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Reporting discrepancies : information needs of airline mechanics and pilots

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REPORTING DISCREPANCIES: INFORMATIONAL NEEDS OF AIRLINE MECHANICS AND PILOTS

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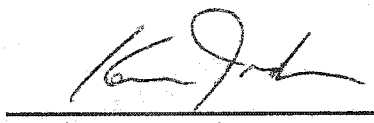

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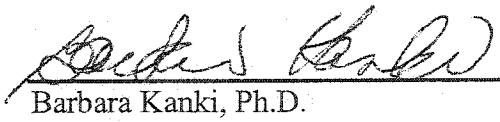

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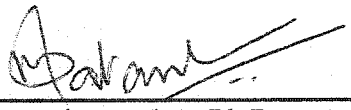

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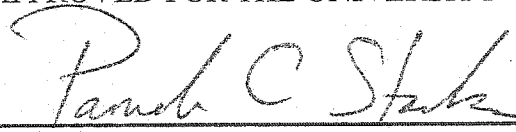

ABSTRACT

REPORTING DISCREPANCIES:
INFORMATIONAL NEEDS OF AIRLINE MECHANICS AND PILOTS

by Pamela A. Munro

Abstract

Communication between airline mechanics and pilots is crucial, as both share responsibility for the legal airworthiness of an aircraft. When they cannot meet directly, information about discrepancies is exchanged between pilots and mechanics via entries in the maintenance logbook. A questionnaire was developed and distributed to pilots and mechanics at two major US airlines to determine what information was most helpful to include in logbook entries and what factors influenced whether or not this information was provided. While both crews demonstrated an understanding of what information was useful to include, mechanics reported they frequently did not receive helpful information about discrepancies from pilots. Mechanics reported they were more impacted by a lack of detail than pilots and often had no procedure to obtain additional information. There were significant differences in the factors influencing what each crew wrote in the logbook, including training, guidelines, and concern about scrutiny by authorities.

ACKNOWLEDGEMENTS

I would like to thank my committee for their support and guidance on this project. The circumstances surrounding its completion included an unexpected and shattering personal loss. Their kindness, generosity, and sensitivity made the process endurable and the obstacles surmountable.

Dr. Kevin Jordan often served as the calm at the eye of the storm. I am grateful for his support, insights, and flexibility. I could not imagine a better chairman. In addition to sharing her expertise, Dr. Barbara Kanki provided support that allowed me to be with my family and continue working. I could not have finished otherwise. Dr. Manoj Patankar (A&P), during a trying time of his own, offered incisive critiques and made sure that I was always technically accurate.

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I benefited immeasurably from the friendship and wisdom of a number of my colleagues as well, in particular Audra Ruthruff (and family), Kirsten Patankar, Susan Dowell, Bonny Parke, Alan Hobbs, Yuri Tada, and Amy Lynn. Heartfelt thanks to Polly Nielsen and Ken Peppard for unstintingly sharing their contacts and, along with Sandy Garcia and Maurice Regan, for listening when things got tough.

This thesis is dedicated to my parents:

Claire McCarthy Munro (1934-2003) for her breathtaking courage, strength, and selflessness. In the face of her own unimaginable suffering, she worried that I might not finish this project.

Bert Munro (Capitol/United/Allegheney/USAir) for inspiring my lifelong interest in aviation, but most of all, for his unwavering support, love, and faith.

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Introduction

The responsibility for the safety and legal airworthiness of commercial airliners is shared by both flight crews and maintenance crews. However, in training and on the job, each crew interacts with the aircraft under different circumstances, which allows them to develop their own specialized knowledge. Mechanics may possess a more detailed understanding of aircraft systems, structures, and components, for example, while pilots may have a better understanding of the operating characteristics of those systems, structures and components, especially in a high-altitude environment. In the event of a malfunction, then, each crew can contribute information that is vital to resolving the problem. Understanding a malfunction and finding the right solution is a collaborative process, one that requires the two professions to share information.

It is not just sharing information, but doing so in a meaningful way, that is "critical to effective and efficient resolution of maintenance problems" (Eiff, Lopp, Abdul, Lapacek, & Ropp 1997, p. 14). What constitutes meaningful communication between flight crews and maintenance crews, however, remains unclear. While communication between other aviation crews who are required to share information to solve problems has been studied in detail (for example, flight crews and air traffic controllers, and flight crews and cabin crews), there have been surprisingly few studies of communication between pilots and mechanics. The studies that have been done have consistently noted a significant level of dissatisfaction within both groups regarding the communication between them. The factors most commonly cited as contributing to this dissatisfaction were crews providing information that was vague, inadequate, or incorrect

and the failure of crews to communicate with each other at all (Drury, Levine, & Reynolds, 1995; Eiff et al., 1997; Mattson, Crider, & Whittington, 1999; Young, Mattson, & Petrin, 1999).

Reporting Discrepancies

Formal Procedure

One of the most critical issues about which pilots and mechanics must communicate concerns "discrepancies" i.e., malfunctions or failures of any part of the aircraft or its components. Most major air carriers have procedures that outline how maintenance and flight crews are to share information regarding maintenance discrepancies. Typically, these procedures include mechanics being assigned to specific arrival gates. Whenever an aircraft arrives at one of his/her assigned gates, the mechanic boards the aircraft and confers with the pilots regarding any mechanical difficulties they encountered during their flight (Eiff et al., 1997).

Most major carriers also have Maintenance Control departments, which serve as a link to pilots during flight. Mechanical problems encountered by pilots while enroute can be radioed ahead or downlinked via the Aircraft Communications and Reporting System (ACARS) or other electronic systems directly to Maintenance Control or Dispatch, who can work with them to troubleshoot malfunctions while they are still in the air. Maintenance Control can further alert Line Maintenance to the incoming problem. Even under these conditions, however, line mechanics are still expected to meet personally with the pilots to get direct feedback and any other supplemental information about the problem.

In a study by Eiff et al. (1997) it was observed that despite having such a formal procedure, most mechanics at one participating airline avoided direct contact with pilots. This was accomplished by waiting on the ground until flight crews left the aircraft, then entering the cockpit to retrieve the maintenance logbook and checking it for any pilot entries. On the few occasions when mechanics did meet with pilots, the exchange was frequently "marked by tension" and "communication was often kept to a bare minimum" (Eiff et. al., 1997, p. 14).

There have been reports by mechanics that often it is the actions of pilots that prevent direct contact. Pilots depart the aircraft before maintenance can arrive, thereby eliminating any opportunity for face-to-face interaction. Whether these situations are due to tensions between crews or to logistical factors, both of which will be discussed in detail in the following sections, is uncertain. What is certain, however, is that when the prescribed face-to-face communication between pilots and mechanics does not take place, the logbook becomes the primary channel of communication about discrepancies on the aircraft.

Maintenance Logbook

The maintenance logbook provides a written record of any mechanical discrepancies encountered by flight crews and documents the corresponding repairs made by maintenance. It remains with the aircraft and must be accessible to flight crews and maintenance crews at all times. The logbook serves as a most recent mechanical history of the aircraft. Because entries are mandated by Federal Aviation Regulations (FARs) (e.g., 14CFR§121.563; 14CFR§121.701), the maintenance logbook also serves as a legal

document, one which can be scrutinized not only by the company but, at any time, by federal aviation authorities as well.

Pilots are required to record discrepancies in the maintenance logbook under 14CFR§121.563 which states that "(t)he pilot in command shall ensure that all mechanical irregularities occurring during flight time are entered in the maintenance log of the airplane at the end of that flight time." Once a pilot has made an entry in the logbook, maintenance must take some action in response to the item(s) reported. Such a response must also be noted in the logbook. According to 14CFR§121.701 "Maintenance log: Aircraft: Each person who takes action in the case of a reported or observed failure or malfunction of an airframe, engine, propeller, or appliance that is critical to the safety of flight shall make, or have made, a record of that action in the airplane's maintenance log."

Finally, before the next pilot accepts the aircraft for a flight, s/he must examine the maintenance logbook to ensure that all discrepancies written up by previous flight crews have been adequately addressed by maintenance. 14CFR§121.563 states "before each flight the pilot in command shall ascertain the status of each irregularity entered in the log at the end of the preceding flight."

Logbook Entries

What the FARs do not spell out, however, is just what a pilot must include in his/her write-up of a discrepancy. This is left to the pilot's discretion, and predictably, leads to a great variety in the quantity and quality of information contained in such write-ups. Some pilots may provide a detailed description of a malfunction, while others may

provide only a cursory notation. Individual carriers' Flight Operating Manuals (FOM) generally offer only broad guidelines about write-ups, such as "flight crews will include all pertinent information when writing up discrepancies." However, despite such recommendations, there is no accepted standard regarding what constitutes a sufficient level of information, nor is there any formal procedure for ensuring they are followed.

On the maintenance side, the FARs offer slightly more guidance regarding logbook entries. However, even here the guidelines leave room for variability. 14CFR§43.9, section 1, *Maintenance record entries*, mandates that mechanics include the date the repair was completed, the name of the person performing the work, the signature, certificate number and certificate type of the person approving the work, and "a description (or reference to data acceptable to the Administrator) of work performed."

This allows maintenance the option of either writing a narrative description of the repair performed, or citing the maintenance manual sections in which the appropriate repair procedure is detailed. While referencing maintenance manual "chapter and verse" is legal, and serves the purpose of creating a paper trail regarding work done to the aircraft, it does not provide meaningful information to pilots of the aircraft, who typically do not have familiarity with or access to maintenance repair manuals and are thus unable to determine what specifically was done to repair the discrepancy. This is important because of the requirement set forth in 14CFR§121.563 that a pilot must determine the status of each discrepancy entered by previous flight crews before making his/her own flight.

As has already been described, the formal procedure for reporting discrepancies

often requires that, in addition to documenting a discrepancy in the logbook, a pilot and a mechanic meet face-to-face to share information. As has been noted, however, such meetings do not always take place. While there are a number of factors that may contribute to this phenomenon, two in particular bear investigation: logistics and culture.

Logistics

Ground Time

Daily line operations at the major air carriers are complex and highly time-critical. Arrivals and departures are tightly scheduled. Since an airplane sitting on the ground does not generate revenue, airlines continually seek ways to reduce the amount of time aircraft spend on the ground between flights. At some carriers, total ground time from arrival to pushback has been reduced to a mere twenty minutes (Huettel, 2001). Such abbreviated gate times leave crews a shorter window in which to accomplish all of their pre- and post-flight duties. For flight crews this may include shutting down one aircraft, obtaining updated briefings on weather and routing for the next flight leg, and conducting a preflight of a new aircraft. At the same time, maintenance crews must investigate any mechanical problems reported by any of the inbound flight crews and either repair them before the next departure, or determine if they can be deferred until a later time. A ground delay can be costly, affecting not only the immediate flight, but potentially rippling through the system impacting dozens of other flights. While they may prove cost-effective, quick turnarounds can actually become a barrier to maintenance-flight crew communications, as they often allow little or no chance for pilots and mechanics to meet directly to discuss mechanical issues.

Scheduling

The majority of pilots work day and evening hours, when the majority of revenue flights are scheduled. Line mechanics work shifts both during the daytime and throughout the night. Since there is little demand for passenger service in the middle of the night, airlines use this time to perform more time-consuming repairs that cannot be done in the short turnarounds during the day. While mechanics working an overnight shift may have the advantage of more time to spend troubleshooting and repairing mechanical faults, they lack any opportunity to meet with pilots to discuss such faults face-to-face.

In addition, most flight and maintenance crews are not likely to be in the same location. Mechanics work from a fixed maintenance base at one airport. Pilots, by virtue of their duties, travel from their home base to a variety of airports throughout each day and, depending on their schedule, may not return to a given city for days or even weeks. This can present an additional barrier to pilot-mechanic interaction.

Culture

The relationship between pilots and mechanics has a long history, starting with the very first airplane flights. A review of this history may provide insight into some cultural barriers to pilot-mechanic interaction.

Historical Background

Since the birth of aviation there have been, of necessity, both pilots and mechanics (Marx & Graeber, 1994). In the earliest days, one individual often assumed both roles. Orville and Wilbur Wright, for instance, were bicycle mechanics who, along

with fellow mechanic Charles Taylor, were intimately involved not only in piloting the first flights, but also in the design and manufacture of the first airplane and aircraft engine. Aircraft mechanic and builder Glen Curtiss made significant structural and design improvements to the Wrights' airplane, in addition to setting numerous flight records (Kelly, 1972).

