investigation schools were former military, Federal Aviation Administration (FAA) or NTSB employees who taught the policies and philosophies they had learned and worked under prior to entering an academic institution to teach this subject (Transportation Safety Institute [TSI] 1990). For 40 years, since the formation of the first formal aviation accident investigation school in California in the early 1950s, there had been little or no change in the philosophies being taught at these schools.

As pointed out in Legal Breakdown (Elias, Randolph, Repa, & Warner, 1990), with the increasing trend of litigation in America, the need for rapid access to correct

and complete factual data was critical. The teaching of the art and science of aviation accident investigation, especially as it addressed, or failed to address, conflicts between the technical and social needs of this activity, was considered important.

As discussed by Transportation Secretary Pena in an aviation trade journal (Lavitt, 1995), there had been a continuing public interest in maintaining a high level of safety within the air transportation system. The aviation accident investigation process was a key factor in achieving that goal. Therefore, the quality and usefulness of aviation accident reports was important to the public. Based on the trends in litigation, and the government's policy of limiting access to aviation accident sites, the conflict between technical and social needs of the investigation process was becoming more critical.

Statement of the Problem

Conflicts exist between the technical and social aspects of the aviation accident investigation process.

Purpose of the Study

The purpose of this research was to identify, document, and analyze the conflicts that existed between the technical and social aspects of the aviation accident

investigation process. The results of the research would then be brought to the attention of the institutions that taught aviation accident investigation courses and to the government agencies that conducted and controlled aviation accident investigations.

Overview of the Study

This study traced the development of aviation and the aviation accident investigation process from the early 1900s to the mid 1990s. The goals of an aviation accident investigation, both technical and social, were examined. This was accomplished by researching how aircraft accident investigation schools were formed; how investigators were trained; how investigations were conducted; and how investigation findings were used.

This latter issue--how investigation findings were used--was the motivation for this research. The public's perception of the lack of quality of the NTSB's investigations had become an issue in the 1990s. The public was demanding a safer air transportation system and seeking compensation through the courts whenever the aviation system failed to maintain an acceptable level of safety.

With the knowledge gained as a result of this research, the aviation community, both civilian and

government, could become more aware of the technical and social aspects of the aviation accident investigation process. Openly discussing these conflicts would encourage debate on the need for changes to the existing accident investigation system. In this manner, legal and philosophical improvements could be made to enhance the value of aviation accident investigation techniques and reports. Improvements to the existing system would better meet the needs of society.

The results of the study were presented to allow discussion of the findings and recommendations contained therein. It was hoped that this would result in improvements to the present aviation accident investigation system and in the teaching of this activity. By doing so, the value of the findings of these investigations might be increased.

Limitations of the Study

There were several limitations to this study. First of all, the data and the problem were related only to activities in the US. While similar conflicts of the aviation accident investigation process existed in other countries, they were not addressed in this study. However, for historical reasons, some reference was made to activities outside the US.

The second limitation of the study was that most of the reviewed literature had been written by people within the system which was being called to question. This may have resulted in an imbalance of the discussion of the conflicts between the technical and social needs of the users of aviation accident reports.

The third limitation was the strong influence of the government, both civil and military, on aviation policy and training. The first aviation laws required military officers to "do a tour of duty" within newly created government agencies. In the late 1930s, the government sponsored a Civilian Pilot Training program (CPT). This became the CAA War Training Command during World War II. It organized and trained the aviation expertise which had governed the policies of aviation ever since. The following generations of aviation administrators, technicians and pilots mirrored the philosophies and work habits of these military trained experts.

A fourth limitation of the study was that few organizations offered training in aircraft accident investigation. Limitation number five, was the small number of instructors who were qualified and available to teach at these schools (Embry Riddle Aeronautical University [ERAU], 1992). These instructors, by training, age, and experience, shared common views on many aspects of

the aviation accident investigation process. It was very natural for them to continue teaching what was historically always done during previous investigations. By human nature, they might be expected to resist any suggestion that social needs, as well as technical needs, should be considered during the aviation accident investigation process.

A final and important limitation of this study was a strong "anti-litigation" bias that existed in much general public interest (Elias et al) and technical literature in the field of aviation (A. Lewis, 1993). Non-airline aircraft production in the US was less than 500 units in 1994 (FAA Aviation News, 1994). In the mid 1960s, annual production rates were in excess of 17,800 aircraft (Bulkeley, 1993). This decline in production was blamed on product liability litigation and monetary judgments against aircraft manufacturers (Tripp, 1993).

The content of much of the aviation literature seemed to reflect this bias. Because of this, a large segment of the aviation community, including aviation accident investigators, had no interest in considering the merits of making any changes to the accident investigation process that might prove helpful to potential plaintiffs or the litigation process (Miller, 1992).

For these reasons, it is possible that some of the recommendations may not be welcomed by the aviation community. If history repeats itself, perhaps the needed changes to the aviation accident investigation process would come in response to the needs of the public, and not from either the aviation community or the legal profession.

Assumptions

The following assumptions were made:

(1) that the organizations and academic institutions that offer Aircraft Accident Investigation training programs were identified and successfully contacted;

(2) that the information furnished in school catalogs and course outlines on Aviation Accident Investigation programs was accurate and complete;

(3) that respondents to written, or personal contacts expressed their views fully and in a truthful manner;

(4) that to the public, the technical (probable cause) and social (finding fault) needs of the aviation accident investigation process have equal merit.

CHAPTER II

REVIEW OF THE LITERATURE AND OTHER ACTIVITIES

Introduction

In tracing the evolution of mankind, researchers have concluded that first man crawled upon the earth; then he learned how to walk upright; then he tamed wild animals to the point where he could ride upon them. Next, the wheel was invented and harnessed to an animal. Later, as technology developed, the animal was replaced by a motor or engine. From this crude beginning, man's desire to travel further and faster has brought forth new and different means of transportation. During this same time span, man had been fascinated by the concept of flight which was considered the ultimate mode of travel (Rotor, 1991).

If one reviewed ancient history from many parts of the world, it would be apparent that man has had a strong interest in flight for thousands of years. This interest was reflected in art, myths, songs, and religious beliefs dating back to at least 3,500 BC. It should not be surprising that history has recorded many attempts of man

trying to fly. These efforts ultimately led to the invention of "flying machines." Perhaps in no other science except aeronautics had the dreams of man remained so strong for such a long period of time. These dreams were still driving man in 1994 as he tried to fly further into space (National Aeronautics and Space Administration [NASA], 1994).

By the late 1800s, glider flights were being conducted in Europe, North and South America, and in other foreign lands (Ward). Once lightweight gasoline engines were invented, powered flight began (Walsh). The experiments of the Wright Brothers, from 1903 through 1908, were considered by many to be among the earliest such activities (Josephy).

In the beginning years of flight, air crashes were fairly common and seemed to be an acceptable outcome of attempts to fly. Investigations of these accidents played an important role in the development of the art, science and mechanics of flight. As aviation matured, the use of aircraft became more common and accidents were no longer an acceptable risk of air travel. In response to public concern over aviation safety, in 1926 the federal government began regulating aviation activities and investigating accidents as a means of improving safety (Air Commerce Act).

The initial goal of accident investigation was to meet technical needs, that is documenting causes of accidents. In this manner, improvements were made to materials, designs, fabrication methods and support systems; such as radio communication, navigation, training, airports, and weather reporting (Civil Aeronautics Act of 1938). However, in the 1990s, the results of government investigations were not primarily being used to improve aviation safety. The social needs of accident investigation, that is to determine fault, had become the most sought after information (Miller, 1993; Wolk).

This change, from technical to social needs, created conflicts in the teaching and carrying out of aviation accident investigations. These tasks were of great importance to public safety. The NTSB stated in its Fiscal Year 1994 Budget, "the Safety Board's independent investigative role is essential to the Board satisfying the public's demand for [a safe aviation system]" (p. 101).

The review of the literature begins with the development of flight, from man's early interests to 1994. This is followed by reviewing the data on the use of accident information to develop and perfect technologies that were being used to carry out successful flight activities such as aircraft structures, engines and aviation support systems. It also addressed the public's

reaction to flight and concern with threats to public safety as a result of aviation activities. This concern was reflected in the actions taken by government organizations which responded to the public's desire for aviation safety. The government's response to public concern was the creation of laws or policies which were designed to ensure the welfare of its citizens. Also reviewed were the aviation industry's responses to the public's interest in aviation accident investigations.

The research identified the various academic institutions, military organizations, government agencies, and commercial businesses that operated schools or conducted formal courses on the art and science of Aviation Accident Investigation. Data from these organizations was collected and analyzed for course objectives, content, and any administrative factors that might have been of significance to the study, such as limitations on who could attend various schools. The review then discussed the social needs, or legal aspects of the aviation accident investigation process. Information on the conflicts and quality problems that existed during the investigation process were then documented.

In this manner, the conflicts between the technical and social needs of aviation accident investigations became obvious. The existence of conflicts was measured by

reviewing the content of aviation legal decisions, trade journals, newspapers, public speeches by leaders of the aviation community, and other similar sources of information that addressed this subject.

The summary of the research recaps the factors which had created the conflicts between the technical and social needs of aviation accident investigations. The "findings" were intended to provide the reader with a logical basis for understanding the aviation accident investigation system as it existed in early 1995. It supported the recommendation that changes were needed in the philosophies being taught and used by aircraft accident investigators, and in the laws and government policies that regulated this activity.

Rand, a well-known author and lecturer, stated that a full and complete understanding of history should help us to be able to realize what factors influenced the development of society as we now see it. Rand said,

> The study of history is important when trying to determine why certain events took place...It is important that any study of history cover a large enough time period so that one can see a true trend within the events that seem to be taking place. Perhaps what I am seeing is a fad, or the result of unusual events...to really understand man's actions, I must know what preceded his visible acts that I am looking at. History must be studied from a long term perspective" (Rand quoted by Peikoff, 1985).

Since one of the factors studied in this research was aviation and how it developed, a review of aviation history literature was selected as the starting point.

Aviation History

As Taylor and Munson stated in History of Aviation, the "image of the winged object...repeats itself the world over, in the legends and folk stories of many nations for many centuries" (1972, pg. 9). At various times during history, man looked up into the sky "to envy the flying bird soaring freely overhead" (Ward, p. 10). This might have been more than envy. "Perhaps man only sought to escape from the wild creatures of that time period; creatures which desired to eat both man and bird" (M.K. Hynes, 1991, p. 8).

Aviation is a modern undertaking, less than 100 years old. However, the fascination and interest among mankind about the concept of flight had been well documented for several thousand years. The "dream of human flight is displayed throughout art, myths and religion" (Ward, p. 10). In about 3,500 BC, Babylonian artists had carved into stone the story of Etana, the shepherd who flew on the wings of eagles. In the history and culture of ancient Japan, the War-God Maris, and in China, the flying chariot of Ki-Kung-Shi are mentioned. The Persian King Kai Ka'us,

in 1,500 BC, had a "Flying Throne" (Ward). In Greek mythology, and halfway around the world, in Peruvian writings of the Inca civilization, myths existed about Kings who flew (Vivan, pp. 8-9). On every continent records of "flight" by special men or gods can be found.

The invention of a kite, large enough to support the weight of a man, was technically possible more than 2,000 years ago in China or Southeast Asia (Boyne, 1987). Even the Bible, both in the old and new Testaments, included many references to flight. Based on these widespread literary discoveries, it was obvious that man, from the first moments of recorded history, had an intense interest in flight. Considering the diversity of locations and social cultures that have had depiction's of flight in their art, myths, songs and religious literature, the interest in flight can be considered universal.

By the early 1500s, da Vinci was writing about the concept of flight from a more scientific viewpoint, but his writings were not made public for several hundred years (Richter, 1970). In about 1670, the writings of Lana, from Spain, included some material on flight which also reflected a high level of scientific research (Vivan). Perhaps Lana foresaw the social impact of flight when he wrote, "God would surely never allow such a machine to be

successful, since it would create many disturbances in the civil and political governments of mankind" (Vivan, p. 31).

On the South American continent, in the very early 18th century, de Gusmao, a Brazilian, was also conducting aeronautical studies and may have made a birdlike model that glided (Boyne). The earliest official record of "flight" was the Montgolfier brothers, who on June 4, 1783, near Lyon, France, built and flew in their balloon (Boyne). Many other examples could be cited to prove this unbroken chain of man's interest in aeronautics for several thousand years.

Moving to the beginnings of "modern" aviation, by the late 1800s, more formal and organized interests in aeronautical matters were appearing. For example, the Royal Aeronautical Society of Great Britain (RAeS) was founded in 1866 (Josephy). In America, the Aerial Experiment Association was founded in 1903 by Dr. and Mrs. Bell and others, including Army Lt. Selfridge (Ward). In France, the Federation Aeronautique International (FAI), the world's oldest, still in existence aviation organization, was formed in 1905 (Burnham, 1977). The Aero Club of America was also formed in the same year to promote the safe, scientific development of aviation in America. The club actually certified pilots and issued flying licenses some 20 years before the federal government's

activities in this area. (Robie, 1993). These organizations acted as clearing houses for technical aeronautical writings. They also published detailed information on experiments that were being conducted. In some cases they funded design efforts which were then freely exchanged from one inventor to another, as was common practice at that time.

To most Americans, the phrases "flight" and "Wright Brothers" were strongly connected and implied that the Wrights' efforts in the early 1900s were the beginning of the modern era of flight. However, a study of early aeronautical history, which includes activities connected with kites, balloons, gliders, helicopters and airplanes, "shows an amazing parallel of efforts among many people, at far apart locations, all taking place at the same time" (M.K. Hynes, 1991, p. 13). In all cases, the lack of a small, lightweight engine was the delaying factor to accomplish powered flight (Combs, 1979).

In the late 1800s, only steam engines were available. They produced about one horsepower per 100 lb. of engine weight, much too heavy for use in an aircraft. The Wright Brothers designed and built their own light weight gasoline engine which produced about one horsepower for each ten pounds of weight.

When one considers the distances between the geographic locations of the various inventors of flying machines, and the existing means of transportation and communication at that time, it was amazing how many parties were coming to the same discovery at similar times. Listed in the first edition of Jane's All the World's Air=ships, [sic] were aeronautical activities in 15 different countries, not including Canada, Mexico, Central and South America (1909, pp. 372-373).

For financial reasons, once the Wright Brothers thought they had learned how to control an aircraft in flight, they no longer shared the results of their experiments with the aviation community. Therefor from 1903 to 1908, the Wright flights were conducted in secret to protect their pending patent applications (Garrison, 1993). Meanwhile, other aviators were busy flying their own designs. By 1909, Jane listed some 91 such efforts in the US and over 350 inventors in other countries (pp. 372-373). Many of these early aviators were making public flying demonstrations of their designs and aeronautical skills, winning fame and fortune while the Wrights flew in secret. For example, Curtiss was awarded the prize for making the first flights over New York in June 1908, some five years after the Wrights flew at Kitty Hawk (Shamburger, 1968). It was felt that perhaps the

preoccupation of the Wright Brothers with the monetary aspects of their invention actually held back the development of aviation in America.

During the five year period, from 1903 the date of the Wright's first flights, to 1909 when they secured a purchase contract from the Army, other aviators were conducting most of the world's flight demonstrations and flight training. In 1909, Jane had some 170 aeronautical projects listed underway in France vs. only 91 in America (pp. 372-373). By 1912 Jane listed 30 countries (p. 5). The center for this activity was Europe, especially France.

The Germans brought the novelty of the airplane into the reality of current events. "Like a tale from ancient mythology of 2,000 BC, fire raining down from flying vehicles became a reality during World War I" (M.K. Hynes, 1991, p. 24). Germany, in preparation for war, had a fleet of almost 600 airplanes which they used in their initial military planning (Vivan). Other countries had only limited aviation resources. In 1914, just before the US entered the war, there were only 23 aircraft in America's military fleet (Bridges, 1993).

World War I brought the "fun" aspect of flying to a halt because most aeronautical activities were directed toward the war effort. The first "mass" training of aviators was conducted by military organizations in

Germany, France, Italy, England and America. At the end of the war, these aviators became the foundation for "the age of commercial aviation." Aircraft manufacturing techniques were also improved to meet the needs for military aircraft. During the last year of the war, 1918, US aircraft manufacturers were capable of producing 21,000 airplanes per year (Bilstein, 1984). Some 29,000 aircraft were produced during an 18 month period, 1917-1918 (Haggerty, p. 1). However, the end of the war caused the new aviation industry to collapse just as it was getting started.

The daring and romantic military pilots of the day did not wish to give up the thrill of flying and return to the lifestyles or tasks of mere earth bound mortals. "It's not that flying is the most important thing in life, it's just that all other pursuits of man are so trivial" (Rotor p. 7). Surplus military aircraft, available for very low prices, were bought by these pilots and the famous magnificent men and their flying machines began their barnstorming in America (Josephy).

About twenty years later, the airplane again became the catalyst for a World War in spite of an earlier prediction by Orville Wright in 1918 that, "The aeroplane has made war so terrible that I do not believe any country will again care to start a war" (Cited by Bilstein, p. 39). In 1939, World War II started when Germany used airplanes

to attack Poland (Rhodes, 1993). Two years later, on December 7, 1941, the world again saw fire raining down from flying vehicles like a tale from ancient mythology. Japan used airplanes to attack Pearl Harbor, bringing the US into World War II. This war lasted longer than WW I and needed large quantities of equipment. Therefore, it was necessary to create a new aviation industry to meet the war needs (Ward).

As part of this planning, in early 1940, President Roosevelt signed into law the CPT Act. While it was publicly stated that this was to "foster the growth of the new aviation industry," (The CPT Act of 1939, Preamble, p. 4), some believed that its true purpose was to train pilots for the coming war. Pisano wrote that the CPT was "to serve as an economic panacea for private aviation, a neglected segment of the industry, and as a bulwark in the national defense that would provide trained pilots in the event of a war emergency" (1988). America did not want to enter into a second world war as ill-prepared as it was for World War I.

According to the Civil Aeronautics Journal, in 1939 the first year of the CPT program, some 9,350 civilians were taught how to fly at 435 American colleges and universities. By 1940, 700 non-college flight schools had joined the pilot training program (1940, p. 3). With the

initiation of World War II, the CPT program was placed under the direction of the CAA, War Training Service. From December 1941 to August 1945, some 435,165 pilots were trained under this program (FAA, 1974).

As a result of the war effort, the engineering, manufacturing and operational aspects of aviation were also greatly advanced. For example, the rate of airplane production peaked at 96,318 aircraft in 1944, over 9,000 in the month of May. However, the end of the war brought a repeat of the aviation industry collapse which took place after World War I. In 1944, two million people were manufacturing aircraft; less than 12 months later, only 219,000 people were so employed, and the number was still dropping rapidly (Ward, p. 158). A good percentage of military aviators, like their counterparts of almost half a century earlier, wanted to stay in aviation. While potential growth was there, it was not until over 20 years later that civilian aviation really became a major industry in America and other countries.

The collapse of the aviation industry after World War II was similar to what happened after World War I. A major difference between the two events was the fact that the quantity of aircraft manufactured and number of pilots trained in the early 1940s was far greater than what took place during World War I. Also, the state of the art of

aviation was at a much higher level of development, almost reaching the "jet age" by 1945.

Less than five years after the war ended, de Havilland began flying the Comet jet liner in England. The plane was certified in January 1952 and put into service by British Overseas Airways Company five months later (Ward, p. 168). The Boeing Airplane Company began testing its model 707 on July 15, 1954. After four years of extensive tests, this aircraft was put into commercial service and air travelers were able to fly in an American jet airliner for the first time (Josephy, p. 375). Industrial diversification in America, the GI Bill flight training programs, general economic prosperity, and filling the dreams of thousands of ex-military aviators combined to form the roots of a modern air transportation system. Even the market for small aircraft prospered. The Cessna Aircraft Company was producing over 10,000 aircraft per year, and by 1978 six firms produced 17,811 small aircraft in the US (Bulkeley).

By the mid 1990s, millions of people were traveling by air (Pena, 1995). This mode of transportation had matured to a level never imagined by the Wright Brothers or any of the other dreamers who lived centuries before them, or during the 90 years after the first flights in 1903.

However, in the early 1990s, the blue sky of aviation was not without some dark clouds. In the preceding ten

years, the "general" aviation industry, that is the manufacturers of small aircraft, had seen their industry collapse for a third time. This collapse was not connected with the end of another war with some foreign power. According to Aarons (1993), this collapse was connected with an ongoing war with America's consumers, social system and legal community.

In spite of the fact that there were over 700,000 pilots in America in 1993 and about 85,000 new pilots starting flying lessons each year, (Aircraft Owners and Pilots Association [AOPA], 1993) from its peak production of 17,811 airplanes per year in 1978, it was estimated that fewer than 300 new "small" aircraft would be manufactured in the US in 1994 (FAA Aviation News). The blame for this reduction in manufacturing activity was directly placed on the existing system of aviation accident investigation and how the results of these investigations were used in the American legal system (Tripp).

In 1993, during congressional hearings, Boeing's T. Collins said defense of liability claims resulted in the lack of new aviation developments and the destruction of the small-plane market (AIA NEWSLETTER, 1993, December, p. 4). Ever since Meyer announced in 1986 that Cessna, the world's largest aircraft manufacturing firm was stopping the manufacture of all small aircraft because of product

liability problems, the aviation community had been trying to get legislative relief for this problem (AIA, 1993). Millar, President and owner of Piper Aircraft, in an article for the firm's newsletter Piper Today wrote, "...the immense cost of defending unmeritorious lawsuits and paying unreasonable jury awards erodes assets and resources (time, people and money) that could and would otherwise be spent on the advancement of personal aviation" (1989, p. 1). Thus, these and similar statements documented and supported the seriousness of the problem being studied by this research.

Aviation Accident Investigation History

Anyone who read Greek mythology should be familiar with Daedalus and his son Icarus. Daedalus was considered a great scientist and inventor of a few thousand years ago. His engineering studies and inventive efforts were among the first recorded accounts of mechanically assisted manned flight.

Upon finding himself and his son imprisoned on the Isle of Crete, Daedalus invented and built wings so they could fly to freedom. During their daring escape, "the son, Icarus, imprudently climbs too high in the sky, the heat of the sun melts the wax which holds the feathers

(wings) together, and the young man plunges to his death" (Bonnefoy, 1991, p. 388).

This might be considered the first detailed aviation accident report. However, one could ask several questions about this event. Was this pilot error? Was this a failure to warn? Was this a failure to properly train the pilot? Was this a design defect? Was this a failure to test properly? Was this a material failure (remember the wax melted)? Was this improper assembly (the feathers came loose) or a defective design since it failed to incorporate a "fail-safe" design concept? Since Icarus drowned in the sea, it is obvious that the necessary emergency equipment was not on board the aircraft.

A proper accident investigation process must consider all aspects of an accident and then eliminate as many of the potential causes as possible. During the January 1995 NTSB public hearings on the USAir Flt 427 accident of September, 1994, McGrew stated that Boeing identified 85 potential causes for this accident and had eliminated 34 of them as of the time of the hearings.

However, at this hearing, Brunner, spokesperson for the families of Flt 427, and others expressed their feelings that the investigation should pursue as an ultimate but perhaps unpleasant goal, the determination of "who" was at fault. According to the literature, it

appeared that not everyone in the aviation community and accident investigation system was willing to accept this concept.