Despite the efforts of such experts, however, early aircraft were generally frail and their engines minimally reliable (Hopkins, 1998; Lindbergh, 1953). Indeed, engine failures were routine (Gann, 1961; Lindbergh, 1953). Since a barnstormer or airmail pilot who found himself in a remote field with aircraft damage or engine failure had no one else to rely on for repairs, many pilots learned how to service their own airplanes and engines (Gann, 1961; Hall, 1942; Lindbergh, 1953). Such mechanical self-reliance was possible because "there were few instruments, if any, the plane was but a structure of wooden rods and cloth, [and] the engine was designed along comparatively simple lines. To take care of it was a less difficult job than it has since grown to be" (Hall, 1942, p. 171).

Even so, the importance of mechanics was not taken lightly by early flyers. When Calbraith Rodgers planned the first transcontinental flight across the U.S. in one of their planes (a flight that would ultimately take fifty days), the Wright brothers sent mechanic Charles Taylor along. They knew the aircraft would never last more than a thousand miles without continuous maintenance, and that Taylor was the only one who could provide it (O'Brien, 2001). When Charles Lindbergh arrived in Paris after his historic

flight across the Atlantic, the very first words he spoke to the crowd that had gathered to greet him were, "Are there any mechanics here?" (Lindbergh, 1953, p. 495).

Nevertheless, it was the visible flying skill and derring-do of pilots rather than the unseen technical skills of mechanics that captured the public's imagination and around which the romance of flying evolved (Hall, 1942; Hopkins, 1998; Hopkins, 2000). Congressman John Martin of Colorado captured the public perception of pilots in 1938 when, after the passage of the Civil Aeronautics Act, he commented, "In my opinion, the piloting of these great airplanes… is the most responsible, the most skillful, and the most dangerous occupation that mankind ever engaged in… [Pilots] are the picked men of the country. It is a profession in which many are called but few are chosen" (Hopkins, 2000, p. 7). Pilots of the era did, indeed, assume a significant amount of risk in their work. Fatalities among airmail pilots were "continuous" (Hopkins, 1998, p. 12), leading to a life expectancy of a mere four years (Heppenheimer, 1995). As Charles Lindbergh, himself a former airmail pilot, noted, "It was commonly said that anyone entering aviation did not place much value on his life" (1976, p. 64).

Changes in Aircraft Technology

As technology advanced, aircraft grew more reliable. They also grew more complex. Correspondingly, the roles of pilot and mechanic grew increasingly specialized. As early as 1942 it was noted that "…it is a rare thing today to find a pilot who is both a good pilot and a good mechanic. The two occupations have expanded too greatly for one man to be expert in the details of both" (Hall, 1942, p. 172). This separation of roles allowed each professional to become highly proficient in his/her own

domain, while at the same time, less familiar with that of the other. With an increasing experiential gap between those who flew the airplanes and those who maintained them, communication about the status of the aircraft and any equipment failures or malfunctions became more important, as each group now had a unique working knowledge and understanding of the aircraft.

Military Influence

Until World War I, both military pilots and mechanics came from the enlisted ranks. During WWI, the military began allowing some pilots to earn commissions to officer rank, even without college degrees, though not without resistance from many traditional career officers (Hopkins, 1998). Mechanics were not offered this option. This disparity in rank was further increased during WWII when, through an act of Congress, all pilots were decreed "officers and gentlemen," while mechanics remained among the enlisted ranks which meant less pay, fewer privileges and lower status (O'Brien, 2001). This prompted an unknown aircraft maintainer to pen the classic poem bemoaning the mechanic's plight as "The Forgotten Man":

The pilot was everyone's hero
He was bold, he was brave, he was grand,
As he stood by his battered old biplane
With his goggles in his hand.

But for each of our flying heroes
There were thousands of little renown,
And these were the men who worked on the planes
But kept their feet on the ground.

We all know the name of Lindbergh,
And we've read of his flight into fame,
But think, if you can, of his maintenance man,
Can you remember his name?

Now, pilots are highly trained people
And wings are not easily won.
But without the work of the maintenance man
Our pilots would march with a gun.

So when you see the mighty jet aircraft
As they mark their path through the air,
The grease-stained man with the wrench in his hand
Is the man who put them there.

After World War II, many of these seasoned pilots and mechanics found work in the burgeoning commercial air transport industry. The airline industry preserved many of the traditions developed in the military regarding the role and status of each profession. Thus many of the disparities in pay, prestige, and privilege between flyers and maintainers that characterized military aviation came to characterize airline culture as well. As these are often at the heart of inter-crew tension, they merit individual examination.

Pay

Salary has been a source of great friction and resentment between pilots and mechanics. In the workplace, salary is often used as a barometer of how highly one's work is valued. Within the airline industry, the disparity in pilots' and mechanics' salaries has always been notable. In 2000, for example, the average salary for a senior airline captain was $179,000, with an industry high of $248,000 (Aviation Week, 2001). In summer 2001, this industry high increased to $300,000 (The Economist, 2001). In contrast, the average salary for airline mechanics in 2000 was $48,600 (Kocks, 2000).

Interestingly, starting salaries for pilots and mechanics are not that disparate. Average starting pay for first officers in 2000 was $32,724. During the same year, entry-level mechanics averaged around $15 per hour, or roughly $31,000 per year (Aviation Week, 2001). Pilot pay, however, increases based on a combination of factors, including seniority, position (captain/first officer/second officer), type of aircraft flown, and routes flown (Aviation Week, 2001; Hopkins, 1998). Thus, in 2000, the average salary of first officers who had been flying five years had climbed to $87,732. For those pilots who had been flying ten years, the average rose to $150,000 (Aviation Week, 2001).

Mechanics, on the other hand, do not have a pay structure based on the type of aircraft they maintain. While both pilots and mechanics must be specifically trained to operate or work on a specific make and model of aircraft, pilots typically fly just one aircraft type. In a line environment, it is not unusual for a mechanic to work on as many as ten different aircraft types (Marx & Graeber, 1994). Pilots receive pay differentials based upon the type ratings they hold, while mechanics are required to be familiar with and to work on all types of aircraft a carrier may have in its fleet with no pay differentials (Eiff et al., 1997).

Prestige

Pilots have long been perceived as white-collar professionals, on par with doctors and lawyers (Hopkins, 1998). In contrast, mechanics are perceived as blue-collar laborers, despite the fact that many are college graduates. One researcher noted that Webster's New Collegiate Dictionary offered, under the entry "grease monkey", the definition "an airplane mechanic" (Eiff et al., 1997, p. 13). Perhaps not surprisingly,

industry executives have noted that the term " 'mechanic' has some negative connotations attached to it" (Phillips, 2000), and that often, "the word 'mechanic' is used as a pejorative' " (Fiorino, 2000). It is interesting to note that while the FAA continues to issue "Aircraft Mechanic" certificates, in the 1990s mechanics at many airlines in the U.S. began to be referred to as "Aviation Maintenance Technicians".

Corporate Status

Economic reality dictates that airplanes only make money for an airline when they are in the air, transporting passengers and cargo from one location to another. And planes cannot be in the air without properly trained pilots. This makes pilots "essential employees" who have historically held the power to shut down an airline (Hopkins, 1998, p. 40). This, in turn, has led airline executives to tread more carefully around pilots than other employee groups. As one executive noted, "Management can always hire new flight attendants, and usually it can contract maintenance work to outside machine shops. But pilots can't be trained overnight" (Bernstein, 1999, p. 38).

The axiom that aircraft do not contribute to the carrier's bottom line when they are not in the air has resulted in maintenance costs being viewed as a liability, an expense that must be controlled (Eiff et. al., 1997). This includes not only parts, but labor. Where high salaries for pilots have at times been touted as safety measures, assuring the public of the pilots' "caution and conservatism" (Hopkins, 1998, p. 16), labor costs for maintenance have historically been considered another expenditure that must be minimized. As a result, the airline industry has increasingly sought ways to contract maintenance to outside providers, thereby reducing a carrier's direct labor and

materials costs.

Unions

Historically, the majority of airline pilots in the U.S. have been represented by the Air Line Pilots Association (ALPA), and the majority of mechanics by the International Association of Machinists and Aerospace Workers (IAMAW). Both unions have been quite powerful in the airline industry and considered by executives and other employee groups to be the most important of all the airline unions, with ALPA conceded a slight edge (Walsh, 1994).

The importance of both ALPA and IAMAW has been attributed to the critical role each profession played in daily airline operations, the specialized nature of the skills of their respective members, and the difficulty airlines typically had in replacing them. This gave these unions bargaining leverage that other industry employee groups lacked, and made them powerful allies for other airline labor groups, who cited them as the sources they most often turned to for support (Walsh, 1994).

With two such powerful unions pursuing the interests of their individual memberships, interests that were not always compatible, it is not surprising that the relationship between the two organizations has been described as "antagonistic" (Bernstein, 1999), marked by "enmity", with disputes "relatively common" (Walsh, 1994). The two unions typically offered each other limited cooperation during labor disputes, routinely crossing one another's picket lines.

Often this mutual antagonism was exploited by airline management during labor negotiations. A notable, and extreme, example of this occurred at Eastern Airlines under

the leadership of Frank Lorenzo. Facing an imminent strike by the IAMAW, Lorenzo attempted to capitalize on the enmity between the two groups by making the pilots a separate contract offer as inducement for them not to support the mechanics. Lorenzo's stated intention was to use Eastern's pilots to "...break the machinists once and for all" (Bernstein, 1999, p. 159).

In recent years safety personnel from the two unions have collaborated successfully on many important safety issues and have developed a close working relationship. A number of new unions representing pilots and mechanics have also come into being. However, conflicting interests during contract negotiations can still lead to tensions between some members of these professions.

Impact on Communication

All of these cultural factors can lead to a certain degree of tension between some mechanics and pilots. This, in turn, can lead them to divide themselves into "separate aristocracies" (Gann, 1961) that regard each other with mistrust and, at times, contempt (Mattson et al., 1999; Young et al., 1999). Such tension can have implications for any members of one group who need to consult with members of the other group about the status of the aircraft (Mattson et al., 1999). When manifested in an environment already laden with logistical barriers to interaction between these groups, the effect on communication can be acute.

As previously mentioned, one of the most critical issues about which pilots and mechanics must communicate concerns discrepancies on the aircraft. Conflict stemming from issues such as pay and professional status has, in some instances, "driven a wedge

of contempt and separation between [pilots and mechanics] which negatively impacts their communication about operational discrepancies on the airplane" (Mattson et al., 1999, p. 743). This has serious operational and safety consequences, as "...effective communication of maintenance discrepancies is critical to effective and efficient resolution of maintenance problems" (Eiff et al., 1997, p. 14)

Author Ernest Gann, himself an airline pilot, described the experience of conferring with mechanics during a preflight: the pilot was "...more than likely to be ignored" by this "...group of expert mechanics, who invariably hold any pilot's opinion on matters technical in low esteem [and who] have spent considerable energy and time making certain the plane is airworthy. They sign their names and reputations to the logbook and do not appreciate suspicion of their efforts" (Gann, 1961, p. 38).

Similarly, while conducting field research at a major carrier, one researcher was "...struck by the frequency and intensity of interpersonal conflicts which seemed to pervade the work environment" of these two groups (Eiff, 1997, p. 14). He noted "...these conflicts represented a formidable barrier to effective teamwork, [and] communication ... [and] were viewed as major influences on error propagation and operational safety" (p. 14).

Studies on Write-ups

Young, Mattson, and Petrin (1999) surveyed pilots and mechanics from 55 organizations across all segments of the aviation industry (i.e., airline, corporate, general aviation, and military) regarding their organization's policy for reporting mechanical discrepancies. Ninety-one percent of the respondents indicated that their organizations

relied on written logbook entries. Fifteen percent indicated that some form of electronic logbook entry, either alone or in conjunction with the written logbook, was also used. Almost half the respondents (46.3%) felt that some aspect of these written or electronic logbook entries was problematic. Problems most often cited were lack of detail, failure to write up discrepancies at all, and vague fault reporting codes.

A study conducted by the Australian Bureau of Air Safety Investigations (BASI) surveyed maintenance technicians in that country regarding the general helpfulness of pilot write-ups in troubleshooting and resolving mechanical discrepancies. When asked how often information provided by pilots in logbook write-ups made it easier for them to identify the problem involved, 54% of mechanics indicated that they were only "sometimes" helpful. Just 3% indicated that pilot write-ups were "always" helpful in identifying the problem. This led the authors to conclude that "overall … descriptions … given by flight crews were not always adequate, making it difficult for maintenance staff to identify and rectify the defect" (BASI, 1999, p. 40).

The Present Study

The present study investigated the informational needs of maintenance crews and flight crews in the reporting of mechanical malfunctions. It explored what information these crews most want to receive from each other in the logbook write-ups of mechanical discrepancies. The influence of logistical and cultural factors on the quantity and quality of information included in logbook write-ups was also examined. Finally, the impact of poor information exchange between crews on the ability of crew members to accomplish their individual tasks was explored.

These goals were accomplished through administration of a survey instrument developed for this study. The survey items covered two broad topics, *Content* and *Context*. The *Content* items served to identify which aspects of a given mechanical discrepancy each crew considered important to include in a maintenance logbook entry. In addition, it sought to define the level of detail each considered necessary to provide in such an entry. Data gathered from this section of the survey served to answer the question of what information these crews most want to receive from each other in the logbook write-ups.

The second topic of the survey, *Context*, investigated the influence of environmental factors on discrepancy write-ups. Environmental factors were classified into two subcategories: Logistics and Culture. Logistics explored the influence of factors such as time, flight schedules, and crew schedules, while Culture investigated the impact of organizational issues and inter-crew dynamics. Data gathered from the Context section sought to identify the influence of logistical and cultural factors on the quantity and quality of information included in logbook write-ups.

Apart from these two sections, a number of questions were included to assess the potential impact poor information exchange between pilots and mechanics might have on each crew's ability to accomplish necessary tasks.

METHOD

Participants

Participants were certificated pilots and mechanics currently employed by two US airlines who agreed to participate in this study. Four hundred surveys were

distributed to pilots and four hundred surveys were distributed to mechanics, for a total distribution of 800 surveys. At the time of distribution, there were approximately 13,700 pilots and 14,600 mechanics employed across the two carriers.

Materials

A questionnaire comprised of 33 items in booklet form was used. The structure of the surveys was identical for both groups, with a Demographics section followed by a Survey Questions section. Demographic items varied slightly, as they were tailored to elicit certification and experiential information specific to each group. Survey questions, however, were identical, with the exception of minor semantic changes to direct a given question to the appropriate participant group (e.g., asking pilots, "How often do you initiate contact with maintenance at the gate?" while asking mechanics, "How often do pilots initiate contact with you at the gate?"). The sequence of questions was additionally identical on both versions of the survey, with one exception. Items 24 and 25 were presented in reverse order so that each survey first queried respondents about their own behavior, then asked about the behavior of the other group. Questionnaire items were presented in a variety of formats, including Likert-type items, rank-order items, and yes/no items. Yes/no items included open-ended follow-ups whereby respondents could, if they chose, elaborate on their answers. Responses to open-ended questions were not included in the present study, but will be analyzed as part of a separate study in the future.

Procedure

Eight-hundred surveys were handed out to current line pilots and line mechanics

(400 each) at several hub airports. Surveys were accompanied by an informed consent letter detailing the purpose of the study, outlining participants' rights, and assuring participants of the anonymity of any information they might provide. They were also accompanied by a postage-paid business-reply envelope which allowed respondents to mail completed surveys directly to the researcher at NASA Ames Research Center in Moffett Field, California.

RESULTS

Of a total of 800 surveys distributed, 319 were completed and returned, for an overall response rate of 40%. Return rate was slightly higher for pilots (43%, n=172) than mechanics (37%, n=147). Results for each employee group were collapsed across airlines as the present study was not designed to examine differences between airlines or corporate cultures. Rather, the use of multiple airlines served to increase sample size and to help mitigate the effects of any organization-specific influences.

Demographics

Pilots

Fifty-eight percent of pilot respondents were captains (n=99), and 42% first officers (n=72). Nine percent of pilots (n=15) held the position of check airman. Pilots were predominantly male (94%), with a small percentage (6%) of females. Mean age for pilots overall was 46.44 years (SD= 7.42), with a range from 29-59 years. Mean age for captains was 49.12 years (SD=6.05) with a range of 31-59 years. First officers' mean age was 42.23 years (SD= 7.23) with a range of 29-59 years. Check pilots had a mean age of 49.80 years (SD= 6.88) and a range of 36-59 years.

Eighty percent of pilots indicated they flew primarily domestic routes, 19% primarily international routes. Fifty-three percent indicated they flew mainly short haul routes, versus 44% flying mainly long haul routes.

With regard to the equipment they were currently flying, 33% of pilots (n=56) indicated they currently flew Airbus aircraft, with the largest percentage of those (86%) flying one of the A320 family of aircraft (A319/320/321). This was followed by the A330 (9%) and the A300 (5%). Sixty-seven percent of pilots (n=116) indicated they currently flew Boeing aircraft, with the largest percentage (53%) flying the B-737. This was followed by the B-757/767 (25%), the B-747-400 (9%), and the B-777 (6%).

Seven percent of pilots participating also held Aircraft Mechanic certificates with Airframe ratings (n=12). Eight percent (n=13) held Aircraft Mechanic certificates with Powerplant ratings, and 1% (n=2) held Inspection Authorizations. Seventeen percent of pilots (n=29) indicated they owned a private aircraft.

Mechanics

One hundred percent of mechanics responding reported they held an Aircraft Mechanic certificate with both Airframe and Powerplant ratings. Nineteen percent (n=28) indicated that they held "Other" licenses. The majority (86%) of these were FCC Radio licenses which allowed them to work on radio communication equipment. Sixteen percent (n=24) of participants currently held the position of lead mechanic.

The overwhelming majority of mechanics who chose to report their gender were male (98%). There was just a single female respondent. Mean age for mechanics overall was 45.42 years (SD= 7.76), with a range of 29-64 years. Mean age for lead mechanics

was 48.91 years (SD=7.81) with a range of 39-64 years.

The majority of mechanics (82%) indicated they were currently working at a line station (n=120), while 16% (n=23) indicated they were currently at a maintenance base.

With regard to equipment maintained, 80% (n=117) of A&Ps indicated they currently worked on Airbus aircraft, with the majority of those (83%) working on one of the A320 family of aircraft (A319/320/321). Seventeen percent reported working on the A300 and 17% on the A330. Ninety-seven percent of mechanics (n=143) indicated they worked on Boeing aircraft, with the majority of those (82%) working on the B-757/767, followed by the B-737 (76%), the B-777 (36%), and the B-747-400 (33%).

Eight percent of mechanics (n=12) held Student pilot ratings, 12% (n=17) held Private pilot ratings, 4% (n=6) held Commercial ratings, 2% (n=3) Instrument ratings, 1% (n=2) Multi-engine ratings, while just a single respondent each held a Certified Flight Instructor (CFI) rating or Flight Engineer rating.

Content Items

As previously described, a number of survey items were designed to determine what information these two crews want to receive from each other and the amount and type of detail they consider important to include in logbook entries. These content items were presented in the form of Likert-type scales and rank-order questions.

Helpfulness of Log Entries

Given that previous research (e.g., Young et al, 1999; BASI, 1999) has indicated some members of maintenance and flight crews don't always find each other's logbook entries helpful, participants in this study were queried on the subject. Each crew was first

asked to rate how helpful they believed their own logbook entries were to the other group. Ratings were made using a 5-point Likert-type scale, where 1= "not helpful" and 5= "very helpful", with a midpoint rating of 3= "somewhat helpful".

The overwhelming majority of pilots believed their write-ups were quite helpful to maintenance. Using the 5-point scale, three-fourths (76%) of pilots gave their write-ups a rating of four or higher. Indeed roughly half the pilot respondents (49%) gave their entries a rating of 5 or "very helpful" to maintenance. Not a single pilot rated flight crew write-ups as "not helpful" to maintenance (see pilot ratings in Figure 1).

Mechanics were less certain that their logbook entries were as helpful to flight crews, with a total of 64% rating their own log entries 4 or higher. Of these, just 33% rated maintenance sign-offs as "very helpful" (rating of 5) to flight crews. In contrast to pilots, nearly 15% of mechanics felt their signoffs were of little or no helpfulness (rating of 2 or lower) to the other group (see mechanic ratings in Figure 2).

To determine how accurate these self-perceptions were, both crews were asked to rate how helpful they in fact found the other crew's log entries to be. When mechanics were asked how helpful pilot logbook write-ups were to them in troubleshooting or repairing discrepancies, the majority (44%) rated them as "somewhat helpful" (rating of 3). Just 20% rated pilot write-ups as "very helpful", while 7% of mechanics felt that pilot entries were "not helpful" at all to them in their troubleshooting efforts. Overall, mechanics found pilot write-ups to be significantly less helpful in troubleshooting discrepancies than pilots believed them to be: $t(317) = 7.86$, $p < .001$ (see Figure 1).

Conversely, when pilots were asked how helpful maintenance sign-offs were to

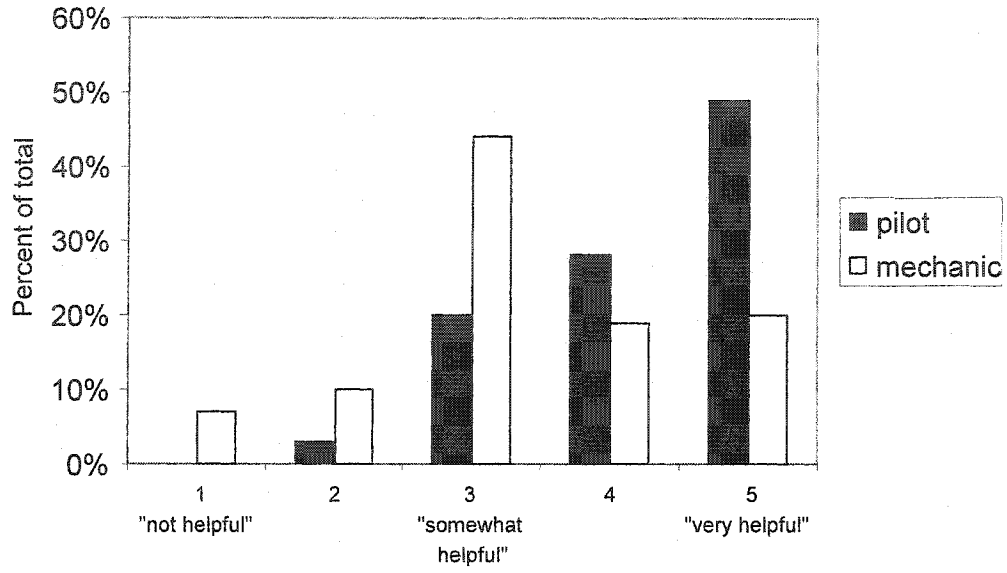

Figure 1. How helpful is the pilot's write-up to maintenance in troubleshooting and fixing a discrepancy?

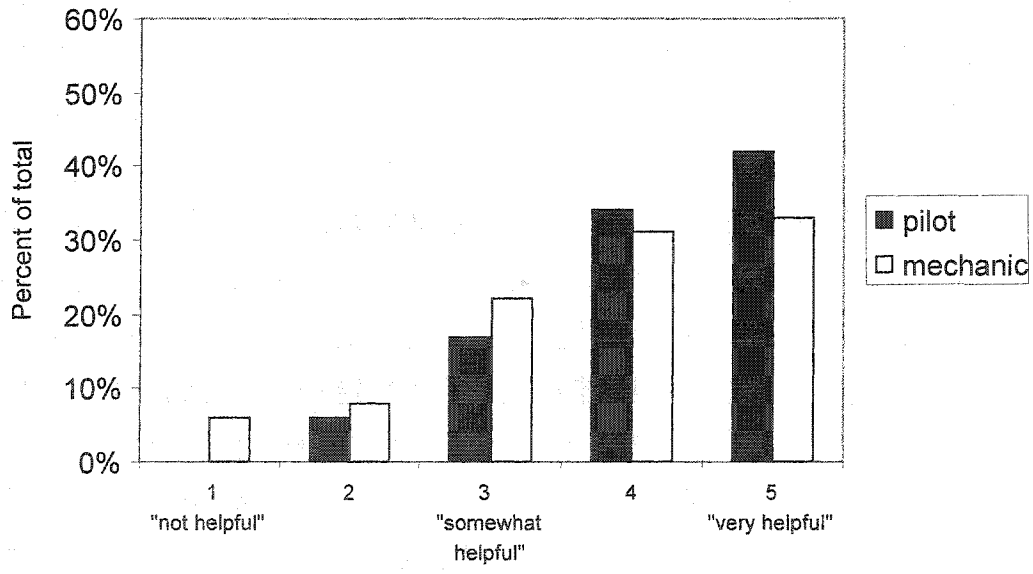

Figure 2. How helpful is the maintenance signoff to pilots in determining the current status of the aircraft?

them in determining the current airworthiness of an aircraft, 77% rated them 4 or higher on the 5-point scale. Forty-two percent in fact gave mechanic sign-offs the highest rating of 5 ("very helpful"). No pilot rated maintenance entries as "not helpful" at all. The degree to which pilots found maintenance sign-offs helpful was significantly higher than mechanics themselves believed them to be, $t(317) = 3.13$, $p < .01$ (see Figure 2.)