The conquest of flight had not been without constant risks. For centuries, since man first leapt from high buildings in an attempt to glide down to earth, or went aloft in hot air balloons, accidents took their toll in broken bones and occasionally human lives. However, it was not until 1908, when Selfridge was killed during a flight at Ft. Myer, Va. that an "official" aviation accident investigation took place.

Selfridge was an accomplished inventor and aviator in his own right, having designed and built the "Red Wing" and the "White Wing" in early 1908. According to Selfridge's Army records, he was the first military aviator of a powered aircraft as a result of his flight in the "June Bug" on May 19, 1908. Selfridge had gained flying experience while he was a member of the Aerial Experiment Association.

The accident in which Selfridge was killed occurred at about 5:18 p.m. on September 17, 1908. At 10:15 a.m. the next day, an Aeronautical Board of the Signal Corps convened at Fort Myer, VA, "for the purpose of investigating and reporting upon the cause of the accident." By the end of the business day, a span of about

six hours, the investigation was complete. During this one day investigation, "The Board visited the scene of the accident, questioned witnesses very carefully and examined the machine" (Squier, p. 2).

Because the aviation industry was new, there were no tax funds available to enact and enforce any national aviation laws or create a system which might include investigating accidents. Thus, the aviation community did not have any uniform regulation or accident investigating/ reporting system until the mid 1920s (Shamburger, p. 100). Whenever an airplane accident took place, usually only the pilots, inventors and perhaps their financial backers, had any interest in what caused the accident. Any "official" government investigations were limited to military aviation accidents.

After World War I, with the beginning of the barnstorming age of aviation, the public began to be exposed to, and were becoming victims of, air crashes. In some cases, when the accident took place within city limits, or near populated areas, the city police or local sheriff would conduct an "investigation", but at best, this was a non-technical undertaking.

As the frequency of these events increased, it brought about public demands for more restrictive aviation laws which drove the enactment of the 1926 Air Commerce Act.

This law provided for the investigation of civilian aviation accidents, and the public reporting of the findings of these investigations.

Under the provisions of the 1926 Act, in an effort to placate the military, a major portion of the staff of the new aviation section, which was part of the Department of Commerce (DOC), were military aviators. This tradition remained for the next half century or more as each "new" government agency created to supervise aviation continued to employ large numbers of ex-military personnel.

Beginning with the knowledge of the early Army aviators, who might have investigated an aviation accident while they were in the military, some non-military federal employees became more skilled at the investigation task by "on the job training." The skill levels of some of these government investigators began to develop to a very high level of expertise. In 1995, "learning by doing" was still the "official" method of training government aviation accident investigators.

With the passage of the Civil Aeronautics Act in 1938, a new agency of the government, called the Air Safety Board (ASB), was created in November of that year. This group was disbanded but reformed as the Civil Aeronautics Board (CAB) under the provisions of the Government Reform Act of 1939 (Journal of Air Law and Commerce, 1939). Over the

next few years, the staff of the CAB truly became the "first detectives of the sky" (Dorman, p. 13). For example, they pioneered the concept of using x-ray equipment to find failures in aircraft parts.

In 1958, after several airline accidents, the public demanded more government control of aviation to improve safety. President Eisenhower called upon Congress to create a new branch of government, the Federal Aviation Agency, "to foster, promote, and regulate aviation" (FAA Act of 1958). As Dunbar stated, "The FAA's mission is paradoxical" (1994). This new organization did not acquire any of the accident investigation functions of the CAB.

Eight years later, in 1966, again in response to public concern over several major airline accidents, President Johnson proposed a new "super" government agency, the Department of Transportation (DOT). This was accomplished by the passage of the DOT Act of 1966. Within the structure of this organization, a "new" Federal Aviation Administration (the second FAA) was also created. Unlike the first FAA, this new DOT/FAA was given the duties of investigating accidents. A special section of the DOT was set up for this purpose. This new group was called the NTSB and took over the accident investigating functions of the CAB.

On April 1, 1967, with the nationwide transfer of only 185 technical and clerical personnel, the CAB ended its 27 year history of investigating aviation accidents and began functioning as the DOT-NTSB (NTSB INtsb Newsletter, 1992). Importantly, there was a major difference in this group's function. These former CAB investigators, now working for the NTSB section of the DOT, were responsible for investigating accidents that took place in any of the five transportation modes that the DOT regulated: air, water, rail, highway, and pipeline. Their workload quickly became overwhelming.

Because of intra-agency conflicts within the DOT, this organizational structure of the NTSB did not work smoothly. In 1973, the NTSB testified before Congress that "unless it is totally separate and independent from any other agency" it cannot function properly (NTSB 1994 Budget, 1992, p. 101). In hopes of resolving these conflicts, Congress passed the Independent NTSB Act of 1974 saying: "No... agency can...perform...[accident investigations] unless it is totally separate and independent..."

This act created a fully independent agency which was the only government organization that had the legal right and power to investigate aviation accidents. Thus, the concept of improving safety through the investigation of aviation accidents, which originated with the Air Commerce

Act of 1926, was carried into the modern age of air transportation.

Control of Accident Investigations

There had been many stages during the formation of the existing government control of the aviation accident investigation process. Outside of the military, initially there was very little government regulation of aviation, let alone any process of accident investigation. Some communities responded to their citizens concern for safety and did enact "local" laws (Jericho, 1991). Because of the mobility of the airplane, the aviation industry and the legal profession realized the complexity of complying with dozens of local or state aviation laws. These two groups joined forces and organized a campaign to make Congress aware of the need for national aviation laws.

In 1911, Gov. Baldwin of Connecticut asked the American Bar Association (ABA) to promote federal aviation laws. This campaign took on a formal status at the ABA convention, which was held at Cheyenne, WY in 1921. Of importance was the fact that these first laws, in combination with the other aviation laws enacted over the next 74 years, greatly expanded federal control over aviation and the accident investigation process.

The 1926 Act gave the federal government the authority for investigating and reporting on aviation accidents. The first such published document on aviation accidents in America was a DOC report to the Senate dated February 24, 1931. This was a recap of the information received by government authorities of aircraft accidents that had taken place between May 20, 1926 and May 16, 1930.

Prior to this, there was no system in place for recording aviation accidents, nor any staff to investigate or analyze them (DOC, 1931). Along with the technical and statistical data contained in this report, there was a letter from Young, the Acting Secretary of Commerce. His letter stated the limitations of these accident reports. It also outlined the philosophy that existed when the concept of government aviation accident investigation was founded.

In his letter Young wrote:

1. No authority has been granted the (Commerce) Department to hold hearings...preserve evidence or engage in other similar procedure in the matter of investigating accidents.

2. ...in many cases...evidence of the cause of the accident does not exist.

3. Therefore, the assignment of causes as shown are to a substantial extent premised upon opinion and conjecture. (pp. ii)

Several of these limitations still existed in 1995 and were causing the conflicts being researched. It might be

of note that according to the 1931 report, in the early days of aviation, pilot error caused about 43.3% of the accidents and material failure was about as frequent. By the 1980s, Nelson felt that pilot error accounted for over 80% of all aviation accidents (1983, p. 19). In 1990 Taylor claimed that it was up to 90%.

Twelve years after the 1926 laws, Congress passed the Civil Aeronautics Act of 1938. This created the ASB, and in 1940, the formation of the CAB. For the next 26 years, until 1966, the CAB investigated and issued reports on aviation accidents. A new federal government organization, the Federal Aviation Agency, was formed to "foster, promote and regulate" aviation by the FAA Act of 1958. Because of the importance of accident investigation, the CAB continued to carry out aviation accident investigations and publicly report their findings on the causes of these events.

In 1967, with the formation of the DOT, a "new FAA" (Federal Aviation Administration) was created. (The first FAA was an agency.) Also created within the DOT was the NTSB. All of the CAB accident investigators and their supporting staff, 185 persons, (NTSB, INtsb) were transferred into the new DOT/FAA to fill the needs of the NTSB. Because of the expanded role of multi-modal transportation system investigations, it was obvious that the former CAB investigators would have to rely upon other

agencies for manpower. Therefore, the FAA and the other transportation agencies, water, rail, highway, and pipeline, provided manpower to the NTSB to conduct accident investigations.

From the enactment of the Air Commerce Act of 1926 to the Independent NTSB Act of 1974, and up to the time of the study, the federal government acting through one of several different agencies had acquired the sole "right" and authority to investigate aviation accidents. Existing laws not only gave the NTSB this right, it excluded all other parties from having access to accident sites, physical evidence, and witnesses. In some cases, the written reports of NTSB staff that contained the results of investigations were not available for public use (The 1974 Act).

The power of the NTSB to carry out their investigative tasks, and to maintain exclusive control of their work products had been challenged in various State and Federal courts on many occasions. The law firm of Gardere & Wynne, in their Aviation Law Newsletter, quoted many cases, such as Miller v. Rich, where parties challenged the refusal of the NTSB to allow access to accident evidence (1990, p. 3).

The public's need for factual information for litigation purposes, the social aspect of the aviation accident investigation process, did not seem to have been

addressed by either the academic community or government authorities.

Aviation Accident Investigation Schools

For the last 90 years, from 1906 to 1995, the two major centers for aviation accident investigation expertise were the military and the civilian sector of the Federal government. The military's role began with the Army Aviation Corps which was expanded through the formation of Naval aviation in the early 1900s and the creation of the Air Force in the late 1940s. The civil government's role began with the formation of the National Advisory Committee on Aeronautics (NACA) in 1915 and the CAA in 1926. This was later followed by the CAB in 1938 and the first FAA in 1958. The DOT, with its new FAA and the NTSB, was created in 1967. The NTSB then became an independent organization in 1974. Because the federal government, acting through either the military or a civil agency, was the major money source for aviation research and buying the technology developed, it had an interest in accident investigation.

The CAB, with its roots being formed by the Air Commerce Act of 1926, was well established in the aviation accident investigation business at a very early stage of aviation development. In spite of the various changes to its structure, the civil aviation accident investigation

function of the federal government had remained fairly intact as the transitions were made from the CAA, to the ASB, to the CAB, to the DOT/NTSB, and then to the independent NTSB.

Since about 1919, many Army aviators felt they were "step-children" of the artillery and other branches of the Army. This was especially true when it came to funding and trying new combat techniques that would give aviation a more important role. For the most part, Army aviators were anxious to gain independence from their "ground thinking" superior officers. This dissatisfaction deepened and was discussed by Rearden (1960) in the History of the Office of the Secretary of Defense. This problem and conflicts between the Army and Navy over "air power" was resolved by creating a new branch of military aviation, called the "Air Force." This was accomplished when President Truman, through enactment of the Key West Agreement, formed the Air Force, a new military aviation unit.

With this newly gained freedom, and advanced technology at hand and on the horizon, the Air Force began to take a new look at how they investigated accidents. In the early 1950s, the Air Force commissioned a study on this subject. The University of Southern California (USC) was the successful bidder for this contract (USC, 1993).

After the USC study was completed, the Air Force formalized the aviation accident investigation training process by the creation of a special school to teach this skill to its personnel. Since the Air Force was pleased with the work USC had performed on the original study, it was not surprising that USC was awarded a contract to teach this subject to Air Force personnel (USC, 1993). For the next 40 years, USC taught aviation accident investigation at the "USAF Flight Safety Officer School." The first classes were taught at the USC campus in Los Angeles, but later classes were at Norton AFB in CA. By 1993, over 5,000 students were trained under this program (ISASI Newsletter, 1993).

The long relationship between USC and the Air Force was broken in 1993 when two events took place. First, Norton was one of the military installations selected by Congress to be closed, forcing the relocation of this Air Force Mission. Second, in 1993 USC was not the "low bidder" on the contract for this program. (G. Parker, personal communication, October 19, 1993). The program was moved to Kirtland, AFB where it was taught by the Southern California Safety Institute (K. Kinkle, personal communication, November 9, 1993).

At one time, other branches of the military sent their staff to the Air Force School operated by USC. However, in

a very short time, the Army was creating its own "air force" and opened a school at Ft. Rucker, AL. The Army wanted a school which was directed more to teaching accident investigation of the type of equipment operated by the Army, such as attack helicopters and small observation/transport aircraft vs. the Air Force type of aircraft (DeLear, 1977). The Navy also developed their own school, called the "Post Graduate School," at Monterey, CA (Navy, 1957).

As stated in the Navy's aviation accident course guide, "The very tap-roots of the safety effort are the aircraft accident investigators....The investigation must be pursued for the dual purpose: to determine the cause of the accident, and to discover any malpractice and faulty procedures or equipment associated with the cause" (1957, p. iv).

Because of the rapid turnover of personnel in the military and the temporary nature of military accident investigation teams, no long term or highly experienced staff of investigators had been formed within the military services. For example, in 1992 at Norton AFB, the Air Force Safety Agency had a staff of about 220 persons, of which 160 were clerical or administrative in nature. This organization was the center for all Air Force accident

investigations (D. Alberico, personal communication, August 29, 1994).

Only 16 pilots, 12 engineers and two maintenance specialists were assigned to this mission (Forum, 1992). To help offset this under staffing, outside contractors, suppliers of hardware, and in some cases even FAA or NTSB staff, have worked with the military during some accident investigations (Kolstad, 1991, p. 2). Considering the worldwide nature of the Air Force's operations, and the fact that some 50 accidents and 5,000 incidents occurred and were investigated each year (Alberico), the size of this staff seemed to be very small.

The military had excellent accident record keeping abilities and modern, computer driven statistical analytical systems. They also had engineering staff and other specialists, such as medical and human factors engineers, who gave support to major accident investigations. Military accident investigation schools had a very narrow focus, few long term or repeat students, and their curriculum addressed highly specialized equipment. These schools were not open to the general public.

The other organization with extensive experience in aviation accident investigation was the CAB, known as the NTSB since 1967. Having begun its operations with a

nationwide staff of less than 30 investigators, no large scale training program was ever undertaken by the CAB. New CAB investigators received their training "on the job," working under the supervision of experienced investigators. This was the method of training accident investigators that was still used by both the FAA and the NTSB in 1995.

Using "on the job training" when dealing with highly experienced aviation personnel may have been acceptable in the past, but conditions had changed. With the FAA and NTSB's affirmative action hiring programs of the 1960s and 1970s, this was no longer the case. The FAA and the NTSB began to employ persons who had no aviation background and at times limited education. Attempting to use on the job training to teach these employees such an important and technical task as aviation accident investigation did not result in the desired outcome. This situation accounted for some of the quality problems that were being experienced within the investigation process (R.J. Gross, personal communication, July 28, 1992).

In 1963, a "National Aircraft Accident Investigation School" (NAAIS) was jointly established by the CAB and the Federal Aviation Agency. As stated in the literature connected with this event:

> The School served as a common training facility for CAB and FAA personnel having a responsibility in the investigation of civil aircraft accidents. The curriculum was based on methods and procedures essential to support the most probable

> cause and contributing factors of aircraft accidents, the reporting of the findings of the accident investigation, and the development of recommendations to reduce, eliminate, or prevent recurrence of accidents. (1967, p. 2)

The school was located at the FAA Aeronautical Center, Will Rogers World Airport, Oklahoma City. This was an ideal site as the FAA had recently created the Mike Monroney Aeronautical Center, also known as the FAA Academy, at this location. The buildings and equipment were new and modern, and the complex contained many technical schools. Staff from other FAA schools were available to teach at this new "National Aircraft Accident Investigation School."

TSI, a new unit of the DOT, was formed and began to operate Aircraft Accident Investigation schools for the FAA, NTSB and other government agencies at Oklahoma City. The FAA was interested in finding fault or violations connected with accidents, and the NTSB was interested in finding probable cause to improve safety by preventing future accidents. This made it difficult to teach both of these philosophies at the same time to a combined group of FAA and NTSB investigators. Therefore, separate classes for each group of investigators became the norm (G. Walker, personal communication, June 6, 1992).

From time to time, for political and financial reasons, the relationship between TSI, the FAA, and the

NTSB had been modified. At the time of this research, the NTSB was conducting its own training at Washington, DC, something it had also done in the past. The content of the training had not changed significantly as a result of the move from Oklahoma to Washington.

The NTSB conducted training sessions about once per year with an average class size of less than 30 persons. Some foreign government staff and military personnel often completed the NTSB courses, but the general public was not allowed to attend (B. Strauch, personal communication, July 25, 1993).

The FAA, like the NTSB, seemed to modify its relationship with TSI and withdrew from using TSI staff. The FAA followed a policy similar to the NTSB and allowed foreign government staff and military personnel to attend their schools. FAA schools were not open to the general public (TSI, 1993).

Some government agencies, such as the Forest Service (USFS), the Customs service, and the Drug Enforcement Administration (DEA), utilized TSI or USC for most of their training (R. Johannesen, personal communication, October 10, 1992). These agencies also sent their staff to the FAA or NTSB schools, and sent representatives to the new ERAU school which opened in 1992 (B. Minter, personal communication, May 25, 1992).

The major non-government aviation accident investigation school, operated by any academic institution, was the USC school at Los Angeles. In an effort to generate additional income, and to capitalize on its work for the Air Force, USC created a civilian version of the Air Force Aviation Accident Investigation training program in about 1956. This school, which was open to the public, marketed its programs to aviation insurance companies, aerospace manufacturers, airlines, and safety personnel of aviation firms that had employees who needed this specialized training (USC).

The school was called the "Institute of Safety and Systems Management." Course schedules normally allowed for the teaching of aviation accident investigation classes approximately three times per year. By 1992, the aviation program had about 15,000 alumni (USC).

Over the last 30 to 40 years, other colleges or universities had started and stopped similar programs, but they were all small and/or short-lived. For example, Arizona State University, working with a Tempe, AZ aviation consulting firm, conducted an aviation accident related course. This program was discontinued after several years of operation (J. Tilson, personal communication, October 28, 1993).

The newest academic entry into this field was ERAU which was the world's largest and best known aviation training institution. Their main campus was located at Daytona Beach, FL and they opened a branch at Prescott, AZ in the 1980s. ERAU began an Aviation Accident Investigation School at Prescott in 1992, working with the same firm that previously worked with Arizona State. Among the colleges and universities of America, only USC and ERAU were found to have full time, "stand alone" courses devoted to the subject of aviation accident investigation (Schukert, 1982 and Williamson, 1994).

In the area of commercially operated, technical education institutions, the only school found was located in Phoenix. In 1960, the Robertson Research Group, which was the firm that previously worked in conjunction with Arizona State University, offered an independent "commercial" course in Aviation Accident Investigation. When Arizona State University withdrew from teaching this program, Robertson continued offering the course as a separate business activity under the name of "The International Center For Safety Education" (ICSE).

Robertson's main business activity was conducting research into aircraft fuel/fire containment. Because of this, the training emphasis of Robertson's programs, as taught by ICSE, were in the areas of fuel containment and

fire prevention. Robertson expanded into manufacturing some of the systems it designed as a result of government funded research. By the early 1990s, manufacturing was a major part of its commercial activities (H. Robertson, personal communication, August 25, 1992).

ICSE was the same organization that assisted ERAU in the formation of its program at the Prescott campus in mid 1992. Robertson staff also taught at the ERAU school. In the latter part of 1993, the ICSE training programs were purchased by Simula, a California firm. Other than a change in ownership, and moving from Tempe to Phoenix, the school continued the same programs (Tilson).

Similar to USC, ICSE offered their courses only a limited number of times per year. They had a "Basic Crash Survival Investigation School" and an "Advanced Crash Survival Investigation School." Each program was offered twice a year (ICSE, 1995). Of note should be the emphasis on the words "crash survival". While this school did teach investigative techniques that were to be used in aviation accident investigations, there was much emphasis placed on the survival aspect of accidents rather than other disciplines important to accident investigation.

Simula, the owner of ICSE at the time of this research, manufactured aircraft seats and interiors. Thus its training programs were somewhat slanted toward seats,

interiors, and crash dynamics vs. the fuel/fire hazard area specialties of Robertson. Staff from Robertson taught at the ICSE facility, therefore the continuity of the program was maintained (Tilson).

Non-US Schools

Since this research was limited to activities conducted within the US, little information was reviewed on schools conducted in other countries. The United States was the world's largest aviation market and supplier of aviation products. For this reason, and the fact that the CAB, NTSB, FAA and the US military made their schools available to foreign governments, very little development of aviation accident investigation schools had taken place in foreign countries. This was especially true on an academic or commercial level of technical education.

It was not unusual for the governments of some countries to have "short" courses on aviation accident investigation for their nation's investigators. In addition to having their staff complete these courses, they sent their staff to US schools. For example, in the first class at ERAU, one student was from the French equivalent of the NTSB, the Bureau Enquetes Accidents (J. Bernard, personal communication, August 6, 1992).

The best known, and most highly respected aviation accident investigation school outside of the US was the British school, "Cranfield Institute of Technology." The programs offered by Cranfield were very similar to the programs offered in the US by USC and ERAU but took longer to complete (Cranfield, 1993).

On a broader scale, the International Civil Aviation Organization (ICAO), which maintained its headquarters in Montreal, had a strong interest in aviation accident investigation. This organization was the oldest and only international body that dealt with aviation laws and other aviation matters on a worldwide basis. ICAO also had "official" or legal status among some 182 nations around the world (Lenorovitz).

Formed in the 1920s, the ICAO had drafted many regulations that dealt with aviation, especially aviation accidents. The most famous ICAO activity was the "Warsaw Convention," held in 1929. As a result of this historic meeting, a set of international aviation laws, the Warsaw Treaty, was adopted and later ratified by member states. These laws were still in effect, and they almost always were invoked when an aviation accident involved international travel (Erickson, 1992, p. i).

As Martineau-Comeau, of the ICAO Public Information Office wrote in his letter of September 17, 1992:

> ICAO develops Standards and Recommended Practices, and guidance material in various technical fields of aviation through a consultation process with States; administrations, international organizations and other aviation experts. Insofar as the Secretariat of ICAO handles the process of rules development, it is up to the States to put these rules and guidance material into practice. (personal communication, p.1)

Another set of agreements, known as the Chicago Convention, were adopted approximately 20 years later. Under these agreements, each State (Nation) has the responsibility to investigate aviation accidents within its territory, or of its aircraft when the event takes place over international waters.

ICAO had not formed or conducted any aviation accident investigation schools, but beginning in 1949, did publish an Aircraft Accident Investigation Handbook [sic.] (Navy, 1961, P. 128). In 1992, Appendix 18, of ICAO's Manual of Aircraft Accident Investigation, "Investigators' selection, training and courses", listed 42 countries with schools. The US, England, Australia, Canada, and Sweden had formal schools. The most frequently attended schools were located in the US, England and Beirut. The Beirut school, very popular among middle eastern nations, was known as the "Beirut Civil Aviation Centre."

Technical Requirements of the Investigation Process

When the aviation accident investigation process began, the main purpose of investigations was to find out why the accident took place. With this information, the inventor of the aircraft could make changes to his design or to the materials that were used to make the aircraft, assuming that pilot error was not the cause (Walsh).

This was a difficult task, as there were many potential causes of accidents. The investigating ability of these inventors and early aviators was not yet very well developed and no one fully understood the science of aeronautics. For example, when the Army conducted its first "official" investigation of the "Wright Flyer" accident at Ft. Myer, VA, the process took less than one full day. The investigating team did not even talk to the pilot, Orville Wright (Squier, p. 2). Because of this, and the briefness of the investigation, there existed several versions of why this accident took place.