Recent history of an aircraft is recorded not only in the log entries of the other crew, but also in the entries by one's peers. How helpful are these entries? The majority of pilots (81%) found the logbook write-ups by other pilots quite helpful (a rating of 4 or higher) in determining the current status of the aircraft (see Figure 3). In comparison, when mechanics were asked how helpful they found log entries by other mechanics when troubleshooting a recurring fault, their opinions, while mostly positive, were more diverse. Nearly a third (31%) gave entries by other mechanics the highest rating of 5 ("very helpful"), while roughly one-third (30%) gave them a rating of 4, and just over a third (35%) gave them a rating of 3 ("somewhat helpful"). Unlike pilots, however, no mechanic rated log entries by their peers as "not helpful" at all (see Figure 4).

In sum, pilots reported finding both the discrepancy write-ups of their peers and the subsequent sign-offs by maintenance to be quite helpful as they attempted to determine the current status of an aircraft. Further, they believed their own write-ups were equally helpful to maintenance. Mechanics, however, rated pilot entries as only somewhat helpful to them in their troubleshooting efforts. Entries by other mechanics were slightly more helpful when troubleshooting recurring problems. When it came to their own signoffs, mechanics believed they were relatively helpful to pilots, but not as

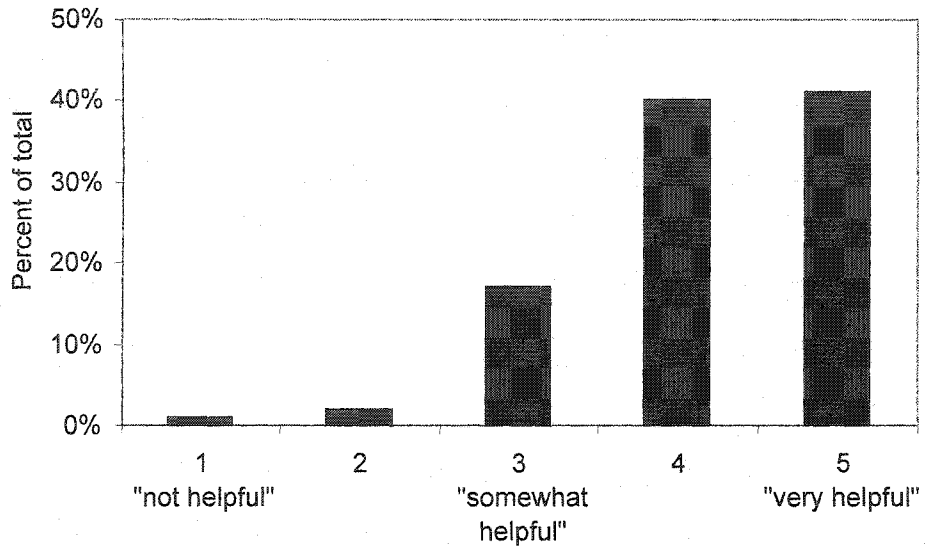

Figure 3. How helpful are write-ups by previous flight crews to you in determining the current status of an aircraft? *(Pilots only).*

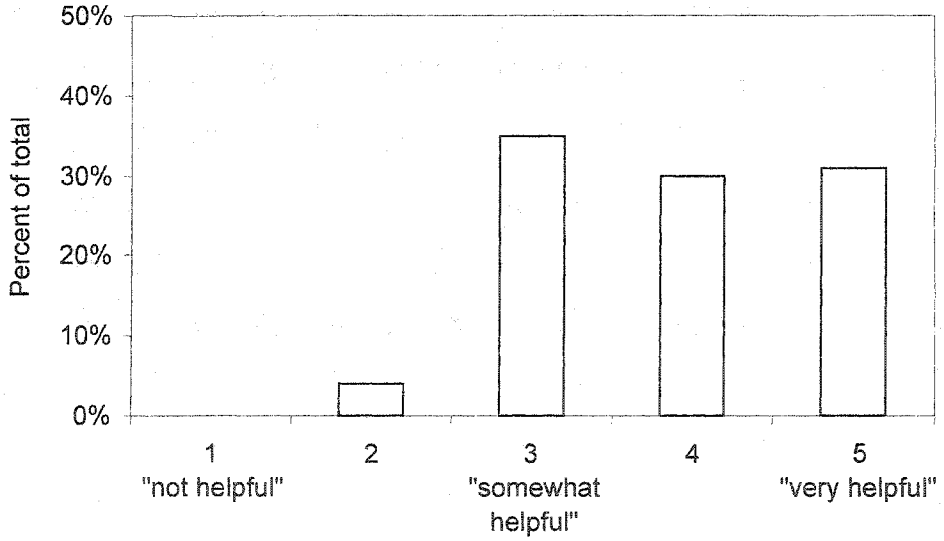

Figure 4. How helpful are previous maintenance signoffs to you when troubleshooting a recurring or ongoing problem? *(Mechanics only).*

helpful as pilots in fact found them to be.

Level of Information

Perhaps the degree to which a log entry is perceived as helpful is influenced by the amount of information it contains. Certainly entries with little or no detail can make it harder to determine what the problem is or how it was fixed. To explore this, respondents were asked to rate how often they read a logbook entry by a member of the other group and wanted more information.

Fully 97% of mechanics reported wanting additional information from flight crew write-ups at least half the time or more (a rating of 3 or higher on a 5-point scale). Indeed, 20% of mechanics stated they "always" read a flight crew log entry and wanted more information. In contrast, 76% of pilots reported reading a maintenance signoff and wanting more information half the time or less (rating of 3 or lower). Indeed, 21% of pilots said they "rarely" wanted more information from a signoff. Thus, mechanics reported wanting more information from pilot log entries significantly more often than pilots reported wanting more information from maintenance entries: $t(316) = -7.61$, $p < .001$ (see Figure 5).

The desire for more information in log entries suggests a possible lack of information, or lack of meaningful detail, in many current entries. Both groups were queried about the prevalence of entries lacking in detail. They were first asked to rate the frequency of "inop" write-ups-- pilot logbook entries in which a component or system is described simply as "inop" (short for "inoperative") with no further detail (for example, "#1 VOR inop"). Results were emphatic. Ninety-one percent

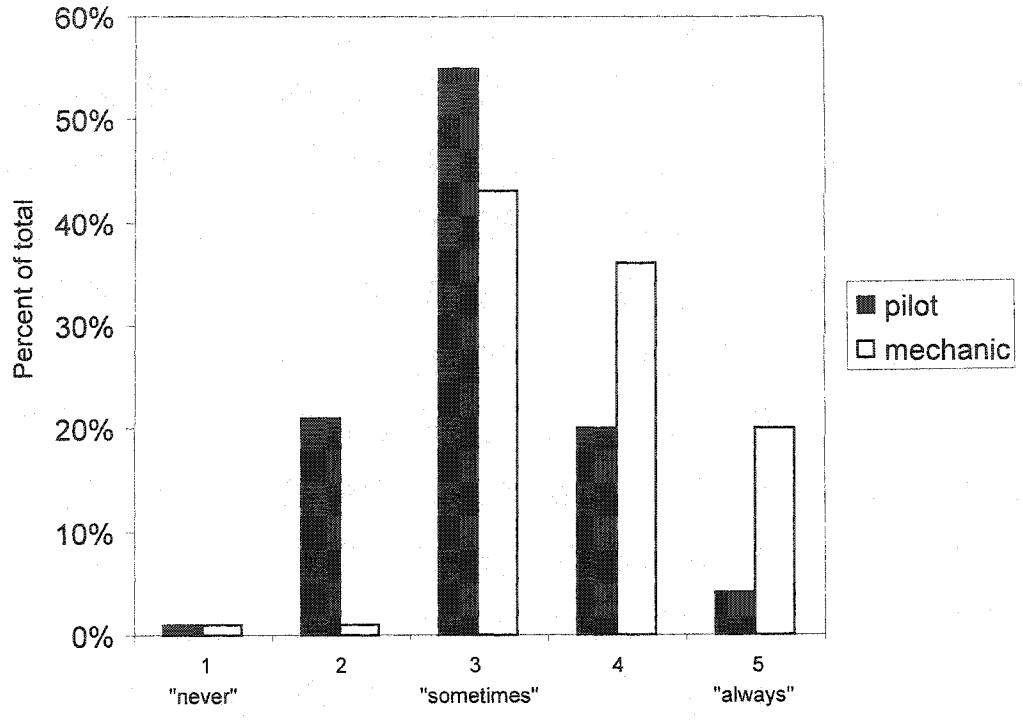

Figure 5. How often do you read a log entry made by the other crew and want more information?

of mechanics endorsed a rating of 3 or higher, indicating they received such write-ups from pilots at least half the time or more, with 40% of mechanics indicating they often or frequently (a rating of 4) received them.

In marked contrast, when pilots were asked how often they wrote up items as "inop" with no additional detail, 97% endorsed a rating of 3 or lower, indicating they made such entries half the time or less. Indeed, fully one-third (33%) of pilots stated they "never" made such entries, roughly another third (30%) indicated they rarely did so (a rating of 2) while a final third (34%) reported they "sometimes" made such entries.

The difference between how often mechanics reported receiving "inop" write-ups and how often pilots reported making "inop" write-ups was statistically significant: $t(316) = -13.9$, $p < .001$. This difference is dramatically illustrated in Figure 6.

Crews were also asked about minimal maintenance signoffs—signoffs in which maintenance provides no detail about a fix beyond listing the Maintenance Manual section in which the repair procedure may be found (e.g., "repaired in accordance with MM 25-12-32"). Eighty-one percent of pilots indicated mechanics gave information beyond the Maintenance Manual reference half the time or less (rating of 3 or lower). Forty-three percent said mechanics rarely or never did so (rating of 2 or less).

When mechanics were asked the same question, three-fourths (76%) answered with a rating of 3 or higher, indicating they provided additional information half the time or more. Differences between groups were significant: $t(315) = -3.97$, $p < .001$, indicating that mechanics believed they provided this information more often than pilots believed they did (see Figure 7).

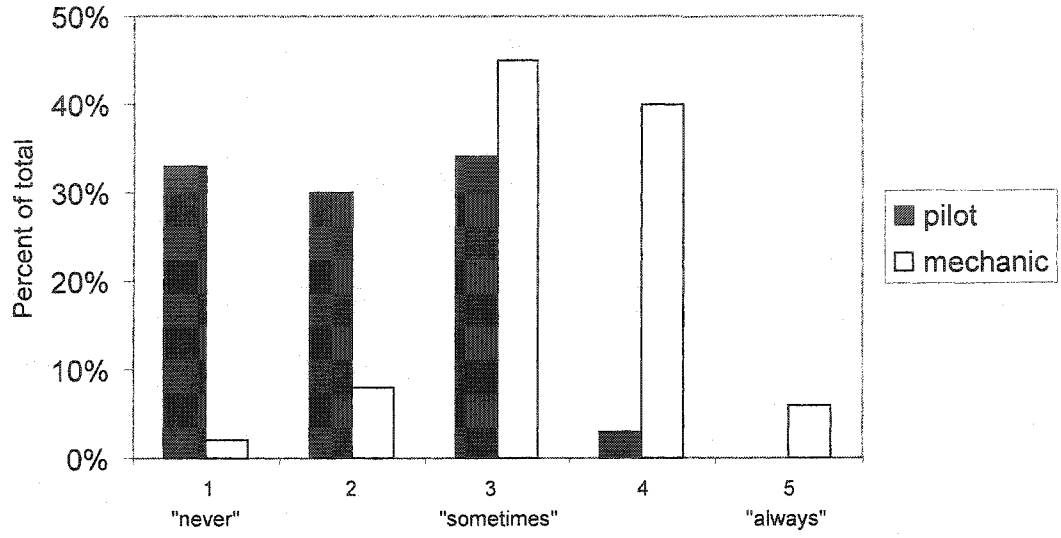

Figure 6. How often do pilots write-up items as "inop" with no additional detail?