It takes time, and lots of thinking, before the various potential and actual causes of accidents are fully discovered. Orville, the pilot during the accident, wrote to his brother Wilbur (1909, p. 955) to give him some of the details about the cause of the accident. Seven months later, Orville wrote about the accident in a letter to

Chanute, a well-known engineer and enthusiastic supporter of aeronautical efforts, who was also a friend of the Wright Brothers.

Chanute was at Ft. Myer at the time of the crash and he "was consulted by the Board" during the official Army investigation (Squier, Appendix #1). Chanute was therefore interested in learning more about the accident from Orville. In his June 6, 1909 letter to Chanute, Orville gave a very detailed explanation of why the aircraft crashed. These technical details were different than those contained in the November 1908 letter that Orville wrote to Wilbur.

The "official" cause of the crash was different from the explanation Orville gave in either one of his two letters. Many historians failed to read Orville's final technical analysis of the accident and used other "probable causes" which are incorrect. Using this first fatal accident as a "case history," it can been seen how complex the technical aspects of the accident investigation process can be.

Initially, engine failures were the most common causes of accidents. Senate Report No. 185, Safety in the Air stated, "Almost every commission or congressional body that has investigated aeronautics during the past generation, and investigations by governmental bodies have averaged at

least one a year since 1916, has found that...aeronautics needs, for safety and for other reasons, more powerful engines" (Copeland, p. 2).

The gasoline engine was a new invention which added to the potential for failure. Trying to make an engine that was able to produce sufficient power for an airplane, and still be very light in weight, was difficult. No prior "flight" testing could be accomplished before taking to the sky with one of these new engines on an airplane.

The most common materials used to build aircraft were wood and fabric, with wires bracing the wings and tail parts. "Box and beam" construction, similar to what was used in bridge building was a preferred design. This may have been an indication of the influence of Chanute, who was a famous bridge builder. Chanute was an active advisor to almost every aeronautical inventor, including the Wright Brothers. Chanute closely monitored the experiments that were taking place in the late 1800s, both in the US and Europe. In 1889, Chanute "wrote a scholarly little book, Progress in Flying Machines, which won him recognition as this country's best authority in the field [of aviation]" (Roseberry, 1972, p. 14).

Before the powered flight era, moderate wind conditions were sought out for early flying experiments (Walsh). By flying into the wind, the length (time) of the

flight was extended, but the distance covered was shorter. Also, the speed over the ground was kept very slow, a safer condition in the event of a crash landing. (Air speed minus the wind speed equals a lower ground speed.)

With only low powered engines available, and the high "drag" (wind resistance) of the airframe, maximum airspeeds were also very low. These low speeds did not require very much strength in the airframe. However, vibration from the engine and the roughness of the take-off and landing areas were causing fatigue damage to the airframe. If this damage was not detected during maintenance or pre-flight inspections, serious accidents usually resulted.

As available engine power increased, airplanes became larger and heavier. They began to fly faster, higher and over longer distances. Aerodynamic stress was now added to the fatigue equation. Fuel, cooling, lubrication, and other systems were also getting more complex. When these auxiliary systems failed, often the aircraft was forced to land away from an airport and on unsuitable terrain. Landing in trees and in newly plowed farm fields did great damage to aircraft.

In some cases, in order to save money and to get the flying experiments back under way as quickly as possible, hasty and incomplete repairs were made to aircraft which had crashed. This often resulted in later failures during

flight at high altitudes which then had very drastic results. These factors meant it was important to learn new skills in accident investigation so similarly caused accidents would not take place. The ability to discover "pre" accident vs. "post" accident failures became a major goal of accident investigations (TSI).

Prior to the first aeronautic laws of 1926, the Naval Appropriations Act of 1915 called for the formation of the NACA. The NACA did extensive studies on many aspects of aeronautics, such as aerodynamic airfoil testing, strengths of materials, and airframe construction methods. This organization did outstanding work and was considered "the chief factor in the recent remarkable development...of aircraft...the world over" (Copeland, p. 6). Copies of NACA reference documents from the 1920s were still being published and sold by the Navy in 1995.

Information contained in these NACA studies was often the result of investigating "failures" that took place, either before or as a result of air crashes. As stated in the Copeland report, "a thorough and searching inquiry should be made into the causes of the wreck...for the prevention of accidents of like character" (p. 1). At this time in history, all aviation accident investigation skills were still being learned "on the job". Young, in his 1930 letter to Congress, indicated that the "state of the art"

of aircraft accident investigation in the era of 1926-1930 was almost nonexistent.

Until the Act of 1938 created the Air Safety Board, which became the CAB in 1939, investigations were limited. As a result of the CAB's efforts, a clear set of technologies and techniques were developed which would be useful to the accident investigation process and could be taught to others. However, according to Lederer in a lecture on April 20, 1939, the industry still had a long way to improve. He stated, "airlines are not yet as free from danger as are our railroads, and it may be sometime before they are" (p. 4).

The curriculums of the first military Aviation Accident Investigation Schools seemed to reflect the improvements in the state of the art of the aviation industry. In reviewing the course outline of one of these early schools, "The US Naval Post Graduate School," (1957) at Monterey, CA, it was noted that the following subjects were being taught:

1. Command Responsibility
2. The Investigator
3. Essentials of Good Investigation
4. Pre-Accident Planning
5. Organization of an Investigation
6. Procedures at the Scene of the Accident

7. Wreckage Recovery and Investigation (there were 42 sub-headings under this section such as airframe structure, engines, aircraft systems-electrical, etc.)
8. Witnesses
9. Records
10. Aero-medical

It should be remembered that this school was an offshoot of the Air Force program developed and taught by USC about five years earlier. According to an early graduate of the school, much of the material used for teaching at Monterey still had the USC name on it (D. Robinson, personal communication, November 8, 1993).

Reviewing non-military government schools, it was discovered that the "National Aircraft Accident Investigation School" (NAAIS) was formed about ten years after the military programs were started in California. This school was jointly operated by the FAA and CAB in Oklahoma City starting in 1964. In addition to administrative matters unique to each government organization, the NAAIS "Course Outline and Contents" (1967, p. 2) of this school listed the following topics:

1. Aircraft Accident Investigation Philosophy and Policy
2. Aeronautical Statutes and Regulations Pertaining to Accident Investigation
3. Management of the Investigation
4. FAA Handbooks - Accident Investigation, Reporting, Notification, and Service Responsibilities

5. CAB Manual - Air Safety Investigation
6. Photography
7. Structures Investigation
8. Operations Investigation
9. Reporting the Investigation
10. Maintenance and Records Investigation (Air Carrier) and also (General)
11. Powerplants Investigation (Reciprocating-Turbine)
12. Systems Investigation
13. Witness Investigation
14. Human Factors Investigation
15. Legal Implications
16. Accident Prevention
17. Public Hearings and Depositions
18. Student Seminars
19. Special Lectures (Nonscheduled guests, evaluation conferences, and field trips)

This course was scheduled for 240 classroom hours over a six to eight week period.

The first non-government, civilian version of an aviation accident investigation school was taught at USC. It began in 1956 and was similar to the Air Force school but the civilian courses took a shorter period of time to complete. A few years later, USC had broken down the original course into several smaller segments, each one of which was offered in addition to the "Aviation Accident

Investigation Course." Some of the names given to these shorter courses were:

Gas Turbine Engine Accident Investigation

Helicopter Accident Investigation

Photography for Accident Investigation

Human Factors in Aviation Safety, etc.

There were 15 such courses. The logic behind this move was to generate more revenue for the school by making the length of each course shorter, thus more appealing to the market for this type of instruction. These courses often lasted only two or three days making them easier to attend (USC).

The newest Aviation Accident Investigation School in the US, was at ERAU in Prescott. In reviewing ERAU's 1995 course content, the following was found:

1. Overview of Aircraft Accidents/Incidents
2. Analysis of Causal Factors/Accident Models
3. Investigative Organizations, Statutes and Regulations
4. Investigation Management and Preparedness
5. Aviation Records
6. Accident Photography
7. Case Studies (a total of four at various points in the course)
8. Witness Interviewing
9. Witness Interviewing Simulation

10. Anatomy of an Accident
11. Initial Actions (upon an accident)
12. Investigation Techniques
13. Fire Investigation
14. Structures Investigation (academic)
15. Structures Investigation (at a Crash Laboratory)
16. Propulsion Systems (Recip Engines/Propellers)
17. Propulsion Systems (Turbine Engines)
18. Electrical System Investigation
19. Flight Control System Investigation
20. Instrument System Investigation
21. Composite Material Investigation
22. Rotorcraft Investigation
23. Establishing Facts - Human Factors
24. Establishing Facts - Aircraft
25. Establishing Facts - Airport/Facilities/Weather
26. Cockpit Voice Recorder & Flight Data Recorder
27. Accident Liability/Legal Implications
28. Probable Cause
29. Crashworthiness (Crash Laboratory)
30. Survival Factors (Crash Laboratory)

These items were taught at the first ERAU program in August 1992 which was conducted at Prescott and called "Aircraft Accident Investigation Course." They were still in the curriculum in early 1995. The first class, in 1992,

was intended to be a combination of both a basic and advanced course (Minter).

By the summer of 1993, the name of the course had been changed to "Aircraft Accident Investigation and Management." Other courses titled Aviation Human Factors, Advanced Accident Investigation, Crashworthiness, CFR Emergency Response, and Aviation Safety Program Management/System Safety Management were also offered. The curriculum of these courses were not much different than the original 1992 courses, but incorporated several additional subjects such as Corrosion Damage, Rejected Take-offs, Wind Shear, Icing, and Rotorcraft Accident Investigation. By 1994, ERAU required students to complete at least three of these courses to meet the curriculum requirements for an Aviation Safety Certificate Program.

The only "commercial" or private organization which offered a course on Aircraft Crash Investigation was ICSE. This school offered a Basic Course which contained:

1. Introduction to Crash Survival
2. Terminology and Basic Crash Force Calculations
3. Crash Dynamics; Crash Test Films, Case Studies
4. Ejection Seats; Parachutes
5. Team Approach to Accident Investigation
6. Human Tolerance Mechanisms, Medical Inventory Procedures
7. Crash Survivability

8. Fire Environment (two different sessions)
9. Crash Force Transmissions to Seated Occupants
10. Crash Dynamics, Acceleration, Velocity, and Displacement (plus other class sessions on Calculations, Energy Absorption, the Kinematigraph, etc.)
11. Structural Container Design for Impact Survival
12. Restraint Systems
13. Helmets
14. Energy Absorbing Seat Design
15. Fire Threat and Human Tolerance
16. Crash Survival Evaluation
17. Accident Photography
18. Fire Investigation
19. Accident Investigation Procedures
20. Evacuation

The "Advanced" course taught at ICSE covered much of this same material, but added the following:

1. Crashworthy Fuel System Design
2. Current Status, Aviation Crashworthiness
3. NTSB Damage Estimate Techniques
4. New NTSB Forms
5. Accident Investigation Procedures - NTSB
6. FAA Crashworthiness Programs
7. US Army FDR Program
8. Legal Considerations
9. Safety - The Manufacturer's View

10. NASA Crashworthiness

There was much emphasis on teaching the "survival" aspects of an aviation accident. The subjects of fire, fuel system, and seat design covered several hours of the course. A major group that attended the ICSE courses were doctors and other medical personnel (Tilson).

The similarity among all of these schools was obvious and reflected the military and CAB (now NTSB) influence. As the technology of aviation and apparent causes of accidents changed over the years, so did the curriculums of these schools. For example, the first updating of course content observed was influenced by the arrival of the "jet age." This required courses on turbine (jet) engines, advanced aerodynamics, and high altitude weather. During the early 1990s, wind shear, the cause of several major airline accidents, was added to the curriculums.

As a result of military needs and government research and development (R&D) grants, new materials, called composites, began to appear on the scene and were incorporated into airframe structures. This called for teaching investigators about "composite" materials. With the airline mid-air collision over southern California, and more recently the collision accident in Philadelphia which killed Senator Heinz, the topic of "mid-air collisions" came into the curriculum. The topic of "ground deicing," a

direct reflection of the several airline accidents that took place in the winters of 1991 and 1992, was added in 1993. The crash of an airliner in late 1994 brought "in-flight" icing into sharper focus in 1995.

The technical needs of the aviation accident investigation process were easy to identify, and as documented in the literature review, seemed to be uniform throughout the schools that taught the highly technical subject of aviation accident investigation.

The Social Needs of the Investigation Process

This section of the research addresses the social, legal liability aspects of aviation accidents. It traces some of the legal philosophies and court decisions from the 1800s to the mid 1990s. Also addressed, were some of the debates that took place during the writing of aviation laws that would regulate the accident investigation process and the funding of aviation related government agencies. Of particular importance was the usage of the terms probable cause and fault. How these terms were used, and included or omitted from legal discussions about aviation accident investigation and litigation laws, had led to the formation of the conflicts being studied by this research.

While the aviation community seemed to think the legal system's impact on aviation was a recent phenomenon, the

first significant law case of record in America was Guille v. Swan. This took place in 1822, almost 100 years before the Wright Brothers first flew (John's, 1912). This was a New York case that was taken all the way to the New York State Supreme Court (Johnson cited by Tyler, 1929).

Of note was the judge's philosophy toward aviation as he ruled on this case. He stated that an aircraft "was something in the nature of a dangerous instrumentality which...was the absolute responsibility of its owner-operator as far as any damage [caused by the aircraft] was concerned" (Cited by R. Wright, 1968, p. 105). The wording of this decision, made over 170 years ago, would certainly seem to fit the logic of many of the legal decisions that were taking place in US courtrooms in 1994 (J. Collins, personal communication, November 10, 1994).

As mentioned earlier, airplane mishaps were frequent, but seldom serious during the early years of aviation development. It was obvious that after the first powered aircraft fatality in 1908 (Selfridge), other deaths soon followed. Aviation fatalities had begun much earlier, as reported by Bruggink (1991), the first fatal balloon accident claimed two lives in 1785. Powered aircraft had introduced a much higher level of flying activity and fatal accidents became the norm. In 1913, Jane's All the World's

Air-craft [sic], listed 16 American pilots killed in 1911, 23 in 1912, and this number rapidly increased (p. 296).

At the San Diego Army Air School, the death rate was eight our of 14 students (57%) in 1915 and the life expectancy of an Air Mail pilot was only four years (Shamburger, p. 100). From May 15, 1918, when the Army first began to fly the mail, until the enactment of the new civilian air mail routes a few years later, 31 out of the first 40 air mail pilots were killed (Bilstein, p. 52). Similar accident rates were seen by the civilian aviation community.

As might be expected, this meant that the litigation of aviation matters became more common. As early as 1920, Frederick Stokey Company had published Woodhouse's Textbook of Aerial Laws. In 1928, Wingfield and Sparkes wrote The Law in Relation to Aircraft which referred to many early aviation laws including the Treaty of Versailles.

This treaty was adopted by 27 signature countries in October 1911 and is an example of the world wide interest in aviation at a very early point in aviation history. In the early years of aviation, in addition to accident cases, there were many legal actions dealing with low flying aircraft and the operation of airplane landing areas (R. Wright).

The interest in aviation litigation and law in America became so great that in 1929 the Air Law Institute was founded at Northwestern University in Chicago. The Journal of Air Law and Commerce began to be published by the University shortly thereafter. Fagg and Wigmore were the first editors of this publication which contains much early aviation legal history (Larsen, 1991). These early editions of the Journal contained articles such as McNair's "The Beginning and the Growth of Aeronautical Law." This article documented aviation laws starting with the 1906 activities of the Institute on International Law (1930, 1 (4), p. 383).

Considering the fact that the Wright Brothers were keeping their flights secret (Combs), other aviators were obviously catching the attention of the legal communities around the world. According to McNair, the first international aviation laws were adopted on October 13, 1919.

Southern Methodist University (SMU) assumed the responsibility for publishing the Journal in 1961 and began holding an "Air Law Symposium" in 1965 (Jerico). According to Tarpley, who spoke at the opening of the 1995 meeting, the SMU symposium is now the world's largest aviation legal meeting of its type. By 1995, the symposium had been held annually for 29 years.

"If one accepts a law in action concept, it is easy to believe that law is not simply a collection of cases, statutes, articles, and treatises. Law is a fluid social activity that changes with time and society" (R. Wright, p. x). The changing social concepts of law, especially as they related to aviation accidents and litigation, had placed new importance on the concepts of "cause" and "fault." The public had changed the way they expected the legal system to protect them, or help them obtain compensation in the event of a loss.

Ogburn (1945) wrote The Social Affects of Aviation, 40 years prior to the public's acceptance of mass air travel. His comments on the social affects that aviation was having on society could be magnified ten fold in 1995. The literature clearly indicated that, contrary to the adverse publicity the legal community was receiving from manufacturers and opponents of consumer rights or product liability litigation, it was society that was driving these changes. Fleming, speaking before the ABA in 1991 said, "We are not per se the most litigious society in the world...the primary reasons for an increase in litigation ...has been civil rights, consumer, and environmental-orientated legislation." Society, acting through juries and/or judges, not attorneys, interpreted laws, decided cases and awarded or denied damage claims. Aviation law

seemed to be following the general social trends of society. Claims for damages that were not allowed years ago were being found more worthy of litigation in the 1990s.

According to former Vice President Quayle, in a speech before the ABA, America was the world's leader in consumer protection and tort litigation (1991). Many countries around the world did not share America's philosophy in these areas. For example, in 1990, a 727 airliner with 16 persons aboard disappeared into the ocean about 160 miles from the south-eastern coast of Canada (Aviation Week & Space Technology [AW&ST], 1990, September 17, p. 42). Since the aircraft was of Peruvian registration and flying over international waters, under ICAO rules, the responsibility for any investigation rested with Peru (Annex 13). Peru took no action to investigate this loss because they did not wish to spend funds on this effort. Since Peruvian laws did not offer compensation to persons who might have suffered losses due to this accident, there was no perceived benefit from an investigation.

In spite of the fact that some of the passengers were US citizens, the US did not wish to spend any money on an investigation either. Since the accident took place under Canadian air traffic control, Canada had a legal right to investigate the accident. For economic reasons, Canada,

like Peru and the US, elected to ignore the accident. As of May 1995, no investigation had been conducted.

Aviation accident investigation activities can be very expensive. For this reason, economic justification, not technical objectives is often the prime motivation for investigations. In discussing this philosophy with NTSB staff, they pointed out that the NTSB requires the answers to three questions before it spends funds on an accident investigation (Schleede). The three questions the NTSB considered were:

1. Why do you want to conduct this investigation?
2. Who is going to pay for the investigation?
3. Who will benefit from the investigation?

Using the Peruvian 727 accident as an example, the NTSB explained that the 727 model was over 25 years old and no longer in production. The NTSB, Boeing and the world "already knew everything there is to know about a 727, there is nothing new to be learned from investigating this accident. It was just a random event" (Schleede). Peru had no funds for an investigation, and the US and Canada did not wish to fund an investigation on behalf of a country that had no strong political ties to the US or Canada. As far as the US passengers that were aboard the aircraft were concerned, the families of these people were mostly citizens of Peru who did not have access to a system of justice similar to that which we enjoy in the US.

Political and economic ties often influenced the NTSB's decisions to investigate international accidents. For example, Air India Flight 182 fell out of the sky on June 23, 1985, 110 miles from the coast of Ireland (Clark & Mukheajee, 1987). Since the flight originated in Canada, and there were claims made about a failure of the Canadian airport security system to detect a bomb, Canada spent six million dollars on the investigation. When the project "ran out of money" the FAA, NTSB, and India joined together and furnished 1/3 million more dollars each, the necessary funds to finish the investigation (Schleede). The NTSB maintained a one million dollar reserve fund for just such purposes (NTSB FY 1993 Budget, 1991, p. i).

From time to time, the NTSB has participated in international aviation accident investigations only because of political overtones. When congressman Mickey Leland was killed in an airplane accident in Northern Africa, the NTSB was asked to participate in the investigation (Wadell, 1990).

If countries wealthier than Peru or India have an aviation loss, they are more willing to spend funds for an investigation. This is especially true when there are also political implications to an aviation loss. For example, in 1987 a South African 747 crashed into the Indian ocean. Because of the large liabilities associated with this loss,

and claims that the aircraft "was carrying smuggled US rocket fuel," the South African government spent 12 million dollars in an unsuccessful attempt to find the cause of the accident (Schleede). According to a February 1995 report in The Aviation Safety Monitor, "All 159 aboard perished in the crash, which has been officially attributed to a fire of undetermined origin." (p. 4.)

Another example of how economic factors can drive the effort expended to find the "probable cause" of an accident is the United Flt. 811 incident over the Pacific in February of 1989. A 747 lost a forward cargo door and nine people died as a result of damage to the cabin area caused by the departing door. Even though the door was not recovered, in April 1990 the NTSB issued its report on the accident. The NTSB found that an "improperly latched cargo door" and "inadequate maintenance by United" was the probable causes for the accident (AAR-90/01).

United did not agree with the NTSB's findings. With millions of dollars in liability claims at stake, United's motivation of "finding fault" was greater than the NTSB's motivation of finding "probable cause." This prompted United to attempt to recover the missing door which laid under 14,100' of water (AW&ST, 1990, September 17, p.42). It was determined that it would cost about 280 thousand

dollars to look for the door. United, Boeing, the FAA, and NTSB agreed to equally split the cost of finding the door.

The door was found after spending only 193 thousand dollars. The door was then recovered at a cost of an additional 250 thousand dollars. The FAA and NTSB each paid 21.5 thousand and Boeing and United each contributed 103.5 thousand dollars. The actual cost of the recovery activities was much higher, but the US Navy furnished the equipment to find and recover the door at a "very low cost" (Schleede).

Upon inspection of the recovered door, the NTSB changed its probable cause findings from "an operational and maintenance error by United" to "a design error by Boeing." The NTSB issued a revised report on this accident in March of 1992 (INtsb, 1992, p. 8). The 152 thousand dollars spent by United, to find and recover the door, allowed it to save millions of dollars by avoiding the liability claims that were made against United as a result of the accident.

This is an example of where the NTSB did not wish to spend their funds to find the door because of the three question rule discussed earlier. In the mind of the NTSB, the cost of finding the door outweighed the public benefit of knowing why the door came off. Obviously even wealthy

countries sometimes limited the resources they were willing to expend on an aviation accident investigation.

If the true cause of the door failure was improper maintenance by United, the NTSB's decision may have been acceptable. However, in view of the later finding that the door design was defective, thousands of airline passengers were at risk while 747s were flying around with unsafe forward cargo door locks.

The economics of accident investigation were still a major factor in 1995. Chairman Hall, during the January 1995 public hearings on USAir Flt. 427, acknowledged that Boeing and others were spending over a million dollars on work the NTSB could not afford to pay for (1995). It should be easy to understand how a third world country such as Peru, did not have the resources to conduct any extensive aviation accident investigations. Perhaps, as reflected in "NTSB Proposes no-growth Plan (AW&ST, 1995, February 20, P. 34), this would become a trend in the US.

The economic issue of accident investigation was even more of a problem when it came time to investigate "small airplane" accidents. The NTSB utilized a system of assigning all aviation accidents to one of five categories: Major; Public Confidence; Prevention/Selected Safety Issues; Delegated; and Limited (property damage only). The public was very familiar with the "major" category, that

was what was seen on TV; the Washington, DC "go team" and many other investigators at work, public hearings, and much media coverage. The 1994 USAir Flt. 427 Pittsburgh accident was an example of a "major" investigation. All airline accidents were in the major category.