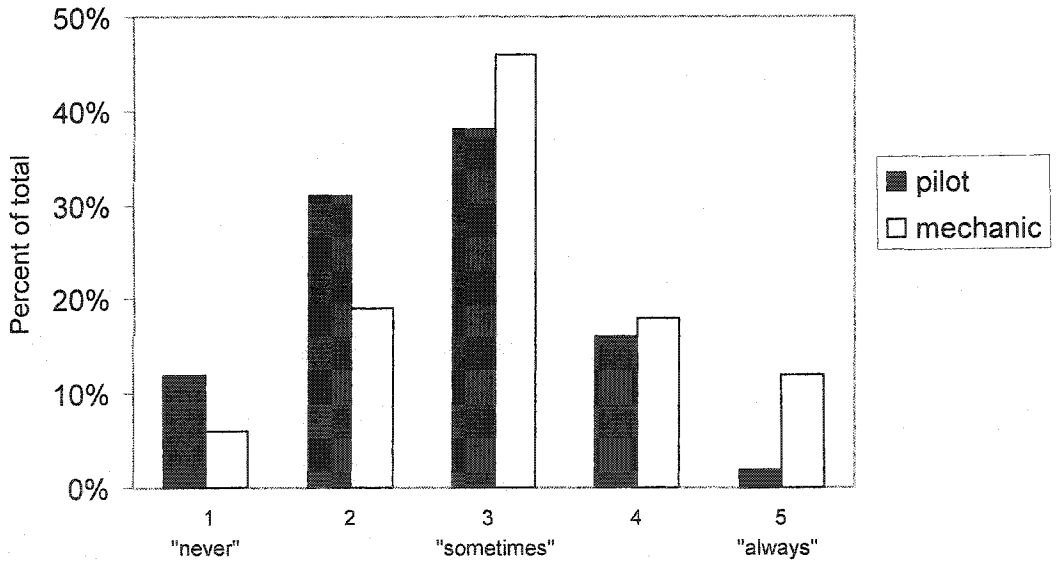

Figure 7. How often in a signoff does maintenance provide detail about a fix beyond citing the maintenance manual section(s) where the repair procedure can be found?

Often discrepancies re-occur, and a flight crew will experience difficulty with an item previously written up by other pilots and repaired by maintenance. In such instances, how often do pilots attempt to provide maintenance with more information about the discrepancy? When asked to rate how often they provided new or additional information about a repeat problem rather than just referring back to previous write-ups, 93% of pilots endorsed a rating of 3 ("sometimes") or higher. When asked to rate how often they received additional information from pilots, however, the majority of mechanics (86%) endorsed a rating of 3 or lower. The difference between pilot and mechanic ratings was significant: $t(317) = 8.95$, $p < .001$, with pilots reporting that they gave new information when writing up a recurring discrepancy significantly more often than mechanics reported that they did (see Figure 8).

What to Include

Despite previous results, both mechanics and pilots appear quite confident that they know what information they should include in their logbook entries. When asked to rate, on a 5-point scale, how often they were uncertain about what information to include about a discrepancy or repair, fully two-thirds (67%) of mechanics and close to two-thirds (62%) of pilots indicated they rarely or never (a rating of 2 or less) were uncertain about what to include. One-third of pilots (35%) did report being "sometimes" uncertain, as did 27% of mechanics. Statistically there was no significant difference between pilots and mechanics in their answers to this question: $t(316) = .63$, n.s.

Subsequent questions attempted to identify more specifically what information each group considered most helpful to include in logbook entries and to compare how

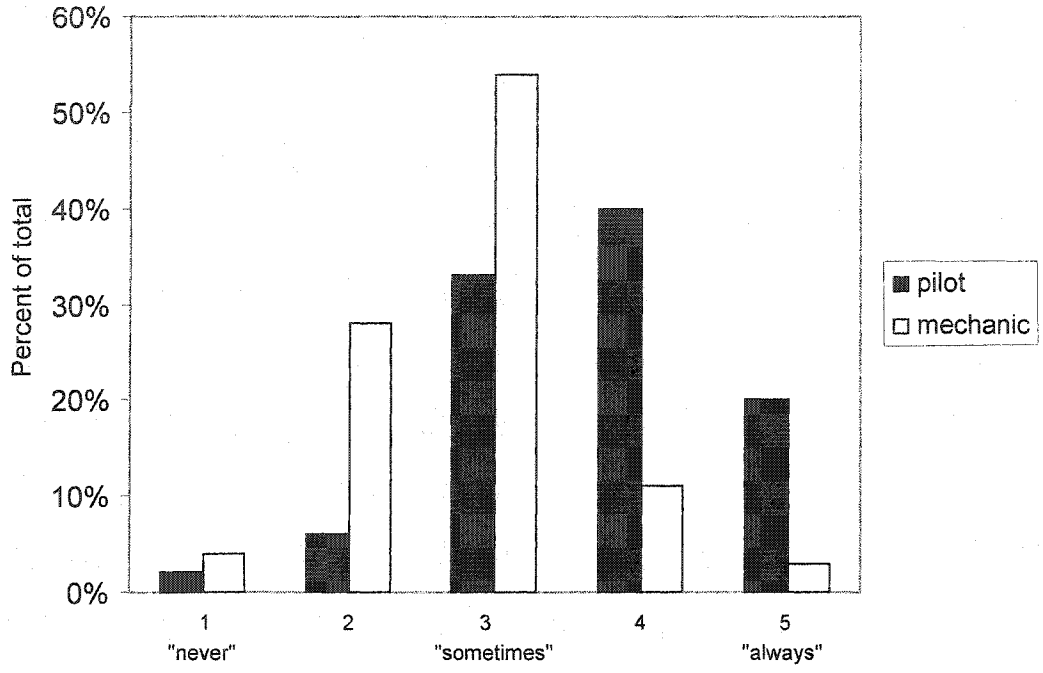

Figure 8. If a write-up involves a repeat problem, how often do pilots provide new or additional information beyond what was given by previous flight crews?

consistently their answers corresponded across groups. One such item focused on the content of pilot write-ups. Mechanics and pilots were provided a list of 10 details, any one of which could be included in a pilot's logbook description of a discrepancy. From this list of 10 items, respondents were asked to narrow the list to the five they believed would typically be most helpful to mechanics as they attempted to troubleshoot. One of these 10 items was "Other", an open item allowing respondents the option of adding an item that had not been included in our list. The discrepancy itself was unspecified as the question sought a general response.

Once they had narrowed the list to five items, respondents were asked to then rank those items in order of their relative helpfulness. Thus, the item they felt would be the most helpful to maintenance would be ranked "1", the next most helpful item "2" and so on, until they had ranked all five items. Tables 1 and 2 provide the list of all ten items presented and the order in which each group ranked them.

Overall, both groups chose the same five items from the larger list of ten. The order in which the two groups ranked them varied, however, as illustrated by the difference between each group's mean ranking of individual items. There was also notable variability within each group, illustrated by both the relatively low mean rankings of even the top items and their relatively large standard deviations. This suggests that while the two groups were in general agreement about what information is helpful to provide maintenance, there was no clear consensus among either group about the relative helpfulness of the individual items themselves.

Each group's mean ranking of the top five items was analyzed to determine

Item	*Mean*	*SD*
Actions of the pilots preceding fault	**2.96**	**1.99**
Troubleshooting actions by flight crew	**3.01**	**1.65**
Phase of flight when fault occurred	**3.67**	**1.96**
Whether fault was intermittent	**3.96**	**1.46**
Whether flight crew was able to reset	**3.97**	**1.52**
If fault self-corrected	4.91	1.37
ATA code	5.56	1.26
Other	5.61	1.30
Altitude	5.65	0.91
Airspeed	5.73	0.79

Table 1. Ranking of answer choices by pilots to the question: What items would be most helpful for maintenance to receive in a pilot's write-up?

Item	*Mean*	*SD*
Actions of the pilots preceding fault	**3.28**	**1.87**
Whether fault was intermittent	**3.38**	**1.46**
Troubleshooting actions by flight crew	**3.55**	**1.94**
Whether flight crew was able to reset	**3.75**	**1.67**
Phase of flight when fault occurred	**3.83**	**2.03**
If fault self-corrected	4.82	1.34
ATA code	5.22	1.56
Altitude	5.53	1.12
Airspeed	5.65	0.99
Other	5.87	0.73

Table 2. Ranking of answer choices by mechanics to the question: What items would be most helpful for maintenance to receive in a pilot's write-up?

whether or not the differences in mean rankings between groups were statistically significant. "Actions of the pilots preceding the fault" emerged as the highest-ranked item for both groups. While pilots' mean ranking for this item (2.96) was somewhat higher than mechanics' (3.28), this difference was not significant: $t(290) = -1.38$, n.s. Though this item topped both groups' lists, the relatively high mean rankings indicate there was not an overwhelming consensus within either group that this was in fact *the* most helpful piece of information.

Several items were ranked equivalently between the two groups, suggesting that not only did they agree these were important details to provide to maintenance, but that they had similar perceptions about how helpful the information was.

There were some items that reflected differences between the two crews. Knowing whether or not the fault was intermittent was ranked significantly higher by mechanics (3.38) than by pilots (3.96) ($t(289) = 3.35$, $p=.001$) suggesting that many mechanics find this information to be more helpful in troubleshooting a fault than pilots may realize. At the same time, the item "any troubleshooting actions taken by the flight crew" was ranked significantly higher by pilots (3.01) than it was by mechanics (3.55) ($t(288) = -2.49$, $p<.05$). This suggests that pilots believe this information to be more helpful to mechanics than many mechanics may find it to be.

To some degree, differences between groups and variability in rankings within groups may be reflective of the manner in which the question was posed. Respondents were not provided a specific discrepancy for reference but rather were asked to rate the helpfulness of each item in a broad, general sense. In reality, specific pieces of

information may be more relevant (and thus more "helpful") when troubleshooting one type of problem versus another. This would make it difficult to give a hard-and-fast rating to each item that would cover all possible scenarios. It is impossible to know which potential scenario respondents had in mind when making their ratings or indeed whether respondents were basing their ratings on the same scenario at all. Overall, however, both groups did narrow their lists to the same five items, suggesting that they agreed, in general terms, about what sorts of details are most often helpful to maintenance.

A similarly-structured question examined the content of maintenance log entries. Respondents were provided a list of details that could be included in the maintenance signoff of a discrepancy. (Again, one of these items was "Other", an open item allowing respondents to write in any item they felt was important but which was not included in our list). From this list of 6 items respondents were asked to indicate the five they believed would be most helpful to pilots as they attempted to determine the airworthiness of an aircraft. Once they had narrowed the list to five, they were asked to rank those five items in order of their relative helpfulness. Thus, the item they felt would be most helpful to pilots would be ranked "1", the next most helpful "2" and so on until all five items had been ranked. Tables 3 and 4 provide a listing of all items presented and the order in which each group ranked them.

Both groups narrowed their lists to the same five items. Additionally, there appeared to be some consensus, at least among pilots, about the ranking of individual items on the list, which resulted in a slight hierarchy among their five items. There

Item	*Mean*	*SD*
Root cause of fault	2.40	1.54
Parts changed/replaced	2.74	1.28
Additional components involved/affected	2.95	1.33
Ability of maintenance to replicate problem	3.28	1.58
Parts repaired	3.91	1.17
Other	5.92	0.52

Table 3. Ranking of answer choices by mechanics to the question: In the maintenance signoff, how helpful do you believe the following pieces of information are to pilots in determining how the discrepancy was resolved?