The rapid growth of the "commuter" and other airlines had created a logistical problem for the NTSB. As reflected in the AW&ST January 1995 article, "Regional Hiring, Purchasing Reflects Vigorous Growth," (p. 24) the expectation of the industry was that this growth would continue for some time. While the major air carriers were losing millions of dollars and cutting routes, closing hubs, selling airplanes, and reducing staffs, in 1993 there were 146 new airlines started (Reed, 1995). The commuter segment of the industry was seeing unparalleled growth.

Commuter airlines had more frequent crashes and might only be a five or six passenger airplane. To control the economics of investigating these events, the NTSB conducted "field office" investigations. The growth of the commuter airline market had been much larger than what the FAA or NTSB had planned. Some of these commuter planes were carrying 60 passengers in jets that were larger than what major airlines operated only ten years ago. When one of these airplanes went down, as happened in Indiana in the fall of 1994, what was the NTSB to do?

McCarthy, chairman of ALPA's national Accident Investigation Board, told the NTSB at its March 1994 Safety Symposium, these field investigations "frequently fail to uncover valuable safety information." He also felt that many of the problems with these investigations can be traced to lack of resources available to the NTSB. He further explained, "neither public interest nor significant safety issues are initially apparent" when these field investigations are conducted. (McCarthy, quoted by Steenbilk, 1994, P. 35.)

Some accidents had a high public interest, such as the accident that killed Senator Heinz in 1991. This investigation received almost as much NTSB effort as a major accident would require (NTSB: DCA91MA031A/B). Normally these high profile accidents were in the "public confidence" category and received varying amounts of the NTSB's resources to investigate. The investigation budget depended upon the media attention the accident attracted. (B. Bahler, personal communication, February 17, 1994).

The "Prevention/Selected Safety" category varied from time to time. In 1995, flight instruction and helicopter accidents were in this category. At best, this meant that special statistical data was being kept on these accidents, but no extra resources were being expended on investigating these types of events (Gross).

The "delegated" and "limited" investigations were almost always performed by the FAA, or perhaps a "phone" investigation effort was made by the NTSB. Almost all "general aviation" accidents were placed into one of these last two categories. This meant that the investigation effort would be subject to all of the quality problems previously mentioned or yet to be discussed. When one considers that more people get killed in "small airplanes" than in airliners, shouldn't the public need for factual information on this category of accidents be at least equal to the public's interest in a major investigation? With an annual average of about 1,200 lives lost in small airplanes, and less than 200 lives lost in airliners, a larger return on the "investigation" dollar in safety could be gained by better investigations of small airplane accidents.

During its 28 years of operation, as of April 1, 1994, the NTSB had investigated 100,332 aviation accidents (Steenblik, 1994). Over 99.8% of these investigations were of general aviation aircraft. Only 155 accidents were airliners (NTSB 25th Annual Report, 1993, pp. 142-145). If the NTSB's expenditures for aircraft investigations are divided by the number of investigations undertaken, the average investigation costs about $3,000 (NTSB, 1994, p. 15). It is obvious that not much of an investigation can

be conducted for $3,000 (M.K. Hynes, in press). Exact dollar amounts per investigation are not made public and the NTSB's accounting system is not organized in a manner that would allow that type of data to be accurately determined (Bahler).

In some cases investigations were conducted only "by phone" (Re. Audie v. Heli-Lift). When the FAA performed the full investigation for the NTSB, only the time it takes to review the FAA's input was needed. The NTSB's "cost" of these investigations were probably much less than the $3,000 average.

With requests for limitations on legal liability, such as Lowe wrote in support of Senate bill S.67 (1993), many people felt that laws should be passed that would further restrict aviation litigation that resulted from aircraft crashes. In reviewing aviation litigation efforts, it appeared that "finding fault" was frequently a stronger motivating force than "finding probable cause." This "higher motivation" of litigants often resulted in finding different causes of accidents than what the NTSB found as a result of their efforts (Wolk, Miller). Perhaps the public needs to rethink the concept of limiting litigation efforts which are the only means of challenging the NTSB's quality of investigation efforts.

The major driving force behind aviation litigation was economics (Madole). Aircraft accidents often involved people with considerable net worth or earning power, and the defendants were usually perceived as being capable of paying large claims (Millar). In aviation, the legal "deep pocket" theory, that is, going after the defendant who had the most money, was almost always at work. In addition to the social aspects of pain and suffering associated with aviation accidents, the economic factor supported the pursuit of justice for wrongs. According to the FAA's Economic Values for Evaluation of FAA Investment and Regulatory Programs , the value of a human life was 1.7 million dollars (1989, p. i). In an aviation accident death case, this monetary prize was worthwhile to pursue.

As new technologies came into use and new legal theories were developed, a larger need for attorneys who were skillful in dealing with aviation litigation became apparent. America's tort system was not perfect, but at the time of this study there was no other system available to resolve disputes that arose from aviation accidents (B. Wagner, personal communication, June 10, 1994).

For the last ten years there were about 3,000 aviation accidents per year in the US, over eight per day. O'Connor stated in 1994 (p. 4), there were several hundred more accidents each year which were not reported to the FAA or

NTSB. Boeing estimated that a major air crash will occur every eight days (UAA Newsletter, January/February 1995, p. 10). When public use aircraft and military aviation mishaps were added to these totals, it was clear that there would be no shortage of potential litigation connected with aviation accidents in the future.

This large level of litigation represented a major social need for accurate and prompt factual information on aviation accidents. This was pointed out by Flinn in Burden of Proof (1992). In view of the fact that any litigation must be based upon facts connected with the accident, how are these facts to be acquired by the parties that need them? Documenting the conflicts that existed between the technical and social aspects of the aviation accident investigation process was the purpose of this research.

It was apparent that society also wanted to find fault rather than just find probable cause when they went to their government for factual information about accidents. This was clearly demonstrated by the public statements of Brunner, one of the spokespersons for the families of the victims of USAir flight 427. She called for more openness of the accident investigation process (1995).

By law, the public was restricted from having access to accident sites, inspecting evidence connected with an

accident, contacting any witnesses, and communicating with the "official" government employees who were looking at the accident first hand. Of particular importance was the definition of "public" by the NTSB. The NTSB had exclusive legal control of the accident investigation process. It also had the power to allow certain parties to help it with its investigative task (49 CFR Part 800). These persons, called "designated parties", had almost full access to everything the NTSB was investigating, and in many cases were major sources of input into the "factual" reports that the NTSB would issue. Were these parties the "public"?

These parties were almost always manufacturers of the aircraft, or some of its components. The background of this tradition originated when the CAB first started investigating accidents. In the early years of its existence, the CAB investigators did not know the many technical aspects of the aircraft that were then in operation. The manufacturer was a logical source for this information, and their assistance during an investigation was not only helpful, in many cases it was an absolute necessity.

In theory this seemed logical, but it must be pointed out, that in the event of design errors, manufacturing defects, and many other potential accident causes, it would be the manufacturer who might later be held "at fault."

Did this present a potential for conflicts of interest as the manufacturer worked with the NTSB investigators? Did the fact that manufacturers, likely to be future defendants of litigation, had access to information not available to plaintiffs, tip the scales of justice out of balance? Was it possible that a manufacturer might actually mislead the NTSB, or even hide evidence from government investigators during the fact finding phase of an investigation?

Heller, an aviation reporter from Tampa, wrote the novel Maximum Impact in the fall of 1993 that addressed these very questions. While the book was considered fiction, there were some aviation experts who felt there may have been more truth in the book than the NTSB and other members of the aviation community would like to admit. Overly wrote a review of Heller's book in The Aviation Safety Monitor. This is a publication that many professional accident investigators and other members of the aviation community read. Overly stated, "Whether Maximum Impact is a book about airplane crashes or journalism--read it...get Maximum Impact and read it--just put your other appointments off" (October, 1993, p. 3). By the general tone of his review, it was obvious that there should be some industry concern with the theme of the book.

Heller utilized Galipault, a well-known and respected aviation safety expert, for technical assistance on the

book. Considering Galipault's reputation in the aviation community, it was thought that he would not have helped Heller unless he felt the book had a "message to deliver" (J. Heller, personal communication, October 27, 1993).

In addition to Heller, consumer advocates Nader and Smith, teamed up to write Collision Course-The Truth About Airline Safety (1993). According to Overly, who also wrote a review on this work in November 1993, the book contained a blistering attack on the FAA and NTSB. Overly said the book asked several important safety questions, such as, "Why does the FAA cower to the airlines and manufacturers on important safety issues?" (p. 4). Anyone who was familiar with Nader knew he was quite willing to aggressively attack any organization on a consumer issue that was safety related. Nader and Smith's book did not fail to continue this tradition as it attacked both the NTSB and the FAA on many of the points discussed in this research.

As an indication that these two books had a valid theme, in the early 1980s, several aircraft manufacturers and their suppliers, had formed a company, called "Aerospace Management Services International (AMSI)." In the interest of efficiency, this organization employed well trained aviation accident investigators who were paid to "help the NTSB during investigations." The NTSB granted

"party status" to AMSI employees and allowed them full access to accident sites and other data. However, other duties of AMSI staff during the investigation may have had a higher priority than helping the NTSB. AMSI was told "to protect the interests of the aerospace manufacturers who were the owners of AMSI. It was common practice for AMSI to submit reports to manufacturer's legal departments. In some cases, these reports were different than the reports given to the NTSB." (L. Keerfoot, personal communication, February 26, 1994.)

The influence of AMSI was protested by others who were denied party status. The definition of allowable "parties" was subject to much debate. The role that AMSI was playing became too obvious for the NTSB to ignore. After much discussion, on July 9, 1985, NTSB Chairman Barnett wrote to Stimpson, the President of the General Aviation Manufacturers Association (GAMA) that "it has come to our attention that some persons who were not employees of the manufacturer may have had or may have represented interests beyond the Safety Board's investigation." On July 10, the NTSB issued a notice to bar AMSI from investigations and conducting any tests for the NTSB. The FAA sent a similar notice to its investigators on July 15th. As of August 15, 1985, the effective date of Barnett's notice to GAMA, only employees of manufacturers would be granted "party status".

According to many, "at best this only reduced the efficiency, not the influence, of GAMA members to influence the NTSB during accident investigations" (Keerfoot).

Lest one think that Nader and Smith's, and Heller's books were two isolated cases of writers finding fault with the FAA/NTSB aviation accident investigation system, a further review of the literature found a series of articles that addressed this same topic. Lederer, who was previously mentioned as a leader in aviation safety as far back as 1939, wrote several more recent papers. One was titled, "Is Probable cause(s) Sacrosanct?" (1992, pp. 8-11). Here he questioned the narrow focus of aviation accident investigations and their failure to address the questions of cause and fault more equally. Lederer was recognized as a "founding father" and active leader of the International Society of Air Safety Investigators (ISASI). This organization was the world's only such group of individuals who worked at the task of aviation accident investigation. Lederer had also been a mentor of many who later worked in the field of aviation accident investigation.

Another long time member of ISASI, and a recognized "dean" of aviation safety and accident investigation, was Miller. He was at one time head of the CAB investigation branch and later formed his own company, System Safety,

which did extensive accident investigation work. He, like others who performed aviation accident investigations on a private basis, often had to re-examine evidence and take other steps to disprove the official "NTSB Probable Cause Report" on an aviation accident. Miller, especially because of his skills and reputation in the aviation industry, was a frequent speaker and writer on aviation safety, usually connected with the accident investigation process.

A small sample of Miller's writings, such as, "Down with Probable Cause" (1991), "Probable Cause: The Correct Legal Test in Civil Aircraft Accident Investigations?" (1992), and "Compatibility of Air Safety Investigations and Civil/Criminal Litigation" (1993), all reflected concern about two very important aspects of aviation accident investigations. These concerns were the quality of the reports and the use of the reports by attorneys during litigation. Litigation was the obvious theme of the latter of the articles mentioned. Both Miller's and Lederer's material also contained a strong anti-litigation bias. These writings also supported the existence of conflicts within the aviation accident investigation system.

In June of 1992, Air Line Pilot magazine published an article by Steenblik titled, "Probable Cause: Help, or Red Herring?" The thrust of Steenblik's message was well-

expressed in the editorial highlighting of the author's comments, "The Safety Board's fundamentally flawed mandate must be changed, and only Congress can do that" (p. 20). Of interest was Steenblik's reference to a statement by Ender who had said, "The 70 or so percent of fatal accident causes--primary or probable--ascribed to pilot or flight crew error is now being unmasked as a misleading statistic" (p. 23). Ender was vice-chairman of the nonprofit, independent Flight Safety Foundation (FSF) and had made these remarks at FSF's "Fourth Annual European Corporate and Regional Aircraft Operators Safety Seminar" (1992). Ender's statement seemed to address the point raised in this research that questioned the accuracy of the FAA/NTSB aviation accident statistical data base, particularly the "pilot error" accident causation category.

In December 1992, Air Line Pilot magazine ran another article that addressed this same subject. "NTSB: Friend or Foe?," by Shipman, an airline pilot for USAir who was also a former NTSB accident investigator. Shipman reviewed and confirmed some of the same points discussed in this review of the literature. He made an interesting quote of Schleede, the head of the NTSB's accident investigation division,

> Our (the NTSB's) primary constituent is the airline passenger, and our primary goal is ensuring his or her safety. We are an independent agency with no ax to grind. It doesn't matter to us if the cause of the accident

> is material failure, inadequate aircraft design, pilot error, or whatever. We only want to investigate the accident thoroughly so we can identify and try to correct problems. (p. 51)

Schleede's comments seemed honorable and certainly reflected the desires of society in the formation of the NTSB. However, as questioned by this research, was society getting what they wanted, in both quality and content?

Air Line Pilot magazine had a narrow but significant readership, some 45,000 professional pilots, most of whom were employed by the airlines. The decision of this publication, to print articles on this subject, reflected on both its reader's interests, and the fact that the publisher of this magazine was the Air Line Pilots Association (ALPA), the world's largest pilot union. ALPA was the only non-government organization in America that had a formal and trained aviation accident investigation team. ALPA was at times granted "party status" by the NTSB during investigations. This gave ALPA a first hand view of how the NTSB functioned. ALPA also had a credible reputation for technical expertise within the aviation accident investigation community.

Following this line of thought, an article by McCabe, published in the LPBA Journal in 1991, also focused on the content of NTSB reports. The title, "The Unreliability and Inadmissibility of Government Aviation Accident Reports," clearly addresses the two major questions being studied by

this research effort. McCabe clearly stated "it is important for people having an interest in the civil liability aspects of an air crash to get involved, if at all possible, early in the investigation" (p. 5). He then went on to discuss the NTSB policies that gave access to defendants but not to plaintiffs, something addressed by this research.

The Lawyer Pilots Bar Association (LPBA) was a unique group of people who were both lawyers and pilots. This organization, through its LPBA Journal, meetings, and seminars, was just beginning to openly discuss the existence of conflicts between probable cause and fault, something that this study undertook to document. One might hope that during their discussion of this topic, the LPBA maintained a high level of objectivity. A review of the writings (1988-1995) in the LPBA Journal, and reports of their discussions on this topic, failed to disclose any rebuttal or disagreement with McCabe's comments made in 1991.

The Aviation Consumer, which as its name implies, is a magazine that targets its content to the aviation community. The publication recently began to feature articles about the technical and social conflicts that existed within the aviation accident system. For example, in "The Great Turn-around, More Thoughts on Reversing the

Downward Plunge of General Aviation," managing editor Weeghman wrote, "Unfortunately, the FAA and NTSB seldom pay attention to the much later [and often better] investigation that attends a serious product trial" (1994, pp. 18-20). This was a clear indication of the need to question the quality of FAA/NTSB accident investigations.

If properly motivated, the NTSB can quickly respond to both the technical and social needs of an aviation accident investigation. This was proven when the NTSB responded to the loss of the space shuttle Challenger. It was ironic that initially NASA had no major "in house" accident investigation capability (Wadell, 1991). This was publicly disclosed as a result of the space shuttle Challenger accident which took place on January 28, 1986. Six days after the accident, on February 3rd, President Reagan formed a Special Commission to investigate the Challenger disaster.

The mandate to the Commission was "to establish the probable cause or causes" of this accident. The investigation was completed and the report issued on June 6th. As a result of this order, some 1,300 NASA employees, plus 1,600 persons from other government agencies such as the NTSB, Air Force, Coast Guard, and Navy, joined 3,100 contractor personnel to complete the task (Challenger Report, p. 1). At the request of the Commission and NASA,

the NTSB managed the investigation and it was estimated that over 400 million dollars were spent on the investigation (M.K. Hynes, in press).

When discussing the conflicts between the technical and social aspects of aircraft investigations, the military's approach to this problem is of interest. The military services did not utilize a concept of a centralized system for aviation accident investigation. As explained in the Flight Safety Handbook (USAF, 1993), when military aircraft mishaps occurred, special investigation teams were formed, usually by the Base Commander who had jurisdiction over the aircraft or the accident site. This team was formed for the temporary purpose of investigating the event. When the investigation was complete, teams were disbanded. Membership on these teams was rotated among military personnel and efforts were made to get different individuals for each investigation.

The reasons for this approach to the investigation process were threefold. First, local knowledge of the individuals, equipment, and mission connected with the event was valuable. Secondly, this was thought to be a type of "peer" review and useful in educating other aviators in safety lessons learned during the investigation process. An additional benefit was achieved by maintaining a "fairness," as aviators judged the acts of other

aviators, while seeking both "probable cause" during the safety investigation and "fault" during the collateral investigation (J. Johnson, personal communication, June 2, 1992).

The military conducted two investigations for each accident. One, called the cause investigation was for safety reasons, and one called the fault investigation was for liability reasons (USAF, 1993). The two investigation concept was used in the civilian world, but the cause investigation was conducted by the NTSB and the fault investigation was accomplished only in connection with litigation. Because of the NTSB's policies, the second "fault investigation" was often attempted without access to factual data obtained during the taxpayer paid for "official" NTSB investigation.

The 1991 Court ruling in the Sioux City, United Flt. 232 case seemed to reignite the issue of admissibility of NTSB data into civil tort litigation. The background of Judge Conlon's decision extends back to 1941 when congress debated Investigating Air Accidents in HR Report NO. 933.

The beginning of any discussion on admissibility of NTSB's work products should start with the statutes that contain the exclusionary provisions being challenged. Title 49 USC, Section 1441(e) states:

> No part of any report or reports of the National Transportation Safety Board relating to any accident or the investigation thereof, shall be

> admitted as evidence or used in any suit or action for damages growing out of any matter mentioned in such report or reports.

This wording was adopted as part of the FAA Act of 1958. When the DOT/NTSB was first formed, and later when the NTSB was made independent of the DOT in 1974, the legal wording was kept almost identical (PL 93-633, Section 1903, c.). This concept dated back to the original 1938 Civil Aeronautics Act, Section 701 (e). Before the testimony of any NTSB employee, this wording is read "into the record."

One of the first major tests of this law was seen in 1951 during the Universal Airline v. Eastern Airlines case. At trial, a CAB investigator was asked to testify about his investigation of the accident. No effort was made to have his or the CAB's report used during the trial. The CAB protested to the Court of Appeals, claiming under statutory exclusion, the investigator should not have been made to testify. The Court ruled against the CAB, and said, the CAB's rules were "sound so far as the Board and its work are concerned", but that had to be balanced against the governmental function of the administration of justice. The court seemed to be saying that the need of a plaintiff to have access to factual evidence was stronger than the need of the CAB to keep its work products out of court.

This practice--of letting investigators testify within limits, while still excluding written CAB reports--seemed

to be more frequent as time went by. As might be expected, aviation litigation was fairly common in US courts. There was not much uniformity as to how each court addressed the inadmissibility question v. the permitting of CAB employees to testify, sometimes even using the prohibited CAB reports to refresh their memory. In Lobel v. American Airlines, the Court of Appeals commented:

> The fundamental policy underlying (the rule) appears to be a compromise between the interests of those who would adopt a policy of absolute privilege in order to secure full and frank disclosure as to the probable cause and thus help prevent future accidents and the countervailing policy of making available all accident information to litigants in a civil suit.

For the last 30 years, that has been the question before the courts, the CAB, which is now the NTSB, and the aviation community. Are investigators able to discover more about accidents because people believe there is some form of immunity in talking with NTSB investigators? According to the results of a poll taken by the NBC TV show Dateline, this may be optimistic thinking. When asked about a major error they made, the public would admit it 12% of the time, ignore it 13% of the time, 28% would lie about it, and 43% would opt to blame someone else (October, 1994).

With millions of dollars of liability at stake, even with an assumption of immunity, most attorneys and professional accident investigators doubt the "average"

person was going to be willing to admit to doing wrong. The Dateline poll seems to confirm this observation. This inherent conflict during aviation accident investigations, the fear of losing millions of dollars by being "at fault" or receiving a violation from the FAA, keeps most people from fully cooperating with either the FAA or NTSB investigators.

Perhaps the NTSB could improve on its investigating quality to the point where its efforts would fill the dual needs of the public, both technical and social. The military seemed to be doing this with its two investigation system. Most people seem to only be asking that the NTSB improve its quality and be more thorough and neutral in its reports (Wolk, Miller, Waldock). The public would also like to have full access to factual information which was gathered by the NTSB at taxpayer's expense. If NTSB work products were of higher quality and "neutral", determining the causes of accidents and then finding out who was "at fault" would be easier. Many felt that this would decrease the need for litigation, something everyone wanted to happen. If FAA or NTSB work products had a more than 50/50 chance of being in error, the economic odds of spending money to "go to court" are reasonable. The undertaking of litigation assumes that the risk of losing is lower than

the reward if one should be the winner (M. Lessin, personal communication, April 10, 1994).

While this research had found many similar articles of interest, they all seemed to follow two lines of thought. One, the quality of the NTSB reports seemed to be suspect, and two, the fairness and ethics of the investigation system seemed to be in doubt. It was felt that the content and tone of the material already reviewed herein had adequately conveyed the existence and seriousness of the problem being researched.

Problems Within the Process

Based upon the literature that was reviewed and confirmed by communications with approximately 125 persons who had worked, or were still working in the field of aviation accident investigation, several problems existed within the accident investigation process.

For example, the FAA played a very large role in many accident investigations. It was important to note that the FAA was not legally authorized to conduct accident investigations for safety purposes (49 CFR Part 800). However, for enforcement purposes, the FAA did investigate any aviation accident of which they became aware (14 CFR Part 13). According to the NTSB 1993 Report to Congress, the FAA had some 2,575 inspectors who investigated

accidents, a number almost 50 times larger than the NTSB investigation staff (1994, p. 23).

The FAA's legal right and obligation to conduct aircraft accident investigations comes from the mandate of Sections 313(a) and 601(b) of the Federal Aviation Act. While the FAA may participate with, or actually conduct an investigation for the NTSB, it "does not make such an investigation a joint one in the sense of sharing responsibility (49 CFR Part 831.2b)." (FAA Order 8020.11, Chapter 1.)

The FAA's role "in aircraft accident investigations was to determine if any of our (FAA) nine areas of responsibility were involved." (TSI, 1990, p. 1.) The nine areas of FAA concern were:

1. FAA Facilities
2. Non-FAA Facilities
3. Medical Qualifications
4. Competency
5. Airport Operations
6. Airport Security
7. FAR Inadequacy
8. FAR Violations
9. Airworthiness

FAA inspectors, in addition to helping the NTSB, completed its own FAA Form 8020.16. Section 22 of this form deals with the nine areas listed above. Inspectors must fill out this form on all accidents. However, "He/she will not be held responsible for determinations that are deemed wrong. In fact, there is no follow-up to see if the

FAA's (cause) identification of areas match that of the NTSB's, which will be published about a year later [after the accident]" (TSI, 1990, pp. 1-2.)

While conducting its investigations, the FAA, upon the first sign of any irregularity, usually opened an Enforcement Investigative Report (EIR) and began to collect evidence of violations so enforcement action might be taken at a later time (14 CFR, Part 13). Because of the enforcement powers of the FAA, and the absence of civil liberty protections for the accused, the aviation community was strongly motivated to avoid all contact with the FAA and were encouraged not to discuss any aspect of an accident with FAA staff.

In 1990, Likakis wrote, "Trial of Steve Faber: When the Feds want your ticket, there are no holds barred." It was intended to be a clear warning to all aviators who were involved in even minor aviation accidents or incidents. "Fighting City Hall," by A. Lewis (1993) also addressed this problem. This philosophy was often extended to refusing to disclose information to the NTSB when it was attempting to determine "probable cause" in an effort to improve safety (P. Huggins, personal communication, November 15, 1993).

Because of the FAA's approach to aviation accident investigation, serious conflicts developed between the

parties involved in the accident and the "official" government investigators who may have been FAA and not NTSB employees. When the FAA was wearing their "NTSB hat" on top of their "FAA enforcement hat", it might be considered an effort by the FAA to hide its enforcement intentions. The "FAA hat" worn alone would have warned an aviator of the potential enforcement intentions of the accident investigator.

FAA investigators were trained to look for evidence of violations and their legal function was to enforce regulations. These two goals influenced FAA investigative efforts. Obviously, these goals did not match well with the NTSB's goal of promoting safety by finding the "probable cause" of accidents. Because of these conflicting goals, cooperation between the aviation industry and the FAA, in obtaining factual data on accidents, was often compromised.

The NTSB acknowledged this problem when they stated to Congress, "FAA investigators were focused on finding operator violations, sometimes at the expense of the inspector's objectivity." To add to this problem, the NTSB also stated, "...not all of the FAA inspectors have been trained in accident investigation; for those who have, necessary refresher training has been nearly nonexistent" (NTSB 1994 Budget, 1992, p. 102). In spite of the NTSB's

complaints about the FAA, in 1995 the FAA was still being asked by the NTSB to conduct investigations, but in a discreet manner. There was some degree of irony in the NTSB's comments about the experience and training of the FAA's accident investigators since the same observations applied to many NTSB aviation investigators.

Under the DOT Act of 1966, the NTSB had the legal right to ask the FAA for help in investigating accidents. When the FAA did the investigation for the NTSB, it was called a "delegated option" or "delegated investigation." When the Independent Safety Board Act of 1974 was passed, the NTSB lost its right to ask the FAA for help. The passage of this law did not seem to influence the working relationship between the FAA and the NTSB.

As the FAA's workload increased and demands for budget reduction were made by Congress to the FAA, the working relationship between the FAA and NTSB stayed the same but an agreement for NTSB to provide funding to the FAA was signed (NTSB Public Notice 1, December 19, 1986). Prior to 1982, about 75% of all aviation accident investigations were delegated to the FAA (NTSB 25th Annual Report, 1993, p. 19). In 1993, similar levels of FAA activity were still being seen (NTSB 1993 Report to Congress, 1994, p. 28). While it was not obvious by the paperwork, from a "labor viewpoint" the NTSB was still utilizing FAA personnel for

many of its aviation accident investigation tasks in early 1995. However, with all branches of government under pressure to reduce staff and operating costs, the FAA had been doing less and less accident investigation work for the NTSB. This greatly increased the workload of NTSB investigators, while at the same time the NTSB was not increasing staff positions. During the 1980s, the NTSB staff was reduced to approximately 300 employees." The NTSB staffing "has never exceeded 400 employees" and was being reduced again in 1995 (NTSB, 1994, p. 11). According to its annual budget requests, the NTSB had also reduced staff in 1991, 1992, 1993, and 1994.

The NTSB had remained one of the smallest government agencies in Washington and had no industry or public support for growth. Growth would require a larger budget, a necessary step prior to increasing the size of the NTSB's staff. As partial justification for its "no-growth plan" (AW&ST, 1995, February 20, p. 34), NTSB administrators felt additional staff and larger budgets would make the NTSB more subject to accountability, political pressure, and more vulnerable to outside criticism (Bahler).

With thousands of accidents occurring each year, it was difficult for the NTSB staff to keep up with their workload. For the last ten years or more, there were less than 60 NTSB aviation accident investigators assigned to

six regions. Their actual duty locations were further spread around the US (NTSB FY 1993 Budget, 1991, p. 75). NTSB investigation reports were often completed by FAA personnel, and then sent to the nearest local or regional NTSB office for processing. If one considered vacation time, training, and personal sick leave, on any given day, there were less than 45 NTSB personnel "on duty" to respond to accidents or to provide guidance to the FAA investigator who was working an accident file for the NTSB (Gross).

With approximately 3,000 aviation investigations to conduct, or at least review the FAA reports on them, NTSB investigators had an average of 50 case files to process each year. Based on the average case cycle time, which the NTSB reported as 14 months, at any one time each investigator might have 55 to 60 open files to manage (Hall). From the six regional offices, these reports were forwarded to Washington, DC as NTSB work products. In some cases, the report had been completed without any FAA or NTSB personnel ever visiting the accident site or inspecting the aircraft that was involved in the accident (Re. Audie v. Heli-Lift). This certainly supported claims by Wolk and others that the quality of NTSB investigations was suspect. More than once, problems with the validity or content of NTSB reports were discovered during "fault finding" litigation.

The NTSB admitted that this was not an ideal work environment. In 1993, the NTSB stated to Congress that it sensed conflicts within the ranks of its investigators, especially when it utilized FAA staff who "were more concerned with law enforcement than accident prevention" (NTSB FY 1994 Budget, 1992, p. 102). This also affected the accuracy and content of many NTSB reports, a situation which had been called into question by many aviation experts.

Several people complained about this problem in various legal and aviation trade journals. "Misconceptions About FAA/NTSB Aviation Accident Investigations" appeared in Experts at Law (M.K. Hynes, 1990) and McCabe (1991), in the LPBA Journal used the title, "The Unreliability and Inadmissibility of Government Aviation Accident Reports." Both of these articles cited legal cases where the quality of NTSB accident reports became a major issue during litigation. The title of Hynes' and McCabe's articles were meant to be a general reflection of the opinion of the NTSB that was held by many members of the legal community. Waldock also wrote about this problem, but the existing NTSB/FAA policies and work practices remained unchanged.

The number and tone of these writings increased with time. Two years later, in 1993, a well-known aviation attorney, Wolk, openly criticized the quality of the NTSB's

investigations in several major publications, including the Wall Street Journal.

The Washington, DC laboratories of the CAB, which became part of the NTSB in 1968, played a major role in attempting to prevent accidents and improve safety by determining "probable cause" for many aviation accidents. As the NTSB stated in its 25th Annual Report to Congress, "The Board's laboratories are world renowned and its technical staff is considered to be among the most experienced in accident investigation techniques" (1993, p. 101). The quality of the work of these labs was very high and had been a major factor in achieving the existing level of safety seen in the world's air transportation system.

However, NTSB labs had a very small staff, less than ten people (NTSB FY 1993 Budget, 1991, p. 85). Lab technicians had a high workload from the approximately 3,000 air crashes that occurred each year, plus major accidents in the other modes of transportation. Therefore, only a small fraction of aviation accidents, less than 2%, were considered worthy of review by these highly trained but overworked specialists (NTSB, 1993, p. 90). Because of this, as Wolk, Miller, and Waldock claimed, the quality of many of the NTSB's accident investigations was sub-standard. Perhaps the existing statistical data on accidents was masking some of the true causes of aviation

accidents and important aviation safety trends were not being detected (S. Houghton, personal communication, July 25, 1992).

It was logical then for the NTSB to compensate for its manpower shortages by utilizing other parties to conduct critical tests and technical analysis of suspected failed parts. It was a matter of policy for the NTSB to utilize the services of "interested" parties for this testing. These parties were frequently potential defendants in future litigation. Many felt this created a high potential for conflicts of interest during the testing process (Heller). Plaintiffs felt it would be better to use "neutral" parties to conduct the tests, or at least let plaintiffs watch defendants conduct any necessary tests (Wolk).

Often it is easy for "outsiders" to complain about any government agency, especially people who seem to be adversely affected by the activities of the agency being discussed. Most of the writings and comments that were reviewed so far were from outsiders "who may have had an ax to grind." What did the FAA and NTSB think about the quality issue?

In October 1991, Del Gandio, who was the Manager of the FAA's Quality Assurance Division, Office of Accident Investigation, wrote, "37% of the delegated accident

reports reviewed were unsatisfactory." He was referring to a sample of work activities that took place from April 1 to June 30, 1991 (1991, October, pp. 1-2). Twelve months later, NTSB Chairman Vogt spoke before the Washington, DC meeting of the ABA's conference on "Litigation in Aviation." Vogt said before he became a member and Chairman of the NTSB, he was an attorney who dealt with aviation accident cases. He had made a sample check of NTSB findings and litigation outcomes, the results of which indicated to him that the NTSB's efforts were seldom up to his expectations and often were of poor quality (1992, October).

In February 1994, ISASI held a meeting in Washington, DC, which had as its theme, "Impact of Federal Aircraft Accident Investigations Upon Civil Litigation." This theme was almost a duplication of the theme of the research being undertaken here. Two of the featured speakers were Campbell, the General Counsel of the NTSB, and Dillman, the Assistant Chief Counsel for the FAA. The speakers panel had four other well known aviation attorneys. It was a surprise when Campbell openly stated he felt a NTSB report on an accident could be a "blueprint for some blood sucking attorney" so why make it helpful to them. He admitted that the NTSB does not want to help any litigation efforts. He also stated that there was "no public policy gain" by

investigating general aviation accidents. He also stated that "perhaps the NTSB should get out of the accident investigation business" when it came to small aircraft. While this philosophy was whispered by many NTSB investigators, this was the first time such a statement was made in public. The audience consisted of about 50 professional accident investigators. However, because of the Washington, DC meeting location, most of the investigators were either FAA or NTSB staff.

When Dillman addressed the group, he emphasized the fact that in his opinion, "over half of all of the accident reports the FAA does for the NTSB contain errors, some of them pretty major." He felt "with odds like that, no wonder so many lawyers want to litigate aviation accidents, even when reports seem to blame their clients." Without more investigators who are better trained, Dillman saw no hope for improvements. More staff, for either the FAA or NTSB, would mean more funding would have to be provided.

Funding for aviation accident investigation efforts had been a problem for many years. Referring to the "Air Safety Board Recommendations" issued on March 22, 1941, it was noted that, "in many instances a lack of funds has restricted desirable activities on the part of the Authority (CAA)" (p. 1). About four months later, this issue was addressed again. A special report titled

"Investigating Air Accidents" was presented to the House of Representatives (HR #933) on July 10, 1941. While this report clearly stated, "It is manifest that no stone must be left unturned in the interest of air safety (p. 3)," funding for the expansion of CAB staff to investigate aviation accidents was not forthcoming.

Over 50 years later, the lack of expansion funding was still an obstacle to the growth of the NTSB and was preventing it from carrying out this important safety task of accident investigation (Kolstad, 1991). Spence lamented this trend in his article, "Cuts loom for the NTSB, too" (1993, p. A-6). This trend continued as the NTSB not only remained very small, but even reduced staff. This was not going unnoticed by the aviation community, but the general public was not aware of this situation.

It was obvious that much literature existed to document man's interest in flight and how that means of travel had grown. Accidents were part of the growing pains of developing a safe air travel system. Society wanted a very high level of safety within the air transportation system and looked to their government to provide it (Hall, 1995). Government actions seemed to reflect a reasonable response to this concern for safety.

Various social needs, such as the public's desire to receive compensation for losses that resulted from aviation

accidents, did not seem to be accounted for within the existing system of teaching aviation accident investigation or when investigations were carried out. Thus the high level of technical capabilities in finding probable cause were not matched by the ability or willingness to find fault. This led to conflicts between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process. If, by the observations documented in this research, an open debate on these conflicts would take place, it was felt that the research effort would have been justified and that the effort had served a worthwhile social service.

As a closure, an attempt to look into the future was made. To do so, the remarks of Vogt, a recent Chairman of the NTSB, were selected. Vogt had addressed the Royal Aeronautical Society during the 1993 "Sir James Martin Lecture," given in London (RAes Journal, August, 1993, pp. 8-14).

In addition to reviewing the history of the NTSB, from the 1920s to 1993, Vogt made some interesting points that applied directly to the topic of this research. He said, "The accident site belongs to us [the NTSB] under the law. We exclude lawyers, who can make a mess of it at this stage." Vogt also went on to say that NTSB investigators use "experts from manufacturers, operators, unions and the

FAA...Every fact is shared with them, and the opportunity therefore exists to dispute the evidence and share their perspectives. Indeed, we invite these parties to offer us their own analysis" (p. 14). It was obvious that these comments confirmed some of the observations that were presented in this research. His comments were also an indication that changes within the NTSB were not likely.

Summary of the Literature and other activities

The findings of the review of the literature and other activities can be summarized as follows:

The interest in aviation has been long term.

Man's fascination with flight has been recorded in his art, myths, songs, and religion for thousands of years. Today, as he reaches into outer space, he is reconfirming his desire to travel further and faster by flight.

Aviation accidents have played a role in aviation's growth.

From the first failures of the Wright brothers and the death of Selfridge in 1908, accidents have played an important role in perfecting aviation designs, techniques of manufacturing, and the operation of a safe transportation system. Even the spectacular accident of the space shuttle Challenger had knowledge to give to the

engineers of NASA as they continued their work to prepare for a future that might include the public's journey into space.

The public has a high concern for aviation safety.

The state aviation laws of the early 1900s reflected the public's expectation of government protection from unsafe aviation activities. The federal government responded to the public's concern by passing the aviation laws of 1926, 1938, 1956, 1967, and 1974. Almost every day, millions of people traveled billions of air miles, all in expectation of a safe journey. In 1995, the public still supported the strong regulation of aviation in hopes of the continued enjoyment of safe air travel.

The Federal Government controlled the accident investigation process.

Beginning with the laws of 1926, civil aviation accidents began to be investigated by the federal government. With the formation of the ASB in 1938, the CAB in 1940, the DOT/NTSB in 1967, and the independent NTSB in 1974, the government had acquired exclusive control of the investigation process and preempted all other parties from participating in the investigation of aviation accidents.

Accident investigation schools developed in a normal manner.

Historical data reflects a logical and natural formation of schools to teach the technical subject of aviation accident investigation. The schools that taught this subject were driven by government needs and funding. Need for this technical training resulted from a desire to prevent future aviation accidents by investigating past events.

Technical requirements of investigations were well developed and met the public's needs.

The literature confirmed that the technical changes of the aviation industry had been incorporated into the teaching and conducting of aviation accident investigations.

The quality of investigations and reports was not acceptable.

Some investigations were conducted in an unacceptable manner. The public questioned the quality, validity, and content, of aviation accident investigation efforts. These problems existed during NTSB investigations and in the reporting of the NTSB's findings.

Not all investigation efforts were equal.

With the exception of airline accidents, unless investigations had high public awareness, the NTSB usually did not expend much manpower or resources to investigate the accident. Even in some airline accident cases, it was the investigations conducted in connection with litigation (the fault finding process) that produced what was later found to be the "real" cause of the accident.

The timeliness of NTSB reports was not acceptable.

The public felt that the delay that takes place prior to the NTSB releasing their reports was unacceptable.

The usefulness of NTSB reports was not acceptable.

The public felt that the legal limitations that courts are placing on the uses and admissibility of NTSB reports was unacceptable.

Conflicts existed between the technical and social aspects of investigations.

The NTSB, in attempting to avoid the concept of "finding fault" during their investigation process, allowed the quality of finding factual reasons or "probable causes" for accidents to be compromised. The public allowed the federal government exclusive access to aviation accident sites and sole responsibility for investigating accidents.

With these privileges must also come the responsibility to meet the needs of the public when the investigation process is carried out. The needs of the public encompassed both technical (probable cause) and social (finding fault) aspects of accident investigation.

Investigations did not meet social needs.

Based on America's use of litigation to meet the social need for compensation to persons who suffered losses from accidents, the existing system of accident investigation, at the academic and government levels, did not meet the needs of society.

For technical quality and social reasons, changes were needed.

As society moves toward the twentieth century, air travel will increase and accidents will continue to happen. This will result in litigation to compensate the public for losses. Changes were needed in the accident investigation process to meet these needs.

The government and academic community were not responding to the conflicts between the technical and social aspects of accident investigations nor the public's concern over these issues.

The review of the literature and other activities confirmed the existence of the findings previously

mentioned. These findings confirmed the existence of conflicts and that these conflicts were affecting the quality, validity, and content of accident reports. However, there did not seem to be any effort being made, by the government or academic community to change the system.

Changes may be forthcoming.

With the recent rash of airline accidents in 1994, the American public's eyes were turned toward their government and their voices were calling for stronger safety enforcement by the FAA. Also being called into question were some of the NTSB's accident investigation methods and policies.

The concept of forming accident "survivor groups" after airline accidents seemed to be well developed. These groups, which individually represent several hundred people, were joining their voices into a stronger and more collective effort to bring about changes in the aviation accident investigation process. These groups receive much media attention which increases the public awareness of the complaints being made. When these citizens were joined by prominent members of the legal community who represent plaintiff's interests, the level of public attention become even higher.

These groups are calling for changes to the existing NTSB investigation system which was causing conflicts between the technical and social needs of the aviation accident investigation process. These groups are questioning the quality, validity, content, timeliness, and usefulness of the NTSB's accident investigation efforts. In the 1950s and the 1960s, public fear of and concern with airplane accidents resulted in major changes to aviation laws. Perhaps the accidents of the mid 1990s would also result in changes.

Thurston (1995) emphasized the importance of accident investigation in his book, Design for Safety. He utilized accident reports and statistics for every technical point in his book and even dedicated his book to accident victims by saying,

> This book is dedicated to members of the aviation community who have contributed to accident statistics and records. The misfortunes of this unwilling group have pointed the way toward design and operational improvements benefiting all who fly now and in the years ahead. (p. iii)

Aviation accident investigations and the data obtained from them continue to be an important part of aviation safety. The literature seemed to indicate that recognizing, understanding and solving the technical and social conflicts that existed in aviation accident investigations would be beneficial for society.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this research was to identify, document, and analyze the conflicts that existed between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process.

In order to do this, it was necessary to review the history of aviation and its impact on American society. This included the public's concern about safety in air transportation. The roles that accidents and accident investigations had in the development of aviation were also important. Public interest in aviation safety was reflected by the laws, regulations, and government policies that were put into effect in response to the public demand for higher levels of safety over the years. Also considered was the aviation industry's and government's response to the public's concern with the aviation accident investigation process.

Of equal importance to the public was what rights they had to compensation when aviation accidents caused losses. Aeronautical activities presented new challenges to America's legal system as the technologies of flight presented questions that had never before been addressed by the courts. To understand the concepts of "property rights", compensation for losses, and "full access to justice", special attention needed to be given to legal literature associated with aeronautical activities.

Academic institutions, military organizations, government agencies, and commercial businesses that operated schools or conducted courses on the art and science of Aviation Accident Investigation were contacted. Data from these individuals and organizations were collected and analyzed for course content, objectives, work techniques and administrative factors that might be of value to the research.

To confirm the need for this research and as a form of a quality check of NTSB investigation efforts, some aviation accident reports were reviewed. Where possible, these reports were analyzed to compare the government's technical "probable cause" with the outcome of litigation efforts to "find fault." The technical and social conflicts within the aviation accident investigation process were observed.

To supplement the literature on these conflicts, correspondence and interviews were used to obtain comments from government agencies and law firms that dealt with aviation accidents. They were asked to comment on the research as it progressed, including being requested to make comments on the findings and recommendations. The comments and suggestions of these people were incorporated into the study.

The research utilized a combination of historical, developmental, and descriptive research methods. The findings were analyzed from an ethnographic perspective to identify the technical and social conflicts that existed during the formation of aviation accident investigation philosophies, principles, and techniques. This data was then used to show how these conflicts were affecting the quality, validity, content, timeliness, and usefulness of the investigation process.

The results of the study were utilized to make recommendations that might result in improvements to the aviation accident investigation system. For historical accuracy, the aviation data researched included material from the early days of aviation, the 1900s, to events that were taking place in 1995, approximately a 95 year period.

Preliminary Procedures

Sources of historical data on aviation and the development of the aircraft accident investigation process were identified. Some of the facilities used for this study were libraries and other resource centers that held data on aviation related subjects. (See Appendix A.)

A list of government, military and civilian organizations, including academic institutions, that once had, or did have at the time of the study, programs or formal courses on the subject of Aviation Accident Investigation was developed. Schukert's, Collegiate Aviation Directory and the University Aviation Association's Collegiate Aviation Guide (Williamson), which contained the curriculums of over 450 academic organizations were principal reference sources.

Also listed in Appendix A, were the names of aviation manufacturers, air transportation companies (airlines), aviation organizations, government agencies, and law firms that provided input to the research.

While this study was limited to the US, data from other countries such as Australia, Canada, and England were included. These countries were thought to have well-developed capabilities in the area of aviation accident investigation. This information was reviewed for historical and technical content. Information from ICAO

was also utilized to analyze the international aspects of aviation accident investigation. ICAO also had information on aviation accident investigation schools in 17 countries.

Operational Procedures

Executing the activities just mentioned was the first step in the operational phase of the research. Various government agencies, technical libraries, and aviation accident investigation schools were visited as shown in Appendix A. Literature from these sources was grouped in chronological order by topic. Meetings, correspondence, and telephone conversations were used to supplement the literature reviewed and to expand the study's content. Personal interviews also formed a network of resource contacts.

Some of the people contacted were founders of aviation accident investigation schools and senior members of the International Society of Air Safety Investigators who had active roles in teaching and/or developing the curriculum for these schools. Current and former FAA and NTSB staff, who were active in the area of aviation accident investigation, were sought out for their comments and suggestions as the research progressed. (See Appendix A.)

The aviation industry's response to the government's control of the aviation accident investigation process, and

the conflicts that developed between the technical and social needs of this activity were researched by reviewing the content of aviation trade journals and newspapers. Transcripts and reports on public speeches by persons within the aviation community were also reviewed.

To document the public's interest in the aviation accident investigation process, a review of laws, regulations and policy manuals of government agencies was made. Material on aviation litigation, and comments from the legal community, were utilized to determine the existence of technical and social conflicts during the aviation accident investigation process.

These social needs, or litigation aspects of aviation accidents, were identified by reviewing the content of legal publications as shown in Appendix A. The Lawyer Pilots Bar Association, the American Bar Association, and the American Trial Lawyers Association provided input for the identification of conflicts between the technical and social goals of aviation accident investigations.

To supplement the information obtained from these sources, interviews were conducted with nationally recognized trial lawyers who specialized in aviation litigation and with the Chief Counsel of the FAA and NTSB as shown in Appendicies A and D.

Note taking, photocopying, and collecting course outlines and school catalogs were the foundation for some of the technical content of the study. The data was arranged in chronological order so that a common time line could be used to determine what influence each segment of the research might have had on some other aspect of the conflicts being studied. Using a combination of historical, developmental, and descriptive research techniques, data was analyzed from an ethnographic perspective.