Item	*Mean*	*SD*
Root cause of fault	1.88	1.32
Additional components involved/affected	2.74	1.30
Parts changed/replaced	3.15	1.56
Parts repaired	3.77	1.14
Ability of maintenance to replicate problem	3.80	1.49
Other	5.85	0.84

Table 4. Ranking of answer choices by pilots to the question: In the maintenance signoff, how helpful are the following pieces of information to you in determining how the discrepancy was resolved?

was not as distinct a hierarchy to mechanics' list, suggesting more variability in how each item was ranked.

"Root cause of the fault" emerged as the highest-ranked item for both groups, although there was a significant difference in the degree of helpfulness each assigned to it. Pilots' mean ranking of this item was 1.88, while mechanics gave it a mean rank of 2.40 ($t(295) = -3.11$, $p<.01$). These rankings suggest that for many respondents, particularly among mechanics, there were other items they felt would be more helpful to pilots.

Several other items also received significantly different rankings from each group. Knowing which parts had been changed out or replaced was ranked higher by mechanics (2.74) than by pilots (3.15) ($t(275) = 2.90$, $p<.01$) suggesting mechanics felt this information was more helpful to pilots than perhaps it was. The same was true for knowing whether or not maintenance was able to replicate the problem on the ground, with mechanics ranking this item significantly higher (3.28) than pilots (3.80) ($t(294) = 2.88$, $p<.01$).

A notable limitation to this question is the fact that the number of answer choices was considerably shorter than on other rank-order questions. With just six items to choose from, it was inevitable there would be considerable overlap in both groups' selection of the top five items, making it more difficult to determine more clearly the degree of similarity or difference between their evaluations of each item.

Influences on Level of Detail

Even if mechanics and pilots were in agreement about what *should* be included in

log entries, there still remain a host of factors that might influence how much of that information is, in fact, entered into the logbook.

In a format similar to the previous rank-order questions, both groups were presented with a list of items that might influence their logbook entries. They were asked to narrow this list of 14 items down to the five they felt had the most influence on the amount of information they included in the logbook. Once they had identified those five items, they were asked to rank them in terms of their relative influence. That is, the item most influencing the amount of information they included in their entries would be ranked "1", the next most influential item "2" and so on, until they had ranked all five items.

The two groups were almost identical in their selection of the top five items, with one notable exception on each list, which will be described below. There appeared to be greater consensus among pilots than among mechanics regarding the ranking of each item, as demonstrated by the distinct hierarchy to their rankings (see Tables 5 and 6).

While the "nature of the problem involved" emerged as the factor with the most influence for both groups, there was a major difference in the degree of influence each assigned to it. While pilots gave it a mean rank of 1.86, mechanics' mean ranking was a much lower 3.13. This difference was significant: $t(241) = -6.63$, $p<.001$. This finding suggests that there was greater consensus among pilots about the influence of this factor than among mechanics. It also indicates that a number of mechanics felt other items had more influence on the level of detail they put in the logbook.

This result might also suggest that pilots vary the content of their write-ups more,

Item	*Mean*	*SD*
Nature of problem	**1.86**	**1.34**
Impact of item on airworthiness	**2.74**	**1.64**
Whether a new or repeat item	**3.60**	**1.48**
Accepted norms/practices at carrier	**4.79**	**1.56**
Input from maintenance control	**5.10**	**1.15**
Company policy on write-ups	5.11	1.22
Time	5.47	1.21
Amount of space available in log	5.47	1.17
Possibility FAA could read entry	5.66	0.92
Other	5.77	1.00
Need for aircraft on the line	5.85	0.52
Time/cost of repair	5.91	0.44
Fatigue	5.95	0.28
Culpability	5.98	0.19

Table 5. Ranking of answer choices by pilots to the question: Which factors influence the amount of information you include in a write-up?

Item	*Mean*	*SD*
Nature of problem	**3.13**	**1.89**
Impact of item on airworthiness	**3.17**	**1.87**
Possibility FAA could read entry	**3.95**	**1.95**
Whether a new or repeat item	**4.37**	**1.70**
Accepted norms/practices at carrier	**4.56**	**1.65**
Company policy on write-ups	4.62	1.64
Time	5.22	1.52
Amount of space available in log	5.28	1.42
Input from maintenance control	5.68	0.89
Need for aircraft on the line	5.69	0.88
Time/cost of repair	5.76	0.73
Culpability	5.83	0.77
Fatigue	5.93	0.32
Other	6.00	0.00

Table 6. Ranking of answer choices by mechanics to the question: Which factors influence the amount of information you include in a sign-off?

depending on the problem, than do mechanics. It may be that there are certain pieces of information that must always be included in a maintenance signoff regardless of what the precipitating problem is. This would lead to maintenance signoffs being more consistent in their content across discrepancies, making the nature of the problem less of an influence.

Closely following this item on both groups' lists was the "impact of the discrepancy on the airworthiness" of the aircraft. The difference between pilots' mean rank of 2.74 and mechanics mean rank of 3.17 was significant: $t(278) = -2.14$, $p<.05$. Mechanics' mean ranking of this item was nearly identical to their mean ranking for "nature of the problem", suggesting they may not have differentiated between these two items to the same degree as did pilots.

Whether the discrepancy being reported was a new or repeat problem also received significantly different ratings from each group. Pilots' gave this item a higher mean ranking (3.60) than mechanics (4.37) ($t(275) = -4.22$, $p< .001$) suggesting this aspect of a discrepancy has more influence on what pilots opt to write in the logbook. It may also suggest that maintenance entries follow a more standardized format, regardless of whether a problem is new or a re-occurrence of a previous problem.

The most notable difference between these two groups was that they each cited an influence the other did not. For mechanics, the "possibility that the logbook may be read by the FAA or other authority" was clearly an influence on the amount of information they included in signoffs. Variability among mechanics' responses, however, was noteworthy, suggesting that this factor was a greater influence for some mechanics than

for others. With an overall mean-ranking of 3.95, this item placed third on mechanics' list, while it was not cited as a major influence by pilots at all. This difference between groups was significant: $t(302) = 10.01$, $p<.001$.

On the other hand, pilots reported that "input from maintenance control" had an influence on the level of detail they included in write-ups. While this item was among the top five influences for pilots, it was not cited by mechanics at all. The difference in pilots' ranking and mechanics' ranking was significant: $t(300) = -4.96$, $p<.001$.

Intended Audience

When pilots and mechanics make an entry in the aircraft logbook, just whom do they expect to read it? And might their perceptions about who is reading their entries influence what they include in them? To explore this possibility, respondents were given a list of five possible audiences (maintenance, pilots, company, FAA, and 'Other', an option which allowed respondents to write in any group not on our list). They were then asked to rank these choices, with a rank of "1" identifying the group they most intended their log entries for; "2" the group they next intended them for, and so on, until they had ranked all options.

As Tables 7 and 8 demonstrate, there was consensus among pilots about the ranking of each item, which resulted in a clear hierarchical order to their answer choices. Among mechanics, however, there appeared to be more parity across items. The primary audience for maintenance log entries appeared to be the FAA, to which they gave a mean-ranking of 2.01. Pilots, on the other hand, were significantly less concerned about the FAA, giving it a mean ranking of 3.82, which placed it last on their list ($t(276) =$

Item	*Mean*	*SD*
Maintenance	1.15	0.59
Flight crews	2.27	0.93
Company	3.40	0.99
FAA	3.82	1.00
Other	5.92	0.56

Table 7. Ranking of answer choices by pilots to the question: When making an entry in the logbook, whom do you feel you are primarily making the write-up for?

Item	*Mean*	*SD*
FAA	2.01	1.22
Flight crews	2.66	1.15
Maintenance	2.71	1.14
Company	2.92	1.08
Other	5.66	1.12

Table 8. Ranking of answer choices by mechanics to the question: When making an entry in the logbook, whom do you feel you are primarily making the signoff for?

14.13, p<.001). The primary audience for pilot log entries was unmistakably maintenance, to which they gave a high mean-ranking of 1.15.

Pilots also saw their peers as a key audience for their write-ups, ranking them second after maintenance. While flight crews were an important target audience for mechanics, the mean-ranking of 2.66 was significantly lower (t (273) = 3.27, p=.001), suggesting that flight crews made their log entries with other flight crews in mind more often than mechanics did so. Mean ranking for the "Company" was significantly higher for mechanics (2.92) than for flight crews (3.40) (t (310) = 4.14, p<.001) suggesting again that having their entries read by an authority is more of a concern for mechanics than for pilots.

When it came to the content of logbook entries, mechanics reported being significantly less satisfied with the information they received from pilots than vice-versa. Mechanics reported they frequently read pilot write-ups and wanted more information, while most pilots infrequently read a signoff and wanted more information. Mechanics further reported that they very often received write-ups in which a pilot described a component as "inop" with no further detail. Pilots, however, reported they rarely made such write-ups.

When asked to identify which pieces of information would be most helpful to provide each other, both groups did in fact identify the same items. However the factors that influenced what each group chose to put in the logbook reflected some significant differences. Mechanics were influenced by the knowledge that the FAA or some other authority might read what they wrote, while pilots were influenced by input from

Maintenance Control.

Context Items

In addition to examining the content of logbook entries, this study also explored the influence environmental factors had on the information included in them. Contextual factors were divided into two subcategories: Logistics (the influence of the daily line environment) and Culture (the impact of organizational structure and inter-crew dynamics). Questions were presented as multiple-choice items, Likert-type scales, Yes/No items and open-ended items.

Logistics

Time at the Gate

One possible logistical barrier to interaction between these two groups is the amount of time an aircraft spends at the gate. The shorter the time in which to turn an aircraft around, the busier both crews become in order to accomplish all of their tasks. This, in turn, leaves them less opportunity to meet. To measure the amount of time available between flights, both groups were asked to indicate, using a multiple choice format, the amount of turnaround time they normally had during the busiest pushes of the day. Answer choices were presented in 15-minute increments, starting with 0-15 minutes and ending with 60+ minutes.

Pilots reported having more time between flights than did mechanics. The majority of pilots (44%) reported having 45-60 minutes between flights, with a smaller group (32%) reporting they had 30-45 minutes. Mechanics reported just the reverse: the majority (53%) indicated they typically had 30-45 minutes with an aircraft from the time

it arrived at the gate until it pushed back, while a smaller percentage (31%) indicated they had 45-60 minutes. The difference between the amount of time reported by each group was significant: $t(308) = 3.41$, $p = .001$ (see Figure 9).

Time Filling out the Logbook

How much of this time might crews actually spend filling out the logbook? Respondents were asked to indicate, using a multiple-choice format, how much time they spent making a typical log entry (whether that entry was in writing, electronic, or both). Answer choices were presented in 5-minute increments, starting with less than 5 minutes and ending with more than 15 minutes.

Mechanics reported spending significantly more time making a logbook entry than pilots. The majority of mechanics (50%) indicated they spent 5-10 minutes making a signoff, while the overwhelming majority of pilots (76%) reported spending less than 5 minutes making a write-up. Differences between the time each group spent were significant: $t(317) = -8.53$, $p < .001$ (see Figure 10).

Number of Gates Covered

Logistical factors can at times require mechanics to cover multiple gates simultaneously. To determine how prevalent this phenomenon is and to examine what effect it might have on maintenance interaction with flight crews, mechanics were asked to indicate the number of gates they typically covered at one time. Roughly half the mechanics responding (47%) indicated they covered just a single gate at one time, with a smaller number (27%) indicating they typically covered 2 gates simultaneously.