Research Design and Analysis

The research was designed to identify, document, and analyze the conflicts that existed between the technical and social aspects of the aviation accident investigation process.

Information on the history of aviation, and how accident investigation activities impacted upon the development of this industry and American society was analyzed. Data on schools that had taught or were still teaching courses on aviation accident investigation was included in the study. Input from active and retired FAA, NTSB, military and civilian accident investigators was also used.

An additional task was the comparison of several NTSB accident reports, both factual and probable cause, with the outcome of litigation connected with the accident, called finding fault. Personnel from government agencies and members of the legal community also furnished insight on the social aspects of the accident investigation system.

Information from these sources was used to further document and analyze the technical and social conflicts that existed during the aviation accident investigation process. This activity supplemented the findings of the review of the literature. The research was designed to answer questions about the public's perception of the quality, validity, content, timeliness, and usefulness of aviation accident investigation efforts. The research results were then used to formulate recommendations that would improve on the value of the aviation accident investigation process.

A combination of historical, developmental, and descriptive research methods were followed to conduct the research. An ethnographic technique was utilized to analyze the material. The findings of the study were presented in a descriptive format that included details of the elements which would contribute to the understanding of the problem being researched. These research methods and

techniques allowed the reader to comprehend the logic of the summary, conclusions, and recommendations of the study.

CHAPTER IV

FINDINGS AND DISCUSSION

Introduction

The literature review and other activities conducted as part of this research identified the conflicts that existed between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process. After analysis of this data, it was apparent that these conflicts and other factors created quality problems within the American system of aviation accident investigation. These conflicts and problems were influencing the quality, validity, content, timeliness, and usefulness of aviation accident investigations.

This situation was aggravated or magnified by the enactment of complex laws and the formation of government agencies which controlled every aspect of the aviation industry. These government actions had been taken over a 75 year period in response to the public's request for government "protection from aviation activities."

From time to time, this request for protection had been more vocal by either the anti-aviation component of society, the providers of air transportation, or the users of the system. The government's response was an expected, normal, legitimate and necessary attempt to provide safety to both the users and non-users of air transportation, while at the same time providing some form of "fostering and promoting" of what was thought to be a nationally important industry (Truman).

Findings and Discussion

The review of the literature and other research activities can be summarized as follows:

The interest in aviation has been long term.

Written history and physical documentation over a period of several thousand years confirmed man's innate fascination with the concept of flight. In art, songs, literature and religion, flight had been an important part of man's conscious thoughts (Ward). In more recent times, flight has become an integral part of modern man's means of everyday existence. Flight, or transportation by air, has become an important part of society's need to move people and objects rapidly from point to point (Truman, Pena). The concept of a global economy had taken on a new meaning through the use of air transportation to move people and

goods rapidly to any location upon the earth, especially to locations that were not accessible by other means of transportation except air (Hall).

As Taylor and Munsen stated in History of Flight, "Human flight is the supreme achievement of our 20th century" (p. 7). Today, as American taxpayers support travel into outer space, they are reconfirming their desire to travel further and faster (NASA).

Aviation accidents have played a role in aviation's growth.

From the first crashes of the Wright brothers and the death of Selfridge in 1908, accidents have played an important role in perfecting aviation. New designs, techniques of manufacturing, and the operation of a safe air transportation system have evolved from the investigation of accidents (Copeland, Thurston). Even the spectacular accident of the space shuttle Challenger had knowledge to give to the engineers of NASA as they continued to prepare for a future that will include the public's flight into space.

Any undertaking as difficult and complex as flight must undergo a long period of experimentation prior to reaching an acceptable level of safety. Mishaps and accidents were therefore a natural part of aviation history and development (Walsh, Thurston). As is often said,

"experience is the best teacher." Unfortunately, "experience" gives the test prior to teaching the lesson to be learned. Only by documenting the causes of previous mishaps and accidents can the teachings of experience be put to beneficial use (Navy, 1957).

In the case of aviation, the lessons of previous accident experiences were being used as a means of learning how to avoid the repetition of similar accidents. This was emphasized in Pope's 1992 article, "Learning from Accidents: It may keep you from having one", (pp. 17-19). The concept of using accident investigations for such a purpose was therefore both logical and necessary for the development of a safe air transportation system (Copeland).

The public has a high concern about aviation safety.

The history of aviation's impact on society and the government's impact on aviation and air safety, indicated the following pattern: first there was public disbelief, fear of the unknown and anti-change philosophies working against the development of aviation (Josephy). Soon, societies or organizations were formed to protect, promote and mildly regulate aviation during its formative years. One such organization was the Aero Club of America, founded in 1905, which actually issued "licenses" to aviators in an effort to promote safety (Robie, 1993).

In the early 1900s, cities, townships, and boroughs enacted laws to protect their citizens from "aviators." Individual community actions were then supplemented by a collage of state aviation laws (D. Hynes, 1995). New Jersey in 1913, Idaho in 1917, Texas in 1919, are examples states that took such actions. Lawmakers realized the mobility of aircraft required aviation regulation on a state wide scale rather than the narrow geographic approach being used by cities or towns (Forlow, et al). These laws were passed in response to demands by the non-flying public who wanted protection from this new, dangerous, and distrusted industry (R. Wright).

By 1925, some 21 states had passed aviation laws, presenting aviators with conflicting rules during a single interstate flight (Forlow et al.). It was felt a much broader or national approach to aviation regulation was necessary. Thus the next step in the historical evolution of aviation regulation was enactment of laws on a national level to protect aviation from "the public" which were passing local laws which were often thought to be harmful to the development of aviation (Act of 1926). The need for laws on a national scale was the realization of the need for a wide geographic approach to aviation regulation.

The operation of aircraft was also thought to be an important concept with great national value. Therefore,

aviation supporters felt that on the federal level a compromise could be reached between protecting the public from the aviation industry and fostering and promoting aviation development. National laws would also "protect" aviators from harsh anti-aviation laws that were being passed in many cities and states.

The state aviation laws of the early 1900s reflected the public's expectation of government protection from unsafe aviation activities. The federal government responded to the public's concern by passing the "aviation laws" of 1926, 1938, 1956, 1967, and 1974. Air travel had become a common means of transportation. Almost every day, millions of people traveled billions of air miles, all in expectation of a safe journey. In 1995, the public still supported the strong regulation of aviation in hopes of the continued enjoyment of safe air travel (Pena, Hall).

However, the public's perception of the government's role in aviation safety was in question. As Feldman pointed out in "On Zero Accidents, Safety and Loose Talk" (1995, pp. 70-71), the FAA and NTSB were seen as taking too much of a political role in aviation accident investigations at the expense of their rightful role of promoting safety by preventing accidents.

The Federal Government controlled the accident investigation process.

Beginning with the first laws of 1926, civil aviation accidents began to be investigated by the federal government. However, these first investigators had no legal rights or power to conduct thorough investigations (Young). By passing new laws, the formation of the Air Safety Board in 1938, the Civil Aeronautics Board in 1940, the DOT/NTSB in 1967, and the independent NTSB in 1974, the government had acquired exclusive control of the investigation process and preempted all other parties from participating in the investigation of aviation accidents.

This absolute control by the federal government, acting through the NTSB, has been challenged many times in various courts. Each time a court granted some relief from this government control, revisions to existing laws, or new laws were passed to restore full control back to the federal government. With the Sioux City court decision, new limits on the use of NTSB reports seemed to be created which further extended the exclusive rights of the federal government to investigate and report on aviation accidents. As Allen pointed out in, "View from Justice-The Independent Safety Board Act Amendments of 1990: Changing the Rules" (1990, pp. 4-9), the NTSB utilized routine legislative activities to enact major changes to the laws that protected the NTSB's activities.

In 1990, a bill to extend the financial authorization of the NTSB for the fiscal years 1991, 1992, and 1993, did "far more than merely re-fund the agency for the next three years. A far more significant provision of the bill for tort litigants is the amendment...to clarify the Board's sole responsibility and authority for determining the conduct of post-accident tests, inspections and tear-downs." Under these "new amendments parties seeking [access to information] will have a new statutory obstacle in their path" (Allan, p. 4).

Accident investigation schools developed in a normal manner.

Historical data reflects a logical and natural formation of schools to teach the technical subject of aviation accident investigation. The development of schools that taught this subject were driven by government needs and funding. The need for this technical training resulted from a desire to prevent future aviation accidents by investigating past events (Young).

The early 1950s Air Force school at Norton was soon followed by the Navy school at Monterey and the Army school at Ft. Rucker. USC, the contractor for the Air Force school, developed a civilian version of its program in the late 1950s. The CAB and FAA began operating their schools in the early 1960s and supported the formation of TSI,

which began to teach this subject to government agencies at Oklahoma City in the early 1970s. ICSE formed its "commercial" aircraft accident investigation school in the early 1970s after working with Arizona State University for several years. In 1992, ERAU was the latest entry into the group of ten US schools that were teaching aviation accident investigation courses in 1995. These schools are listed in Appendix C with notations on their availability to the general public.

Technical requirements of investigations were well developed and met the public's needs.

The research confirmed that changes in aviation technology had been incorporated into the teaching and conducting of accident investigations. The technical requirements of the aviation accident investigation process were well-known and well understood. The literature review showed that they were being taught by the academic community, government agencies, and others who were training accident investigators.

Technology changes, such as jet engines and composite structures, were rapidly incorporated into teaching curriculums. Thus no problems seemed to exist in the technical requirements of the aviation accident investigation process, that is finding probable cause of accidents. Therefore the teaching and undertaking of

aviation accident investigations was technically correct and acceptable, and was meeting the needs of the public.

The quality of NTSB investigations and reports was not acceptable.

The importance of aviation in society and the undisputed need for "the highest standard of care" when providing air travel (14 CFR, Part 121) supported the need for high standards and ethics during the investigation process. The public was questioning the quality, validity, content, timeliness, and usefulness of aviation accident investigation efforts (Miller, Wolk). The research confirmed that serious quality problems existed in the NTSB's investigations and reporting of their findings.

Proper documentation requires certain conditions to exist before the contents of a report can be of any value (Wheeler, 1971). As Key indicated in his text, Research Design (1993), documentation must be factually correct, it must be complete, it must be of sufficient quantity to yield trends, and it must be capable of easy retrieval.

The literature review and other research activities indicated that, in the area of aviation accident investigation, these conditions--factually correct, complete, sufficient quantity, and easily retrieved--were below acceptable standards. When one considers the highly technical nature of aviation, the fact that the industry

was approximately 100 years old, and that it had been closely regulated for almost 70 years, the deficiencies of quality, validity, content, timeliness, and usefulness should not have been present. The research documented these shortcomings and then recommended actions that should be taken to correct them.

The practice of official documents, reports, and forms being marked "none-found" in response to questions about malfunctions, when in fact, tests were not actually conducted on the parts or systems in question was a problem. Later inspections and tests, conducted by more motivated and supposedly neutral experts, often confirmed that malfunctions actually did take place (Kelly, 1993; Miller). This was a reflection on the lack of quality within NTSB activities and reports.

Having the FAA conduct accident investigations on behalf of the NTSB was not conducive to obtaining full and candid information from the aviation community. FAA enforcement intentions were feared by all who came into contact with FAA employees who were wearing NTSB "investigator hats." As advised in The View from the Right Seat (M. J. Hynes, 1994), "If you are involved in any type of incident your order of priorities should be: #1 take care of your passengers, #2 take care of you and your crew,

#3 call the ...union..., #4 call the company." (p. 1). The advice went on to emphasize staying away from the FAA.

The NTSB has publicly testified before congress that the FAA has played too large of a role in past investigations. The need for FAA participation in the aviation accident investigation process needs to be reviewed and efforts should be made to reduce any role the FAA might have in the early stages of this activity.

An additional deficiency was the NTSB's policy of granting "party status" to manufacturers to conduct parts of the investigation. If the NTSB routinely granted manufacturers and other aviation firms party status which gave them full access to NTSB information, did this not tip the scales of justice in favor of defendants vs. plaintiffs during litigation as Nader & Smith claimed? If the NTSB relied upon defendant airlines, manufacturers, and other aviation firms to conduct parts of the official factual investigation, and to conduct tests, did not the frequent opportunity for "cover-up and fraud" occur? (Heller) Many people, such as M.K. Hynes, Miller, Steenblik, and Wolk, were asking these questions. Perhaps the past practice of the aviation industry, and more importantly the government, to ignore or downplay these questions could no longer be tolerated.

Since the NTSB frequently used potential defendants to conduct important tests on products that might have had malfunctions, it would appear that the correctness of NTSB Factual Reports could be compromised. Plaintiffs were not only denied "equal access", at times they were denied "all access" to factual information obtained by the NTSB (Re. Sioux City). As far back as 1941, in HR Report No. 933, Investigating Air Accidents, the government took the position that, "disclosures [of information] by [airline or manufacturers] witnesses might serve to prejudice their positions [in future litigation] if this testimony was made public" (p. 2).

An important factor affecting the quality of the NTSB's investigation activities since it was formed in 1967 was insufficient staffing. The NTSB started its operations with a very small CAB staff and immediately saw a much expanded work load. The NTSB assumed responsibilities for investigating accidents in five modes of transportation; air, water, rail, highway, and pipeline. Over the past 30 years, the NTSB work load has expanded in both variety and quantity. During the same period there was a lack of NTSB organizational growth. When one considers the increase in NTSB's areas of responsibility, the size of the NTSB was too small. As pointed out in the March 31, 1995 issue of the General Aviation News & Flyer, "as of April 23, the

National Transportation Safety Board is responsible for investigating accidents involving public-use aircraft." This would mean several hundred more investigations the NTSB would have to conduct each year. The industry was asking, "Will [the] NTSB be able to keep up with its new responsibilities" (p. 17).

In the 1960s, the CAB had 185 technical and clerical staff which formed the NTSB. In view of the growth of all forms of travel, particularly air, the need for additional NTSB staff was obvious. For example, the NTSB had only two "helicopter specialists" on their staff. Considering several hundred helicopter accidents occurred throughout the US each year, this staff could investigate only a small fraction of the accidents. Total NTSB field investigator staff was less than 60 persons (NTSB Budgets).

The low staffing problem was not limited to accident investigators. According to its reports to congress, because of manpower shortages, the NTSB labs are only reviewing material from about 2% of all aviation accidents. Some experts, such as Wolk, Waldock and others, felt that this resulted in an under reporting of "material failure" as an accident causation and distorted the statistical data base on accidents.

While it may not be economical for the NTSB to invest in high technology lab equipment, the NTSB could contract

out more inspection tasks. These inspections could be closely monitored by NTSB staff, and as often as possible, these tests should not be conducted by parties directly connected with the accident. More use of NASA technical personnel and facilities would assist the NTSB in maintaining a higher level of quality and reduce the potential for conflicting input from other sources.

Not all investigative efforts were equal.

Major airline accidents were investigated in a thorough and uniform manner. Commuter airline accidents received varying amounts of NTSB effort depending upon the political sensitivity of the public regarding the passengers who were on the aircraft when it crashed (M. K. Hynes in press). As McCarthy stated, the field investigations of commuter aircraft "frequently fail to uncover valuable safety information"...and "neither public interest nor significant safety issues are initially apparent." (Steenblik, 1994, p. 35).

The NTSB investigation of accidents by small aircraft were usually very limited. The NTSB effort averaged about $3,000 per investigation. With an annual average of 1,200 lives lost in small airplane accidents each year, and less than 200 fatalities in airline operations, the need for thorough investigations of small aircraft crashes should

have high social value to reduce accidents. As Stewart, the President of the Canadian Society of Air Safety Investigators, pointed out, "According to ICAO, the purpose of accident investigation is the prevention of accidents...there must be increased emphasis on developing a capability to 'investigate' the system and identify problems before they result in a loss" (p. 9). It would appear that a larger return on the taxpayers dollar spent by the "NTSB's investigation efforts" in safety would be gained by better investigations of small aircraft accidents. These investigations do not have to be as extensive as airline investigations but they do need to have the quality, validity, content, timeliness, and usefulness that the public is entitled to when it attempts to use these reports.

The timeliness of NTSB reports was not acceptable.

Failing to issue reports in a timely manner was also a problem that needed correction. When the time delay of the issuance of NTSB reports was added to the problems of missing data, and plaintiff's not having access to the full contents of reports, their attempt to undertake litigation was made much more difficult.

It was usually just under 14 months from the time of the "smoking hole" to the time of the NTSB report on the

accident being made "public" (Schleede). In many issues of litigation a one or two year "statute of limitations" existed between the date of the event and the last date for the filing of a legal action. This meant that litigation was often started before factual reports were made available to the public. This may explain the origin of some of the "unfounded legal claims" about which the aviation community was protesting (Flinn).

Was it a matter of policy for the NTSB to delay the public release of their reports in a deliberate effort to harass plaintiffs? It was a matter of policy for the NTSB to discourage their investigators from cooperating in any manner with litigation efforts (Campbell). Investigators were to destroy their investigation notes after they sent their reports to Washington.

In addition to the delay that normally precedes any litigation, it often takes three to five years for a case to "come to trial." With such a long time span between the investigation and the trial, it is normally not very helpful for parties to the litigation to be questioning the NTSB investigator about his several year old report. He had no notes, he couldn't remember much, and referring to the contents of the "public" NTSB report was usually the only basis for his testimony (M.K. Hynes in press).

For plaintiffs to hire experts to look for useful factual evidence after such a long period of time was very expensive and only added to the cost of litigation, something everyone seemed to be unhappy about, but not willing to resolve (Waldock). These policies, when combined with the factual errors and gaps in content of NTSB reports, seriously compromised the value of NTSB reports (Wolk).

As proven by the response to the space shuttle Challenger accident, the government can act quickly, with significant resources, using industry help, and provide full disclosure of factual data, when the public demands this type of accident investigation activity.

The usefulness of NTSB reports was not acceptable.

As mentioned earlier, the federal government had full control over the aviation accident investigation system. This control excluded potential plaintiffs from the investigation process. When, during their fault finding efforts, plaintiffs were denied access to and/or the use of some of the NTSB factual reports, this resulted in expensive and sometimes unfounded litigation efforts. This type of litigation hurt plaintiffs and defendants alike. The Sioux City ruling has brought new interpretations to

the NTSB's powers and the admissibility of factual evidence during litigation.

Using the courts to argue these issues case by case, is time consuming and expensive. It also results in conflicting admissibility practices from court to court. This in turn creates what is known as "forum shopping", where attorneys try to bring their cases to trial in courts that have previously ruled more favorably to a plaintiff. Forum shopping adds to the cost of litigation and detracts from the uniformity of justice. Only by clearing up the "exclusive right to data" and admissibility questions through legislative changes, can these problems be solved.

Conflicts existed between the technical and social aspects of investigations.

By avoiding the concept of "finding fault" during the investigation process, the quality of finding factual reasons or "probable causes" for accidents has been compromised. This has lead to problems in the quality of the investigation process.

The public has allowed the federal government exclusive access to aviation accident sites, and sole responsibility for investigating accidents. With these privileges must also come government responsibility to meet the needs of the public when the aviation accident investigation process is carried out. The needs of the

public encompassed both technical (probable cause) and social (finding fault) aspects of accident investigation.

The conflicts are serious and are resulting in quality problems during the investigating process. The American justice system gives every citizen a right to "their day in court" (Wagner). Because of these conflicts, as early as 1984, attorney Wolk made an issue of this situation in "Point of Law: Products Liability-Aviation's Nemesis or Conscience (A Personal Opinion)" (p. 166). The research has indicated that the present accident investigation system is still not meeting this public expectation and right to justice as Wolk and others were pointing out in more recent years.

Investigations did not meet social needs.

Based on America's use of litigation to meet the social need for compensation to persons who suffered losses from aviation accidents, the existing system of aviation accident investigation, both at the academic level and at the government level, did not meet the needs of society.

With limited access to accident sites, witnesses, and evidence, plaintiffs were at a distinct disadvantage when it came time to produce factual evidence in court (Wolk). With some recent rulings (Re. Sioux City) that prohibited some NTSB data from being used as evidence, plaintiffs were

without a factual basis for their claims and thus denied their "day in court" (Wagner).

The concept of torts--that is the courts awarding of compensation to offset losses--was deeply rooted in both European and American law (Madole). It was changes in the social thinking of the public that created the existing product liability laws. These changes cannot be ignored nor are they necessarily wrong. Society was obtaining what society wanted from its legal system (R. Wright). On what grounds did the aviation community seek government protection from the American justice system? (Wolk)

More thought and attention should be given to what drives the growing frequency and high cost of aviation litigation. If public confidence in the quality and impartiality of aviation accident investigations was falling, disputes as to both probable cause and fault would be normal (Miller). Historically, the resolution of these disputes required correct, complete and timely reports on accidents before the legal system could be used to resolve these disputes (Madole, Wolk, Wagner).

The government should respond to the needs of the public during the aviation accident litigation process. Who is the public? Is it the aviation community or the users of aviation or perhaps the anti-aviation constituency? (Campbell.)

For technical quality and social reasons, changes were needed.

In 1994, the US air travel industry had its worst year for accidents since 1988. The scheduled airlines had 20 accidents, four of which were major crashes that claimed 239 lives over a period of less than five months. In January 1995, Transportation Secretary Pena called a special two day conference to address this problem. He challenged airline officials to "elevate margins of safety" and to undertake new efforts to reach a zero accident rate, which the public has come to expect (Phillips, 1995, p. 26).

Pena should also challenge the parties that have a role in the accident investigation process. The teachers of aviation accident investigation techniques, the investigators themselves, the government agencies that control investigations, and the legal community that deal with this activity, all have a role in improving aviation safety. By recognizing the existence of conflicts within the system, and how these conflicts are affecting the quality of accident investigations, reports and litigation, the system can be improved to better serve the public.

One way of improving the system would be to correct the lack of compatibility between the computers that stored the FAA and NTSB statistical data on accidents. Not only were these computers unable to exchange data, but the entry

codes of each system were different. To add to this problem, the policies followed by the FAA and the NTSB for assigning "key" words to blocks of data, both factual and as to "accident cause" were different (Houghton). The computer problem had been debated for at least 15 years, but for political reasons had never been corrected (M.K. Hynes, in press).

An additional factor that was affecting the quality of NTSB investigations was the "human factors" side of the investigation process. This seemed to have been given little attention by the aviation community. The psychological stress of investigating one air tragedy after another, day after day, placed NTSB investigators under great personal strain (Kolstad). While not a part of the topic being researched by this study, this personal strain diminished the quality of the NTSB's work product and therefore was worthy of mention. Recommendations were made to address this problem in Chapter V.

The government and academic community were not responding to the conflicts and need for change.

The review of the literature and other activities confirmed the existence of the findings previously mentioned. However, there did not seem to be any effort being made, by the government or academic community, to change the present system (Vogt).

The question being researched by this work centered around the aviation accident investigation process. Under current laws, only a very narrow segment of society was being served by the accident investigation reports of the NTSB (Campbell). Even then, serious questions were being raised by Nader & Smith, Heller, Wolk, and others about the philosophies and quality of NTSB investigation activities.

The social aspects of the investigation process were not acknowledged or addressed by either the academic community or government agencies that dealt with this important task (Miller). Historically, the question of fault, vs. the question of probable cause, had been recognized and debated for many years. (Miller, Lederer) However, the aviation industry supporters and technocrats seemed to have prevailed, and the concept of fault was not recognized or accepted by either the aviation community (Wolk), the FAA (Dillman) or the NTSB (Vogt, Campbell).