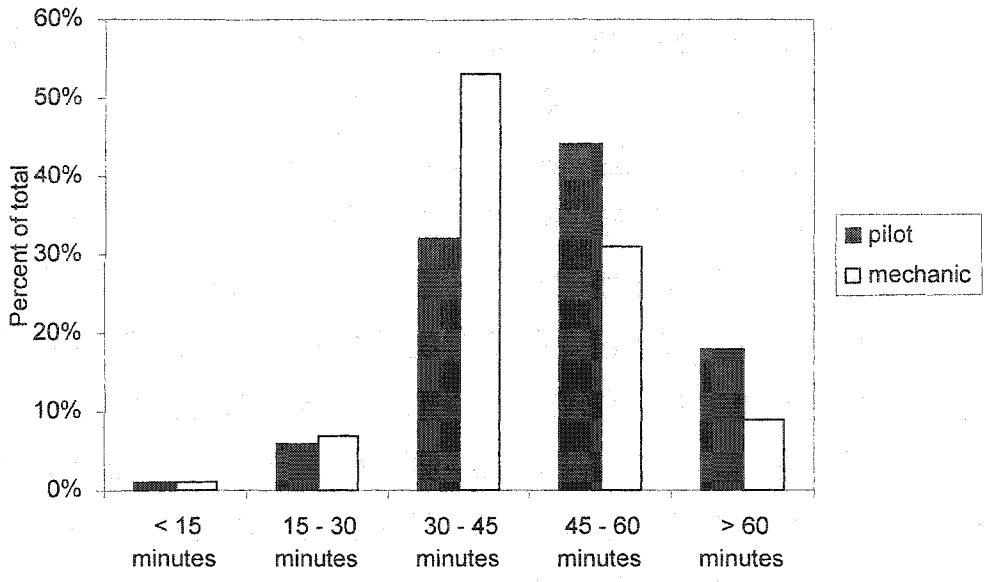

Figure 9. How much turn-around time do you typically have during the busiest times of the day?

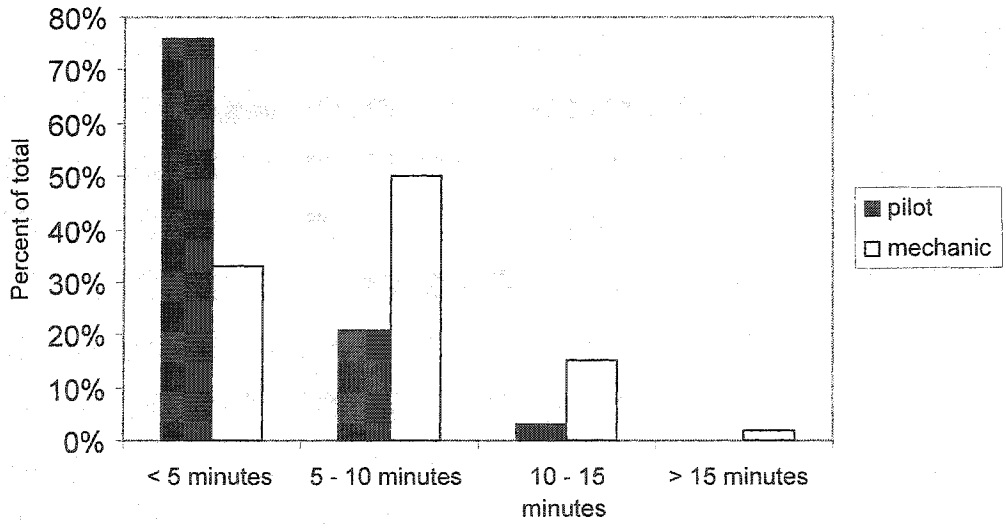

Figure 10. How much time do you spend making a typical logbook entry (whether that entry is on paper, electronic, or both) ?

Boarding the Aircraft

The best opportunity for mechanics and pilots to interact is onboard the aircraft or at the gate as the pilots are leaving the airplane. How frequently are they both in position to do so? Respondents were asked to indicate this using a 5-point Likert-type scale, where 1= never, and 5= always, with a midpoint rating of 3= sometimes.

When asked how often they boarded an aircraft before the flight crew departed, 37% of mechanics said they "sometimes" did, while 31% said they often did (rating of 4). When pilots were asked how often they were still onboard when maintenance arrived, nearly half (49%) indicated they "sometimes" were, while 39% said they were often (rating of 4) were still onboard the aircraft. Statistically there was no difference in the frequencies reported by each group: $t(316) = 0.93$, n.s.

Space in the Logbook

Neither group felt the need to make logbook entries that went over the space allotted to do so. When asked how often they continued an entry onto another page, coupon, or sheet, 59% of flight crews and 52% of mechanics stated they rarely or never (rating of 2 or less) went over the space provided. Equivalent groups (40% of mechanics, 38% of pilots) said they "sometimes" did. Differences between the two groups were not significant on this question: $t(315) = -1.13$, n.s.

Legibility

Difficulty reading logbook entries due to poor handwriting was not a major factor for either group, although mechanics found it to be somewhat more of a problem than did pilots. Using a 5-point Likert-type scale, roughly half the mechanics indicated they

"sometimes" had difficulty reading log entries due to poor handwriting, and they did so whether those entries were made by pilots (53%) or by mechanics (50%). In contrast, just 37% of pilots "sometimes" (rating of 3) had difficulty reading maintenance entries, while 41% "sometimes" had difficulty reading entries by other pilots. The difference between how often each group had trouble reading flight crew entries, however, was significant: $t(316) = -6.70$, $p < .001$, as was the difference between how often they each had difficulty reading maintenance entries: $t(314) = -3.89$, $p < .001$ (see Figures 11 and 12).

Overall, it appears logistical factors may in some instances present obstacles to interaction between pilots and mechanics. Most notably, mechanics reported having significantly less time with an aircraft at the gate between flights. They also reported spending significantly more time filling out the logbook. Occasionally mechanics may find themselves covering more than one gate at a time. Clearly these obstacles could combine to limit the time available for interaction with pilots. Thus, it is not surprising that when it came to being in the same place at the same time, both crews agreed they were onboard an aircraft at the same time only about half the time. With regard to the logbook itself, neither group felt the need to use more space than was available when describing a fault or a fix. Difficulty reading log entries due to poor handwriting was slightly more problematic for mechanics than for pilots.

Culture

Crew Interaction

When asked how often they encountered unfriendliness or lack of cooperation

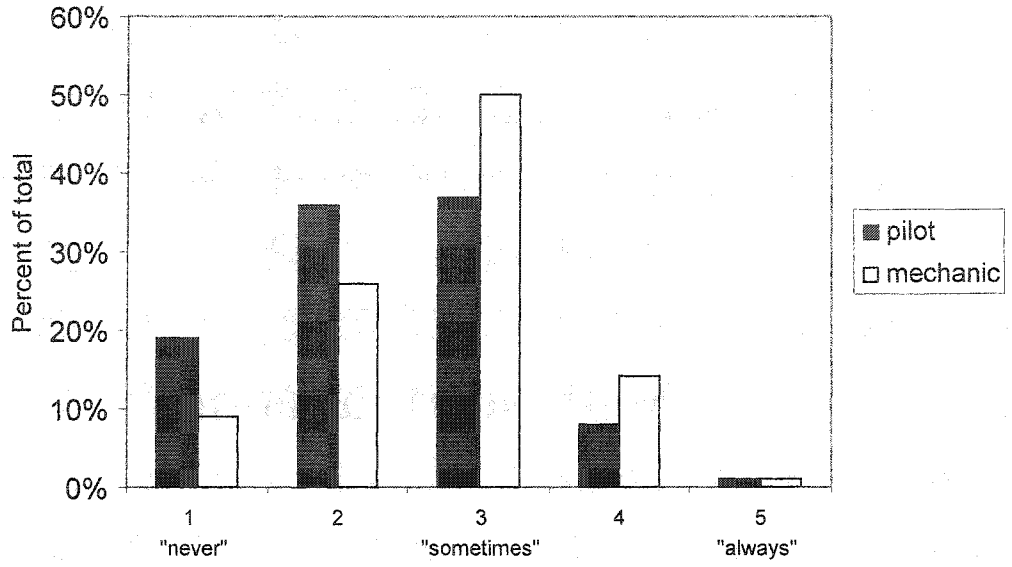

Figure 11. How often do you have difficulty reading maintenance log entries due to poor handwriting?

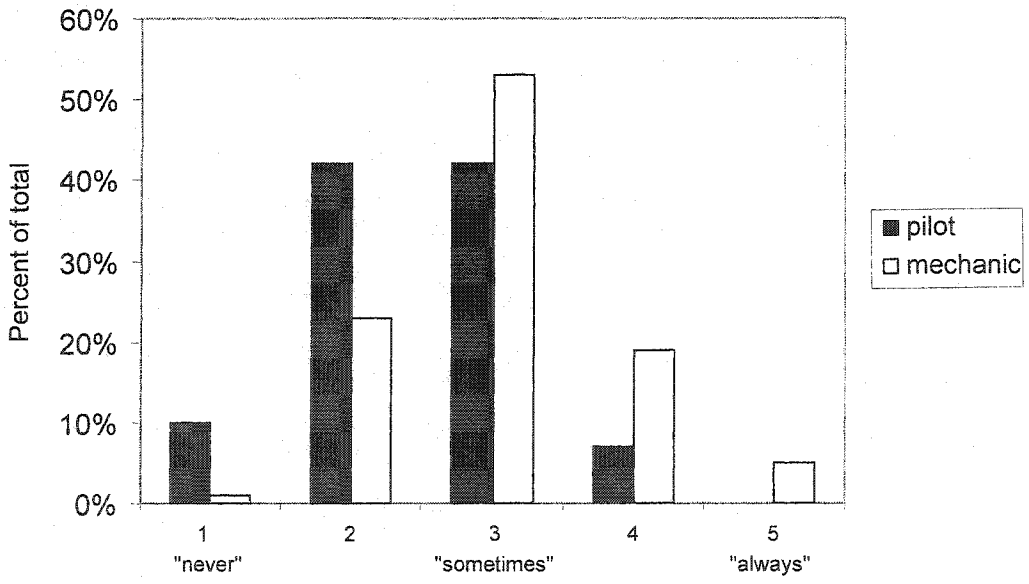

Figure 12. How often do you have difficulty reading flight crew log entries due to poor handwriting?

from the other crew, mechanics were somewhat more likely to report encountering unfriendliness from flight crews than vice versa. This difference, however, was not statistically significant: t (317)= -1.37, n.s. (see Figure 13).

Both groups were asked to rate, using a 5-point scale, how often they initiated face-to-face contact at the gate, and how often the other group initiated it. The majority of pilots felt they were the ones who initiated contact, with 46% reporting they did so often (a rating of 4), and 41% doing so "sometimes". While 42% of mechanics agreed pilots "sometimes" initiated contact with them, another 40% said pilots rarely or "never" (rating of 2 or less) did so. The difference between the two groups' ratings of how often pilots initiated contact was significant: t (316) = 2.77, p= .01 (see Figure 14).

With regard to maintenance-initiated contact, the majority of pilots (54%) indicated that mechanics initiated contact with them only "sometimes". While 33% of mechanics agreed with pilots that they "sometimes" initiated contact, another 28% said they often did so (a rating of 4) and 12% of mechanics said they "always" initiated contact with the flight crew. (Only a single pilot agreed with this assessment). At the same time, 27% of mechanics admitted they rarely or never (rating of 2 or less) initiated contact with pilots. The difference between the two groups' ratings of how often maintenance initiated contact at the gate was significant: t (316) = 2.75, p= .01 (see Figure 15).

It should be pointed out that line mechanics work not just at gates but also in line hangars. Additionally, many work overnight rather than during the day when most passenger flights occur. Since mechanics working in a hangar would not have the

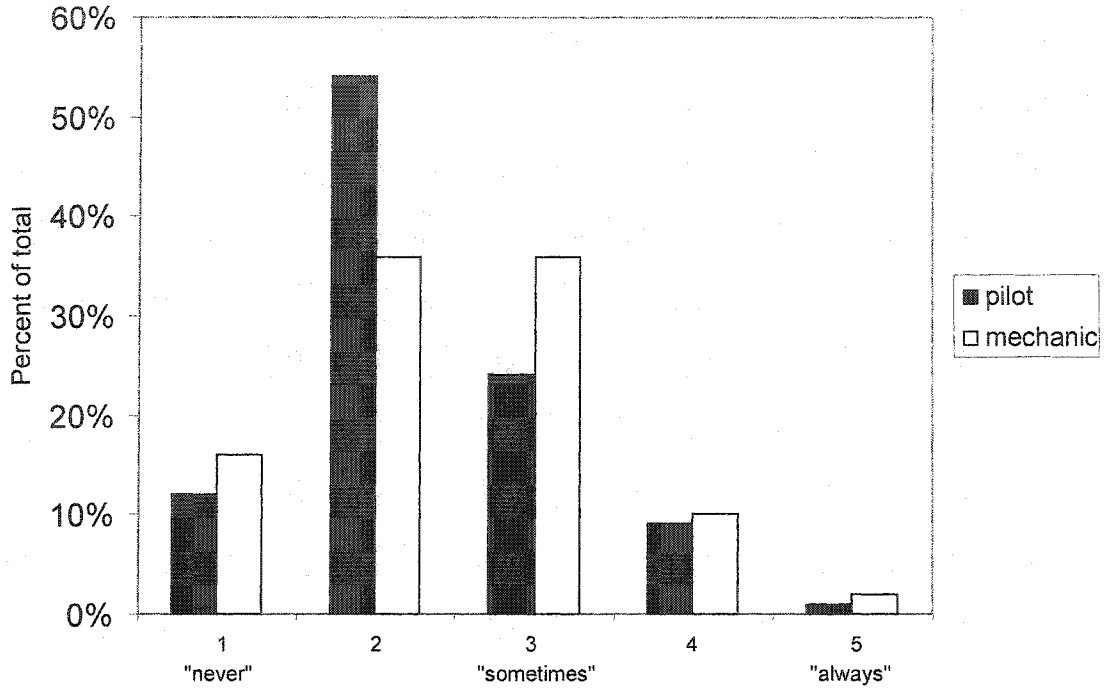

Figure 13. Pilot and mechanic responses to the question: How often do you encounter unfriendliness or lack of cooperation on the part of the other crew?