In the last ten years the public has begun to demand recognition of fault, not as a priority, but at least on an equal footing with the technical concept of probable cause (Wolk, 1984). The concept of "torts" was still valid (Madole) in spite of the claim that America was preoccupied with litigation (Elias, et al.). According to Millar and Meyers, the fear of product liability losses had destroyed the general aviation industry. However, public safety is

more important than any one firm's profits. As DOT Secretary Pena stated, "we will not settle for anything less than zero accidents" (quoted by Feldman, p. 70).

How other countries addressed the issue of litigation associated with aviation accidents was not of concern to Americans. America was founded upon freedoms and the right to justice through law (Wagner). American beliefs were that the government was supposed to protect citizens not oppress them. American citizens would not accept the many legal concepts of other nations in the areas of civil liberties, consumer rights, and economic freedoms (Nader & Smith). The American justice system might not be perfect, but it still seemed to be the best system in the world (Wagner).

Some modern industrial countries, such as Japan, did not have consumer rights or product liability laws to protect its citizens from even obvious harms created by dangerous products or business actions. Other countries, especially in the Middle East, had religious or social systems that used the concept of "it's God's will" to explain all misfortunes and to preclude any interest in pursuing liability litigation. As found in the literature, some countries, such as Peru, were not always interested in assisting their citizens by investigating an aviation accident.

This was pointed out by Tompkins at the ABA Aviation and Space Law Conference held in Atlanta in 1991. He informed the group that the average "passenger liability settlement in the US" was almost $1.2 million per person while in countries other than Japan it averaged less than $200,000 per person. Even though Japan did not recognize "fault litigation" Japanese social concepts allowed its government to award citizens a little over $600,000 for each loss. Americans were not interested in adopting these approaches to the so called product liability litigation explosion being complained about by the aviation community (Wagner).

Changes may be forthcoming.

Historically it was not always just a numbers game where majority ruled. The government had protected industries with national value in the past. American laws written for railroad development were well-known. The radio and TV industry had seen similar treatment. Many aviation laws were intended to be pro-aviation such as the Act of 1926 and the FAA Act of 1957. For 50 years, American presidents, such as Truman, Johnson, Carter, and Clinton continued to encourage this philosophy.

By the mid 1990s, almost 30 years after the last major revision to national aviation laws, another generation of

voices, such as those of Millar and Meyers, were raised to obtain new, more favorable laws for the aviation industry. One request called for major revisions to the existing FAA engineering requirements for the design approval and production of new aircraft. This was accomplished in 1993 by enacting revisions to 14 CFR Part 21 to provide for a simplified aircraft certification process, called "Sport Plane Certification."

The second response was The General Aviation Reformation Act of 1993 which was defeated in congress but replaced by the General Aviation Revitalization Act of 1994. The major impact of this Act was the creation of a limit on manufacturers liability (Fitzpatrick, 1994, pp. 3-5). The main sponsors were Congressman Glickman (D-KS) and Senator Kassebaum (R-KS). Not surprisingly, they both represented Wichita, KS, the "Small Airplane Capitol of the World" (Chamber of Commerce). The aviation industry's pleas for protection from overbearing consumer litigation was acted upon by the passage of this law. The 1994 congressional elections resulted in major changes to the government's view toward industry. With this in mind, GAMA President Bruner said "GAMA's major legislative focus this year is the future of the FAA." He sees a "revitalization of the general aviation industry" possible by enacting additional FAA policies and regulations. (pp. 1, 11).

But what about the needs of the "public?" If history repeats itself, changes to the FAA and NTSB may be forthcoming. After the major airline crashes in the 1950s, the first FAA was created. After the major airline crashes in the 1960s, the DOT, with a new FAA and NTSB was created.

As NTSB Chairman Hall stated on January 23, 1995, when opening the public hearing on the USAir flight 427 accident, "The American public has been shocked in recent months by a series of catastrophic airline accidents." Will the shock of these airline crashes bring about new aviation laws in the mid 1990s? Will another cycle of changes be made in how the government conducted accident investigations? How should the government respond to the public's demand for additional air safety? Was the nation in the mood for changes to both the FAA and the NTSB?

To add to the confusion and doubt as to what regulatory changes might actually take place, public displeasure with the philosophies of the FAA and the NTSB, and their work products, were beginning to come to the surface. As Naisbitt wrote in Megatrends (1982), when Americans began to see and hear frequent open discussion about a national problem, it was a warning of changes about to come. While displeasure with the FAA and NTSB had been expressed in some aviation circles for several years, because of the power of both the FAA and the NTSB over the

aviation industry, open discussion of this discontent was almost nonexistent within the aviation community for fear of reprisals. Thus, the public was not made aware of the problem. Beginning with M.K. Hynes in 1991, by early 1995, almost every few months a new challenge to the current FAA/NTSB safety system was being raised by various people, as was reflected in the writings of McCabe and Wolk.

The review of the literature indicated that the potential for changes was indeed appearing upon the regulatory horizon of the air transportation system. During the course of this research, draft copies of Chapter V, "Summary, Conclusions, and Recommendations," were sent to ALPA. Several of the concepts discussed in Chapter V were later presented by ALPA to the NTSB at the March 1994 "Industry Symposium on Aviation Safety." An early draft of Chapter V was also given to the FAA, NTSB and several members of the ABA, ATLA, and LPBA for their review and comments. In January 1995, when Transportation Secretary Pena held the "Summit on Airline Safety," several of the recommendations contained in Chapter V were listed as industry goals.

The research identified and documented the conflicts that existed between the technical (probable cause) and social (finding fault) aspects of the investigation process. It then showed how these conflicts were affecting

the quality, validity, contents, timeliness, and usefulness of aviation accident investigation activities. The research attempted to document these observations in an impartial manner for the purpose of open discussion.

There is a need for both technical factual information which can determine probable cause and for factual evidence which would be helpful in answering the social question of finding fault. As society moves toward the twentieth century, air travel will increase and major airline accidents will continue to happen. Boeing predicts one major crash per week by the end of the century (UAA, 1995, p. 10). These accidents will be investigated and the results of investigations will be used during litigation undertaken in an effort to obtain compensation to the public for losses that result from accidents.

Past courts have recognized the importance of the NTSB's work rules and have stated that these rules were "sound as far as the Board and its work are concerned", but that the needs of the NTSB had to be balanced against the governmental function of the administration of justice. Access to "justice" is a deeply rooted American belief. Justice denied by a government agency has been found to be intolerable in the past. Wolk, Wagner and others found this denial of justice intolerable.

Perhaps it was time to remember the Biblical words, "Kindness and truth shall meet; justice and peace shall kiss. Truth shall spring out of the earth, and justice shall look down from heaven." (Psalm 85, 11-12) Based on this research, it seemed as if the need for more kindness, truth, and justice during the aviation accident investigation process was at hand. The consideration and adoption of the recommendations presented in Chapter V, could fill these needs.

CHAPTER V

SUMMARY, CONCLUSIONS, and RECOMMENDATIONS

Introduction

This research was undertaken to identify, document and analyze the conflicts that existed between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process.

This might best be described as differences or conflicts between the technical reasons for accidents, which are referred to as the probable causes of an accident, and the social aspect of accident investigation which is usually undertaken through litigation, and is called finding fault. The research was designed to answer questions about the public's perception of the quality, validity, content, timeliness, and usefulness of aviation accident investigation efforts.

The aviation accident investigation process has played a major role in the development of aviation safety within America's air transportation system. The information obtained during investigations would continue to be an

important element in preventing future accidents. The work product, or outcome of these investigations, would also continue to be a necessary element of litigation connected with an aviation accident.

The research documented the technical requirements and social philosophies being taught and used when conducting aviation accident investigations. It compared FAA, NTSB, and aviation industry philosophies toward aviation accident investigation with the needs of the public for factual information regarding aviation accidents.

The existence of conflicts and the need for change was confirmed by the research. The following questions were also discussed: How did these conflicts develop? Were these conflicts affecting the quality of the accident investigation process? Can changes to the investigation process resolve or reduce the conflicts and improve the system? What changes might be considered? Who was to make the changes?

In order to complete the research, a combination of historical, developmental, and qualitative research methods were used. The information gained from the review of the literature was supplemented by personal contacts with the staffs of law firms, government agencies, academic institutions, and aviation organizations. Many of the people contacted were leaders in the field of aviation and

law, who had played key roles in the development of the accident investigation system. Personnel from government agencies and members of the legal community provided input on the social aspects of the investigation process.

The data was then analyzed utilizing an ethnographic approach. As a result of the research, it was determined that the investigation process was tightly controlled by the federal government. During the past 20 years, major social changes had taken place within the American legal system. However, the existing philosophies and laws, as they addressed the aviation accident investigation process, had not been updated or modified to reflect these social changes.

Summary

Information was acquired and then documented as a result of reviewing the literature indicated in the bibliography and by making contacts with persons who had direct knowledge of the topic being studied. This material was then analyzed in the findings and discussion section of the research. The research confirmed the existence of conflicts between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process. It also confirmed the public's perception of the lack of quality in the validity, content,

timeliness, and usefulness of aviation accident investigation efforts.

Also documented were other aspects of the accident investigation system which contributed to the conflicts or were deficiencies in themselves. How these conflicts and deficiencies came about, and how they might be resolved were then addressed. Young had stated, "the assignment of [accident] causes as shown [in reports] are to a substantial extent premised upon opinion and conjecture" (p. ii). This approach to aviation safety was no longer practicable, prudent, acceptable or necessary. Copeland's message to Congress that "a thorough and searching inquiry should be made into the causes of the wreck...for the prevention of accidents" (p. 1), was even more valid at the time of this study.

Despite Vogt's statement, "the accident scene belongs to us," (1993, p. 14), others had valid and legal rights to the factual information gained through NTSB investigations. As shown by this research, the current system of aviation accident investigation did not meet society's "social" need for factual data on accidents.

Pena's message, that the US airline industry must abandon its mindset that "every once in a while we have an accident" (p.16), acknowledged that the public is demanding a higher level of safety. "[The January 1995] Washington

meeting made it clear that air travel within the US has become so accepted, sophisticated, and convenient, that passengers expect it--even demand it--to be virtually risk free" (AW&ST, Ed., January 23, 1995, p. 70). As Feldman asked in the April 1995 issue of Air Transport World, "was this just loose talk by Pena and Hinson?" (p. 70)

The research resulted in a comprehensive analysis of the system currently in use for aviation accident investigations. Readers were given insight into the social implications that aviation, and aviation accidents, have had on the American public. Also documented was the history of the technical and social impact that government control had over aviation while providing safety to the users of the air transportation system and other citizens who were being impacted by aviation.

As R. Wright stated, one must accept "a law in action concept". He emphasized that law was not a static collection of cases or regulations, "Law is a fluid social activity that changes with time and society (p. x)."

Conclusions

This research confirmed that conflicts did exist between the technical (probable cause) and social (finding fault) aspects of the aviation accident investigation process. It also confirmed that serious quality problems

existed in the validity, content, timeliness, and usefulness of aviation accident investigation efforts.

Adopting the recommendations of this research would diminish these conflicts and improve the value of aviation accident investigations. Because of the existing regulatory structure of the investigation process, and the legal limitations on the use of NTSB work products, the adoption of these recommendations will require action by several different government agencies. The FAA, NTSB, Department of Justice, the Courts, and congress will have to adjust their philosophies toward the aviation accident investigation process. Such adjustments will only take place in response to public demands for change.

It is up to the public, both air travelers and non-air travelers, the aviation industry, the government, and the legal community, to debate the issues identified by this research. If these parties share in the conclusion of the research, that is, that conflicts do exist between the technical (probable cause) and the social) (finding fault) aspects of aviation accident investigations, change must be forthcoming.

With over 13.0 billion dollars in the Airways Trust Fund (Jennings, 1993, p. 65), there are ample funds available to undertake these recommendations. With thousands of under employed, or unemployed highly skilled

aviation personnel available to fill the recommended NTSB manpower increase, it appears that now is an opportune time for consideration and adoption of these recommendations.

Recommendations

Based upon the research, the following recommendations are presented for consideration by the public, the aviation industry, the FAA, NTSB, and other government agencies, and the legal community.

The recommendations are:

1. All of the parties that have an interest in aviation safety, and who are affected by the aviation accident investigation process, should join together to support an expansion of the NTSB. They should also support changes in laws and policies that limit the usefulness of present NTSB investigative efforts. Everyone must agree that all accident investigations deserve equal effort, that safety lessons can be learned from all accidents, and that accidents should not be considered as "random events."

2. The organizations that teach accident investigation techniques must consider both the technical and social aspects of the investigation process and incorporate these into their curriculums. Teaching material should address the potential for conflicts in the present investigation system and openly discuss this as part of the training of

investigators. Schools should also emphasize the need for high quality, ethical investigation techniques.

3. Military, civil government, and private sector accident investigators must realize that society is now placing equal value on the technical and social aspects of the investigation process. Investigations should be undertaken with this public need in mind and should recognize the need to use high quality, ethical investigation techniques;

4. Government, industry and private sector attorneys should recognize the existence of conflicts between the technical and social aspects of the accident investigation process and that these conflicts cause problems with the quality of NTSB efforts. The legal community should:

   a. demand a higher level of ethics during the investigation and reporting process;

   b. demand reasonable access by plaintiffs and defendants to accident sites and factual information during the NTSB investigation process;

   c. request input from all parties and allow NTSB reports to contain minority opinions as to conflicting factual evidence;

   d. allow public access to, and use of, all factual evidence obtained during NTSB investigations;

5. The NTSB should:

   a. analyze and combine the FAA and NTSB accident report computerized data bases. This information should be of higher quality and stored in a single data base with more uniform retrieval capabilities;

b. begin the collection and storage of "incident" and minor mishap data through a voluntary reporting system similar in nature to the NASA "Aviation Safety Reporting System" and programs in use in other countries;

c. review of the outcome of litigation undertaken as a result of aviation accidents to determine if new factual evidence was discovered or errors in NTSB data were present. New evidence or corrections should be added to the existing NTSB reports and aviation accident computerized data base;

d. restrict the FAA's role in the investigation process as much as possible;

e. diminish the role of manufacturers, suppliers and other potential defendants during the investigation process;

f. issue reports on a timely basis. Except for major accidents, factual reports should be issued within 90 days. The Probable Cause Report should be issued within 60 days of the Factual Report;

g. stop responding "none found" to questions that concern failures and other technical issues when no effort was made to find this data. The correct answer in such a case would be, "Not determined";

h. identify missing elements of reports. Reasons why information was missing should be given;

i. require investigators to have experience in aviation technical subjects and one member of each team should have pilot experience;

j. increase investigator staff. Investigations should have a minimum of two NTSB persons present at the accident site;

k. increase laboratory staff to conduct more tests of critical items and/or utilize contractors for testing. Test costs should be paid by the party requesting the test. The NTSB should be a neutral observer and resolver of testing technique conflicts;

l. provide more training of investigators, including attendance at non-NTSB investigation schools. Training must be completed prior to a person acting as the NTSB Investigator in Charge. Provide continuing education of investigators, including non-NTSB courses;

m. minimize the adverse psychological effects on NTSB investigators of constant work at the task of accident investigation. Provide training and counseling to NTSB investigators in this area.

The aviation and legal communities, and the public, should join together to debate these recommendations and then request that the changes they desire be implemented. High quality aviation accident investigations that result in valid, complete, timely, and useful aviation accident reports are reasonable expectations of the public.

As a result of a rash of major air crashes in 1994 and early 1995, the public confidence in the American air transportation system had been lessened. Several times in the past, such events resulted in major changes in the manner in which the government regulated aviation. Again, a series of aviation accidents may be an indication of the need for change.

Making the recommended changes to the aviation accident investigation system would add to the safety of air transportation and restore the public's confidence in this mode of travel. Some of the 13.0 billion dollars in the Airway Trust Fund (Jennings) could be utilized to fund these changes at no cost to the taxpayers or the aviation industry.

As it was written several thousand years ago in the Old Testament, "Make justice your aim: redress the wronged, hear the orphan's plea, defend the widow." (Isaiah I, 17) Such a profound obligation still holds true. The adoption of the suggested recommendations would help to accomplish this ancient but still valid request.

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APPENDIX A

DATA ON THE SCOPE OF THE RESEARCH

Listed below are the names of some of the individuals and various organizations that were contacted and/or surveyed for the purpose of collecting data which could be used for this study.

I. Personal Communications (selected sample of names):

Abete, E.; aviation accident investigator; 08/01/92, Prescott, AZ.
Alberico, D. Lt. Col. USAF; Director Air Force Safety Agency; 08/29/94, Kirtland, AFB, Albuquerque, NM.
Allan, P. Esq.; private practice; 10/01/94, Dayton.
Bahler, B.; NTSB Public Affairs Officer; 02/17/94, Washington, DC.
Benson, M.; NTSB Public Affairs Officer; 02/17/94, Washington, DC.
Bernard, J.; aviation accident investigator Bureau Enquetes Accidents (France); 08/06/92, Prescott, AZ.
Bernstein, S.; aviation business owner; 03/03/94, Levelland, TX.
Besco, Dr. R.; aviation accident investigator; 10/10/94, Dallas.
Block, M. Esq.; private practice; 10/10/93, Chicago.
Brune, K. Esq.; private practice; 11/10/94, Tulsa, OK.
Brunner, M.; Flt. 427 Family representative; 01/26/95, Pittsburgh.
Campbell, D.; Esq. NTSB General Counsel; 02/17/94, Washington, DC.
Carson, J.; Directory of Safety, AOPA; 08/01/92, Frederick, MD.
Carter, D.; Director of Safety, HAI; 01/28/95, Washington, DC.

APPENDIX A (continued)...

I. Personal Communications: (continued)...

Chesterfield, B.; Manager Aviation Safety Division, TSI; 04/04/93, Oklahoma City.
Chu, M.; President, Brantly Helicopter, Inc.; 02/13/95, Vernon, TX.
Ciavanelli, T.; Instructor, Aviation Safety Programs, Navy Post Graduate School; 04/04/92, Montery, CA.
Cochran, G.; Director of Safety, Omni Flight; 08/01/92, Prescott, AZ.
Collins, J. Esq.; private practice; 10/20/94, San Francisco.
Conyers, R.; aviation accident investigator, Associated Aviation Underwriters; Prescott, AZ.
Couch, T.; Special Projects, FAA; 10/04/94, Washington, DC.
Culliton, J. Esq.; private practice; 10/17/94, Sacramento.
David, J. Col.; Director of Flight Safety, National Defense; 04/04/92, Seattle, WA.
Del Gandio; Manager, Recommendations and Quality Assurance Division, FAA; 02/02/95, Washington, DC.
Dillman, J.; FAA Asst. Chief Counsel; 02/17/94, Washington, DC.
Dollar, J. Esq.; private practice; 10/10/94, Monroe.
Dougherty, S.; aviation accident investigator, NTSB; 09/09/94, Washington, DC.
Dudenhefer, F. Esq.; private practice; 10/10/92, New Orleans.
Edwards, B.; Dir. Aviation Programs, Southeastern Oklahoma State University; 09/03/93, Durant, OK.
Ferguson, H. Esq.; private practice; 10/12/94, Corpus Christi.
Fleming, V. Esq.; private practice; 05/29/91, Little Rock.
Gassaway, O.; aviation business owner; 03/03/94, Lantana, FL.
Gillaspie, B.; Director of Safety, PHI; 09/09/92, Lafayette, LA.
Goodrich, M. Esq.; private practice; 10/10/93, Reno.
Granito, F. Esq.; private practice; 01/20/95, New York.
Grant, R. Esq.; private practice; 02/20/94, San Deigo.
Gross, R.J.; aviation accident investigator, former NTSB; 07/28/92, Frederick, OK.
Hartsell, Dr. H.; Dir. Technical Education, Western Oklahoma State College; 11/11/93, Altus, OK.

APPENDIX A (continued)...

I. Personal Communications: (continued)...

Harvey, D.; aviation accident investigator; 01/28/95, Dallas.
Haueter, T.; Chief Aviation Investigator, NTSB; 02/17/94, Washington, DC.
Heater, H. Esq.; private practice; 03/03/93, San Deigo.
Heller, J.; Author, news editor, St. Petersburg Times; 10/27/93, Tampa.
Hillmer, R. Lt. Col; Director of Safety Education, USAF; 08/25/92, Norton AFB, CA.
Hinton, T.; Director, Investigations, Transportation Safety Board of Canada; 08/15/92, Ottawa.
Holliday, D.; aviation accident investigator; 10/19/93, San Diego.
Houghton, S.; aviation accident investigator, former FAA; 07/10/93, Oklahoma City.
Howland, B. Esq.; private practice; 01/20/93, Louisville.
Huffman, D. Capt.; United Parcel Service; 04/15/95, Oklahoma City.
Huggins, P.; aviation accident investigator, ALPA; 11/15/93, Herndon, VA.
Hunt, D. Dr.; ERAU professor, aviation accident investigator; 08/06/92, Prescott, AZ.
Hurt, H.; aviation accident investigator; 10/19/93, West Covina, CA.
Hynes, D. 1st Lt. USAF; pilot; 03/20/95, Langley, AFB, VA.
Hynes, K.; aviation business owner; 03/23/95, Wichita Falls, TX.
Hynes, M. J.; airline pilot, Continental Airlines; 03/20/95, Houston, TX.
Jackalus, P.; aviation accident investigator; 03/04/95, San Diego.
Janison, J.; Data Analyst NTSB; 08/01/92, Prescott, AZ.
Johannesen, R.; aviation accident investigator, DEA; 10/10/92, Washington, DC.
Johnson, J. Capt. USAF; attorney; 06/02/94, Washington, DC.
Key, J. Dr.; Professor, OSU; 10/10/93, Stillwater, OK.
Keerfoot, L.; accident investigator; 02/26/94, Washington, DC.
Kennedy, D. Dr.; accident investigator; Boulder, CO.

APPENDIX A (continued)...

I. Personal Communications: (continued)...

Kinkle, K.; Air Force Safety Agency staff; 11/09/93, Kirtland AFB, Albuquerque, NM.
Knisley, B.; aviation manufacturer; 03/12/95, Sacramento.
Koan, N.; Chairperson, National Air Safety Committee, Association of Flight Attendants, AFL-CIF; Rio.
Lane, A.; Supervisor, Pilot Ground Training, Bell Helicopter, Textron; 01/19/95, Ft. Worth.
Layton, D.; aircraft accident investigator; 11/09/94, Menlo Park, CA.
Lederer, J.; aviation accident investigator, former CAB; 11/11/93, New York.
Lesser, N.; Safety Information Staff, FAA; 02/17/94, Washington, DC.
Lessin, M. Esq,; private practice; 04/10/93, Philadelphia.
Logan, T.; Manager, Flight Safety, Northwest Airlines; 09/09/92, St. Paul, MN.
Luke, L.; aviation accident investigator; 08/01/93, Lancaster, TX.
Martineau-Comeau, T.; ICAO; 09/12/92, Montreal.
Mass, C. Col. USAF; Deputy Director of Aerospace Safety; 02/03/93, Norton, CA.
Melodia, J.; private investigator; 11/01/93, Menlo Park, CA
Meninger, W. Capt.; Chief Safety Branch, USCG; 08/01/92, Prescott, AZ.
Miller, C.; aviation accident investigator, former CAB; 08/06/92, Phoenix.
Mills, R.; Air Safety Investigator, NTSB; 02/17/94, Wasington, DC.
Minter, B.; Director of Aviation Programs, ERAU; 06/10/93, Daytona Beach.
Murphy, T. Capt.; Air Lingus; 03/20/94, Dublin.
Murray, R. Dr.; aviation accident investigator; 06/06/93, Norman, OK.
Norman, J. Esq.; private practice; 12/12/94, Oklahoma City.
O'Brien, P.; aviation accident investigator; 02/02/95, Stratford, CN.
Pangia, M. Esq.; private practice; 10/26/94, Washington, DC.
Parker, W. George.; former instructor aviation accident investigator school, USN; 10/19/93, Monterey, CA.

APPENDIX A (continued)...

I. Personal Communications: (continued)...

Patterson, R. Capt.; Executive Assistant; International Society of Air Safety Investigators; 03/03/94, Sterling, VA.
Plevin, F. Esq.; private practice; 03/12/95, San Diego.
Pool, R. Lt. Col. USAF; Contractor Administrator; 11/09/93, Kirtland AFB, Albuquerque.
O'Reilly, T. Esq.; private practice; 10/20/94, Menlo Park, CA.
Robertson, H.; President, Robertson, Inc.; 08/23/92, Phoenix.
Robinson, D. Esq.; NTSB practice; 11/08/93, Washington, DC.
Robinson, F.; President, Robinson Helicopter, Inc.; 01/28/95, Las Vegas.
Robinson, G.; accident investigator; 04/04/92, Tequesta, FL.
Rodriguez, C. Esq.; private practice; 03/03/92, Corpus Christie.
Schleede, R.; NTSB aviation accident investigator; 02/17/94, Washington, DC.
Schweibold, J.; aviation accident investigator; Pottsboro, IN.
Schram, B.J.; aircraft manufacturer; 04/04/93, Tempe, AZ.
Smith, D. Esq.; private practice; 06/06/94, Dallas.
Snapp, R. Lt. Col. USAF; 11/09/93, Kirtland AFB, Albuquerque.
Specter, H. Esq.; private practice; 01/28/94, Pittsburgh.
Steel, R. Esq.; private practice; 01/22/95, Grand Isle, NB.
Steigch, S. Esq.; private practice; 04/08/94, New York.
Stopher, E. Esq.; private practice; 05/05/90, Louisville.
Strauch, B. Dr.; NTSB aviation accident investigator; 07/25/93, Washington, DC.
Taff, C.; aviation business owner; 01/10/93, Bethany, OK.
Taylor, F.; Director, Aviation Accident Investigation Training, Cranfield College of Aeronautics; 08/31/92, Bedford, UK.

APPENDIX A (continued)...

I. Personal Communications: (continued)...

Taylor, G. Esq.; TSI aviation accident school instructor, private practice; 06/26/92, Oklahoma City.
Tilson, J.; President, ICSE, Simula, Inc.; 10/28/93, Tucson.
Tomlin, T. Esq.; private practice; 10/17/94, Sacramento.
Tompkins, G. Esq.; private practice; 05/29/92, New York.
Topham, T. Esq.; private practice; 10/10/94, San Antonio.
Turek, K. Esq.; private practice; 01/20/95, San Deigo.
Vogt, C. Esq.; Chairman, NTSB; 06/02/94, Washington, DC.
Wadell, W.; NTSB Aviation accident investigator; 06/06/94, Dallas.
Wagner, B. Esq.; private practice; 02/16/94, Tampa.
Welch, B.; aviation accident investiator; 01/11/94, Jackson, MS.
Waldock, B.; ERAU professor, aviation accident investigator; 08/06/92, Prescott, AZ.
Williamson, R.; aviation accident investigator; 03/03/93, Paducah, KY.
Wolk, A. Esq.; private practice; 02/14/94, Philadelphia.
Yarme, B.; Instructor, Simflite; 02/10/95, Dallas.

II. Government Agencies: 21 organizations surveyed.

Bureau of Land Management (BLM)
Civil Aeronautic Authority, Australia
Civil Aeronautic Authority, Canada
Civil Aeronautic Authority, United Kingdom
Department of Agriculture
Department of Commerce
Department of Energy (DOE)
Department of Interior
Department of Transportation (DOT)
Drug Enforcement Agency (DEA)
Federal Aviation Administration (FAA)
International Civil Aviation Organization (ICAO)
National Air and Space Administration (NASA)
National Transportation Safety Board (NTSB)
National Oceanic and Atmospheric Administration (NOAA)
Nuclear Regulatory Commission

APPENDIX A (continued)...

II. Government Agencies: (continued)...

Tennessee Valley Authority (TVA)
Transportation Safety Institute (TSI)
United States Customs and Immigration
United States Forest Service (USFS)
United States Postal Service (USPS)

Only three government agencies had aviation accident investigation schools, none were open to the public. The agencies were:

National Transportation Safety Board, Washington, DC.
Federal Aviation Administration (DOT), Oklahoma City.
Transportation Safety Institute (TSI), Oklahoma City.

III. Military services: 12 organizations surveyed.

Oklahoma National Guard
United States Air Force
United States Air Force Civil Air Patrol
United States Air Force Reserve
United States Army
United States Army Reserve
United States Coast Guard
United States Coast Guard Reserve
United States Marine Corps
United States Marine Corps Reserve
United States Navy
United States Navy Reserve

Only three military organizations had schools, none were open to the general public. The three schools were:

US Air Force, Kirtland Air Force Base, NM
US Army, Ft. Rucker, AL
US Navy, Monterey, CA

IV. Aviation/Professional: 32 organizations surveyed.

Aerospace Industries Association of America, Washington, DC.
Airborne Law Enforcement Association, Van Nuys, CA.
Aircraft Builders Council, Inc., New York.
Aircraft Owners and Pilots Association, Frederick, MD.

APPENDIX A (continued)...

IV. Aviation/professional organizations: (continued)...

Air Line Pilots Association (ALPA), Herndon, VA.
Air Transport Association of America, Washington, DC.
Allied Pilots Association, Washington, DC.
American Association of Airport Executives, Alexandria, VA.
American Bar Association (ABA), Washington, DC.
American Helicopter Society, Alexandria, VA.
American Institute of Aeronautics and Astronautics, Washington, DC.
American Trial Lawyers Association, Washington, DC.
Aviation Distributors and Manufacturers Association, Philadelphia.
Experimental Aircraft Association, Oshkosh, WI.
Flight Safety Foundation, Arlington, VA.
General Aviation Manufacturers Association, Washington, DC.
Helicopter Association International, Alexandria, VA.
Helicopter Club of America, Dumfries, VA.
Independent Association of Contintental Pilots, Houston.
International Society Air Safety Investigators (ISASI), Sterling, VA.
Lawyer Pilots Bar Association , Washington, DC.
National Aeronautic Association, Arlington, VA.
National Association of Flight Instructors, Dublin, OH.
National Business Aircraft Association, Washington, DC.
The Ninety-Nines, Oklahoma City.
Popular Rotorcraft Association, Clinton, LA.
Royal Aeronautical Society, London.
Soaring Society of America, Hobbs, NM.
Society of Automotive Engineers, Warrendale, PA.
Sport Aircraft Manufacturers Association, Tempe, AZ.
Twirly Birds, Oxon Hill, MD.
United States Ultralight Association, Frederick, MD.

Only one organization had an aviation accident investigation school and it was not open to the general public. It was the

Air Line Pilots Association, Herndon, VA

APPENDIX A (continued)...

V. Commercial Air carriers: 113 organizations surveyed.

Airlift International
Air Atlanta
Air Logistics
Air Midwest
Air New England
Air Wisconsin
Air North
Alaska Airlines
Allegheny Commuter
Aloha Island Air
Aloha Airlines
Altair
American Airlines and four American Eagle commuters
Atlantic Coast Airlines
Atlantic Southeast Airlines
Aspen Airways
Braniff Airlines
Business Express
CCAir
Comair
Continental Airlines and three Continental commuters
Cascade
Capitol
Crescent Airways
Crown/Dorado
Delta Air Lines and two Delta Connection commuters
DHL
Eastern Airlines
Energy Helicopters
Express Airlines 1
Freedom
Federal Express (FedX)
Frontier Airlines
Golden Isle Airlines
Golden West
Hawaiian Air Lines
Houston Helicopters
Imperial
Island Helicopters
Jetstream
Los Angeles
Mark Air
Mesaba
Metro (SAI and SUN)
Modern
National Airlines

APPENDIX A (continued)...

V. Commercial Air carriers (continued)...

New York Air
New York Airways
New York Helicopter Airlines
North Central (Republc)
Northwest and two Northwest commuters
Northeast (DAL)
Overseas National Airways
Ozark (TWA)
Pan American Airways
Panagra
Pennsylvania Air
Petroleum Helicopters
Piedmont
Pioneer
Pocono
People Express
Precision
Presidential Airways
Prinair
Punkin Air
Reeve
Republic (NWA)
Rocky Mountain Helicopters
Ross
Royale
Saturn (TAA)
San Francisco
San Juan
Simmons
Sky Airlines
South Central Airlines
Southern (Republic)
Southwest
StatesWest
Sun Airlines
Sunaire Express
Trans America
TACA
TAG
Trans Caribbean (AAL)
Transtar
Trans States
Trans World Airlines and Trans World Express
United Air Lines
United Parcel Service (UPS)
Universal

APPENDIX A (continued)...

V. Commercial Air carriers (continued)...

USAir and four USAir Shuttle airlines
US Postal Service
Wien Alaska
WestAir Commuter
Western (Delta)
Wright
Universal
Zenith (BWA)

No commercial air carrier had an aviation accident investigation school.

VI. Manufacturers: 55 organizations surveyed.

Aerospatiale, Inc., Grand Prairie, TX
Agusta Aerospace Corp., Philadelphia
Air Tractor, Inc., Olney, TX
Allied Signal Aerospace, Torrance, CA
Allison Engine, Co., Indianapolis
Astra Jet Corp., Princeton, NJ
Avtek Corp., Camarillo, CA
Ayres Corp., Albany, GA
Beech Aircraft Corp., Wichita
Bell Helicopter Textron, Inc., Ft. Worth
The Boeing Co., Seattle
Brantly Helicopter Industries Ltd., Vernon, TX
Ken Brock Manufacturing, Stanton, CA
Cessna Aircraft Co., Wichita
Collins General Aviation Division, Cedar Rapids, IA
Commander Aircraft Co., Oklahoma City
Convair
Curtiss-Wright Corp., Lyndhurst, NJ
Douglas Aircraft Co., St. Louis
EDO Corp., College Point, NY
Enstrom Helicopter Corp., Menominee, MI
Fairchild Aircraft, San Antonio
Falcon Jet Corp., Paramus, NJ
Farrington Aircraft, Paducah, KY
GE Aircraft Engines, Fairfiled, CT
General Dynamics Corp., Ft. Worth
Gulf Stream Aerospace, Savannah, GA
Hamilton Standard, Windsor Locks, CT
Hughes Aircraft Co., Los Angeles
Jetstream, Inc., Sterling, VA
Kaman Aerospace Corp., Bloomfield, CT

APPENDIX A (continued)...

VI. Manufacturers: (continued)...

Knisley Manufacturing, Loma, CA
Lake Aircraft, Inc. Gilford, NH
Lear Jet, Inc., Wichita
Lockheed Corp., Calabasas, CA
Maule Air, Inc., Moultrie, GA
McDonnell Douglas Aerospace, St. Louis
McDonnell Douglas Helicopter Co., Mesa, AZ
Mitsubishi Heavy Industries America, Inc., New York
Mooney Aircraft Corp., Kerrville, TX
Northrop Corp., Los Angeles
Parker Hannifin Corp., Cleveland
Piaggio Aviation, Inc. Wichita
Piasecki Aircraft Corp., Essington, PA
Piper Aircraft Corp., Vero Beach, FL
Pratt & Whitney, Hartford, CT
Robinson Helicopter Co., Torrance, CA
Saberliner Corp., Chesterfield, MO
Schweizer Aircraft Corp., Elmira, NY
Sikorsky Aircraft, Stratford, CT
Snow Aviation Intl., Inc., Columbus, OH
Spitfire Helicopter Co. Ltd., Media, PA
Swearingen Aircraft, Inc., San Antonio
Teledyne Continental Motors, Mobile
Textron Lycoming, Williamsport, PA

None had aviation accident investigation schools.

VI. Academic Institutions: Approximately 450 institutions were surveyed utilizing Schulert's The Collegiate Aviation Directory and the Collegiate Aviation Guide (Willimason). Contacts were made with all of the institutions that listed any course offerings on aviation accident investigation.

Three institutions had offered an aviation accident investigation course. They were:

University of Southern California, Los Angeles, CA
Embry Riddle Aeronautical University, Prescott, AZ
University of Arizona, Phoenix, AZ (discontinued)

APPENDIX A (continued)...

VII. Commercial firms or organizations: 5 firms surveyed.

Flight Safety International, New York
International Center for Safety Education, Phoenix
Simcom, Inc., Orlando, FL
Simuflight, Division of Southern Air, Ft. Worth
Systems Safety, Inc. Prescott, AZ

Only one firm had an aviation accident investigation school. It was the:

International Center for Safety Education, Phoenix, AZ

VIII. Libraries: 27 libraries were visited as part of the research data gathering process. They were:

Aviation History Center Library, San Deigo
Civil Aeromedical Institute (FAA), Oklahoma City
Clarence E. Page Aviation Library, Oklahoma City
Dulaney Browne Law Library, Oklahoma City University
East Central State University, Ada, OK
Embry Riddle Aeronautical Institute, Daytona Beach, FL
Embry Riddle Aeronautical Institute, Prescot, AZ
Enoch Pratt Library, Baltimore, MD
Federal Aviation Administration, Washington
Federal Aviation Administration, Oklahoma City
International Society of Air Safety Investigators, Sterling, VA
Library of Congress, Washington
National Air & Space Museum, Washington
National Transportation Safety Board, Washington
New Orleans City Library
Oklahoma State University, Stillwater, OK
University of Oklahoma, Norman, OK
San Diego City Library
San Francisco City Library
University of Texas at Dallas
US Air Force Academy, Colorado Springs, CO
US Air Force, Brooks AFB, San Antonio
US Air Force, Kirtland AFB, Albuquerque
US Air Force, Wright-Patterson AFB, Dayton
US Army Safety Center, Ft. Rucker, AL
Western Oklahoma State College, Altus
Western Reserve Law School Library, San Diego

APPENDIX A (continued)...

XI. Legal and aviation publications: 57 publications were utilized for this research; 35 are listed in the Bibliography and the following 22 publications were also reviewed:

ABA Journal (American Bar Association)
Aeronautical Journal, Royal Aeronautical Society
Aerospace Engineering (Society Automotive Engineering)
Air Classics
Air Progress
Airbeat (Airborne Law Enforcement Association)
Airline Executive
Armada
Aviation Law Newsletter
Defense Helicopter World
Expert & The Law
Flying
Helicopter World
Journal of the American Helicopter Society
Lawyers Weekly
Plane & Pilot
Private Pilot
Professional Pilot
Rotors (Helicopter Association International)
Rotor & Wing International
Trial (American Trial Lawyers Association)
Trial Lawyer
Vertiflite (American Helicopter Society)

APPENDIX B

DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations apply to this study:

ABA, American Bar Association, Chicago.

Accident, an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person (occupant or non-occupant) suffers a fatal or serious injury or the aircraft receives substantial damage (49 CFR 830.2).

AFB, Air Force Base (US Air Force).

AIA, Aerospace Industries Association of America, Washington, DC.

ALPA, Air Line Pilots Association, Washington, DC.

AMSI, Aerospace Management Services Inc., Washington, DC.

AOPA, Aircraft Owners & Pilots Association, Frederick, MD.

ASB, Air Safety Board (Civil Aeronautics Administration).

ATLA, American Trial Lawyers Association, Washington, DC.

AW&ST, Aviation Week & Space Technology magazine, NY: McGraw Hill.

BOAC, British Overseas Airways, Corporation, London.

Boeing, The Boeing Co., Seattle.

Bureau Enquetes Accidents, French equivalent of the NTSB.

APPENDIX B (continued)...

CAA, Civil Aeronautics Administration 1926.

CAA, Civil Aeronautics Authority 1938.

Cause, something that precedes and brings about an effect or a result.

CAB, Civil Aeronautics Board (Act of 1938).

CEO, Chief Operating Officer.

CFR, Crash-Fire-Rescue services at airports.

CFR, Code of Federal Regulations, USA.

CPT, Civilian Pilot Training (Act of 1938).

DEA, Drug Enforcement Agency.

Defendant, the party against which legal action is taken.

Designated Party, special status given by the NTSB to persons during an accident investigation.

DOC, Department of Commerce.

DOT, Department of Transportation, Washington, DC.

EIR, Enforcement Investigative Report (by the FAA).

ERAU, Embry-Riddle Aeronautical University, Daytona Beach, FL and Prescott, AZ.

Enthographic research, a long term, multi-disciplined technique for the study of social and technical factors which affect history.

Exposure data, information that indicates the amount of opportunity for an event to occur. Cycles, distance, and time, for passengers or vehicles, are the principal exposure types. They are used in the denominators of rates, such as fatalities per passenger departure or electrical system failures per aircraft hour.

FAA, Federal Aviation Administration (1967 to date); the DOT Act of 1966, PL 89-670, 49 USC Sec. 1651).

APPENDIX B (continued)...

FAA, Federal Aviation Agency (1958 to 1967); the FAA Act of 1957, PL 85-726, 49 USC Section 1301).

FAI, Federation Aeronautique International, Paris, France.

Fatal injury, any injury which results in death within 30 days of the accident (49 CFR 830.2).

Fault, the party or parties responsible for the cause.

FDR, Flight Data Recorder.

Flying machines, name given to early aircraft, pre 1930s.

FSF, Flight Safety Foundation, Arlington, VA.

GAMA, General Aviation Manufacturers Association, Washington, DC.

General Aviation, the non-airline, non-military segment of the aviation industry (usually small aircraft).

GI, Veterans from World War II or subsequent wars.

HR, House of Representatives, US Congress.

ICAO, International Civil Aviation Organization, Montreal, Canada.

ICSE, International Center for Safety Education, Phoenix.

IIC, Investigator In Charge, the NTSB person responsible for the investigation and who usually grants designated party status to others during NTSB investigations.

Incident, an occurrence other than an accident associated with the operation of an aircraft which affects or could affect the safety of operations (49 CFR 830.2).

Investigator In Charge (IIC), the NTSB person responsible for the investigation and who usually grants designated party status to others during NTSB investigations.

ISASI, International Society of Air Safety Investigators, Sterling, VA.

APPENDIX B (continued)...

Jet age, the 1950s, when turbine (jet) engine airplanes become popular.

Level of safety (or risk, fatality or injury rates), only past levels of safety can be determined positively. Accident rates are closely associated with fatalities and injuries, and are acceptable measures of safety levels. Fatality, injury, and accident rates are benchmark safety indicators. Current and future safety levels must be estimated by other indicators or by past trends (NTSB).

LPBA, Lawyer Pilots Bar Association, Cleveland.

NAAIS, National Aircraft Accident Investigation School, Oklahoma City.

NACA, National Advisory Committee on Aeronautics.

NASA, National Aeronautics and Space Administration.

NBC, National Broadcasting Corp.

NTSB, National Transportation Safety Board (1967 to 1974) The DOT Act of 1966, PL 89-670, 49 CFR Section 1651; (1974 to date) The Independent Safety Board Act of 1974, PL 93-633, 49 USC Section 1901).

PL, Public Law (Federal government, USA).

Plaintiff, the party which initiates a legal action.

Probable cause, determined with a high degree of certainty (over 50%) as a cause of an accident.

R&D, Research and development.

RAeS, the Royal Aeronautical Society, London.

Recip, reciprocating gas or diesel engines.

Res ipsa loquitur, legal term, the thing speaks for itself.

S, Senate, US Congress.

APPENDIX B (continued)...

Safety factor, a procedure or event associated with fatalities, injuries, or accidents of their prevention.

Safety indicator, a measurable safety factor.

Serious injury, any injury which requires hospitalization for more than 48 hours, results in a bone fracture, or involves internal organs or burns (49 CFR 830.2).

SMU, Southern Methodist University, Dallas.

Substantial damage, damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component (49 CFR 830.2).

Tort, an injury or wrongdoing against another.

TSI, Transportation Safety Institute, Oklahoma City.

UAA, University Aviation Assoication, Auburn, AL.

UAL, United Air Lines, Inc., Denver.

United, United Airlines, Inc., Denver.

USAF, United States Air Force.

USC, United States Code (US federal laws).

USC, University of Southern California, Los Angeles.

USFS, United States Forest Service.

Wright Flyer, the name given to the first powered aircraft flown by the Wright Brothers.

APPENDIX C

AVIATION ACCIDENT INVESTIGATION SCHOOLS

At the time of this research, there were ten organizations teaching aviation accident investigation courses in the United States. They were:

a. three military organizations:

the Air Force at Kirtland AFB, Albuquerque,
the Navy Post Graduate School, Monterey, CA,
the Army Safety Center, Ft. Rucker, AL;

b. three federal government agencies:

the FAA school at Oklahoma City,
the NTSB school at Washington
the TSI school at Oklahoma City;

c. one private (not open to the public) organization:

the Air Line Pilots Association, Herndon, VA;

d. two academic institutions:

Embry Riddle Aeronautical University,
Prescott, AZ
the University of Southern California at Los
Angles;

e. one commercial firm:

The International Center for Safety Education,
Tucson, AZ.

APPENDIX D

AN ANALYSIS OF THE INTERVIEWS CONDUCTED

As part of the research effort, interviews were conducted with over 125 individuals. As indicated in the research report, the comments from these persons may be influenced by their connection with the aviation industry and their interest in the topic of aviation accident investigation. A general summary of the professional interest of the persons interviewed is shown below:

Aviation accident investigators:		46 persons
General public:		20 persons
Government personnel:		24 persons
Lawyers:	Defense	19 persons
	Government	5 persons
	Plaintiff	29 persons
Manufacturers, etc.		16 persons

The above numbers total more than the number of persons interviewed due to the fact that some persons had major personal interests in more than one professional area.

VITA

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Education: Graduated from Forest City High School, Forest City, Pennsylvania in 1953; received Associate of Science and Associate of Arts Degrees from Polk Community College at Winter Haven. Florida in 1974; Associate of Science and Associate of Arts Degrees from Western Oklahoma State College, Altus, Oklahoma in 1975; a Bachelor of Science in Aviation Technology from Thomas Edison State College, Trenton, New Jersey in 1989; a Master of Liberal Studies from the University of Oklahoma, Norman, in 1991; completed requirements for the Doctor of Education degree at Oklahoma State University, Stillwater, Oklahoma in July 1995.

Professional Experience: Is an adjunct professor at Western Oklahoma State College, Altus and a commercial pilot with 16,010 hours flight experience; is a Federal Aviation Administration Designated Pilot Examiner, Airline Transport Pilot and Flight Instructor for airplanes and helicopters; holds Airframe and Powerplant Mechanic Certificates with Inspection Authorization; has owned or managed 13 aviation businesses, including an aircraft manufacturing firm; has conducted over 200 aircraft accident investigations; has written over 150 articles or technical papers and two books; is a member of the International Society of Air Safety Investigators, the Royal Aeronautical Society of England, the University Aviation Association, the National Expert Witness Society, and several other organizations.