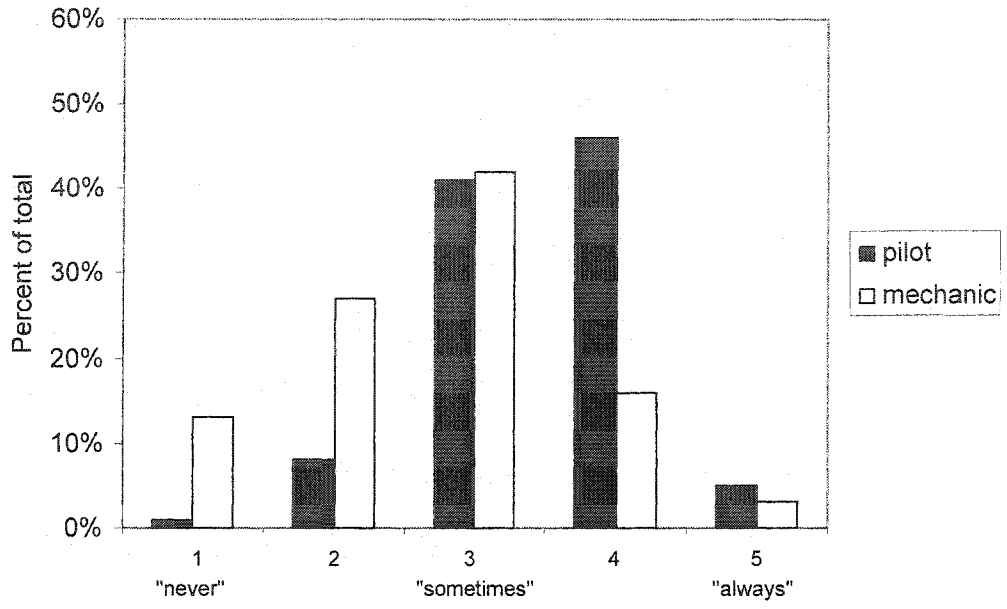

Figure 14. How often do pilots initiate face-to-face contact with mechanics at the gate?

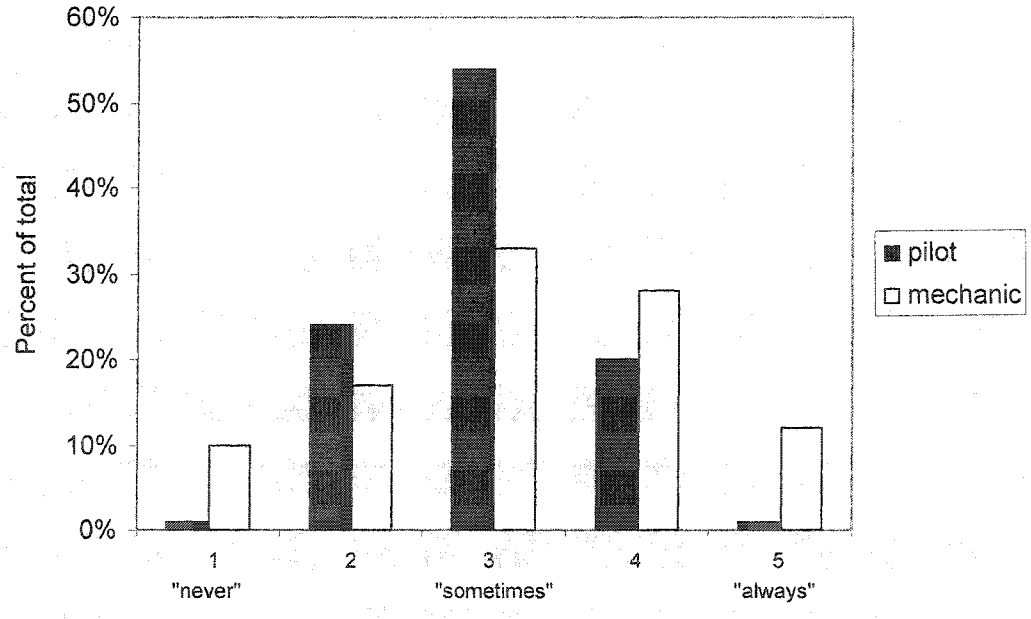

Figure 15. How often do mechanics initiate face-to-face contact with pilots at the gate?

opportunity to interact with pilots, nor would mechanics working overnight shifts, it is perhaps not surprising to find a percentage of mechanics indicating they never initiate contact with pilots and that pilots do not initiate contact with them.

Respondents were asked how often they conferred with each other about how a discrepancy should be written up in the logbook. Pilots were more likely to report conferring with mechanics, at least sometimes, about how to write-up a discrepancy in the logbook. Forty-three percent said they "sometimes" conferred with mechanics at the gate, although 37% reported rarely doing so (a rating of 2). Just 12% of pilots said they "never" conferred with a mechanic. In contrast, almost one-third of mechanics (32%) reported they "never" conferred with pilots about how an item should be written up. Differences in how often each group reported conferring about a log entry were significant: $t(316) = 2.86$, $p = .01$ (see Figure 16).

Quality of Communication

When asked to rate the overall quality of communication between pilots and mechanics at their carrier, pilots tended to give a higher rating than did mechanics. Most pilots rated the communication between themselves and mechanics as "average" or above average (rating of 3 or 4). The majority of mechanics, on the other hand (54%), felt their communication with pilots was just "average" (rating of 3). Differences between groups on this item were significant: $t(317) = 6.25$, $p < .001$ (see Figure 17).

Organizational Factors

Company policy. Respondents were asked whether or not their carrier had a clearly stated policy that provided specific instruction about the level of detail to be

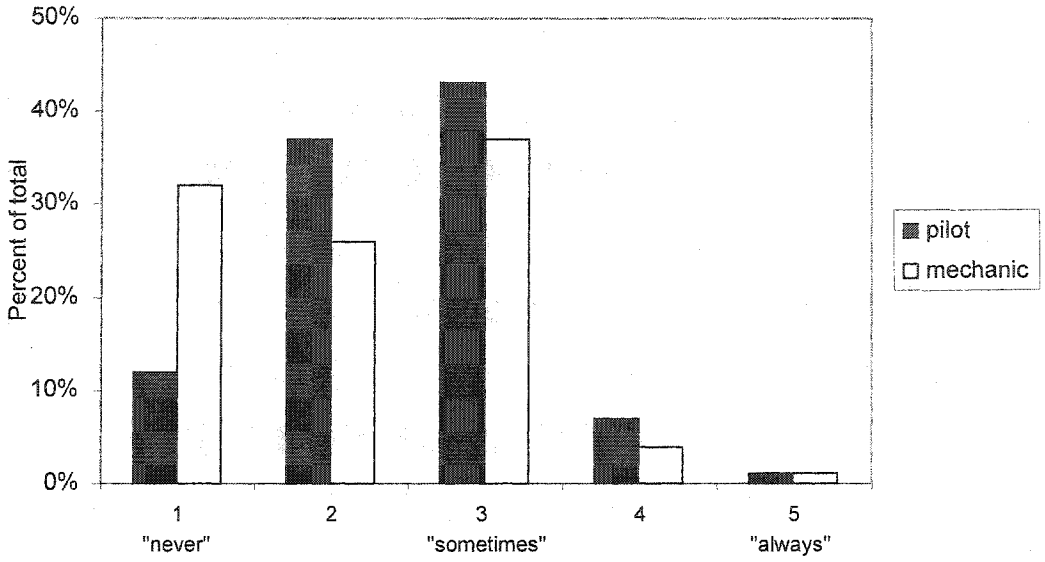

Figure 16. How often do you confer with each other at the gate about how a discrepancy should be entered into the logbook?

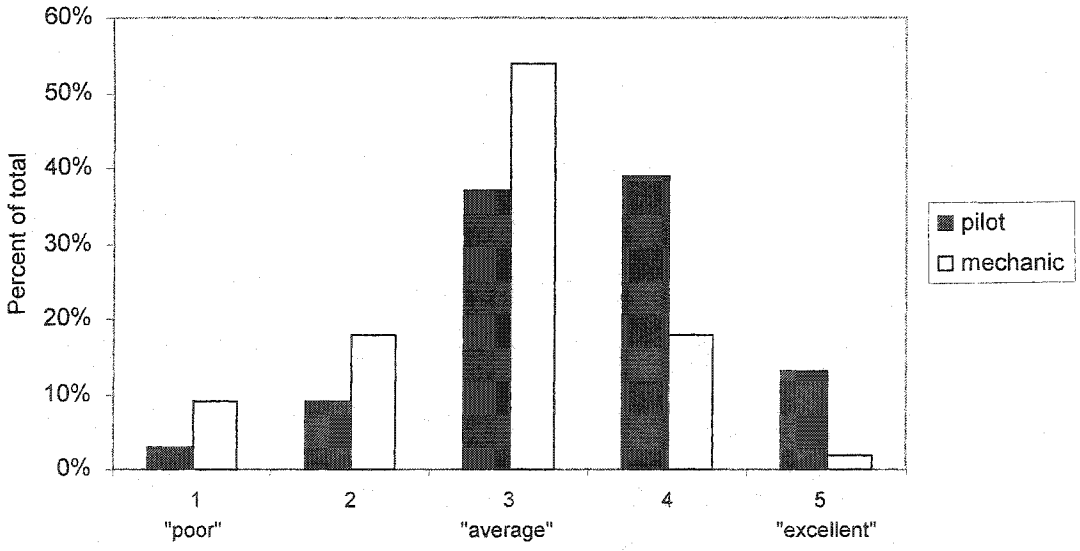

Figure 17. How would you rate the overall quality of mechanic – pilot communication at your carrier?

included in a logbook entry. The majority of mechanics (64%) indicated their company did have such a policy regarding maintenance signoffs, while the majority of pilots (57%) stated their company did not have such a policy regarding flight crew write-ups (see Figure 18). The difference between groups was significant: χ^2 (1, 314) = 13.72, p< .001, phi = .21.

Accepted norms. When both groups were asked if there existed any preferred practice or accepted norm among their peers about what should be included in a logbook entry, the majority of mechanics (68%) said yes. Pilots, on the other hand, were almost evenly divided, with 52% indicating there was an accepted norm among their peer group and 48% indicating there was not. Differences between groups were significant: χ^2 (1,316) = 8.91, p= .01, phi = .17 (see Figure 19).

Training. Respondents were asked to indicate how they had been trained to make entries in the aircraft logbook: in a formal classroom setting, through formal on-the-job-training (OJT), or on their own. Answer choices were not mutually exclusive; respondents could check any or all options that applied. Neither group indicated receiving much training on logbook entries in ground school or classroom setting: just 32% of pilots and 40% of mechanics endorsed this answer choice (χ^2 (1,319) = 2.30, n.s.) (see Figure 20). Mechanics were more likely to indicate they had received some form of on-the-job-training, with 57% endorsing this option, compared to just 36% of pilots (χ^2 (1,319) = 14.21, p< .001, phi= .21) (see Figure 21).

Pilots were considerably more likely to say they learned to make write-ups on their own over the course of their training or work experience. Over three-fourths (77%)

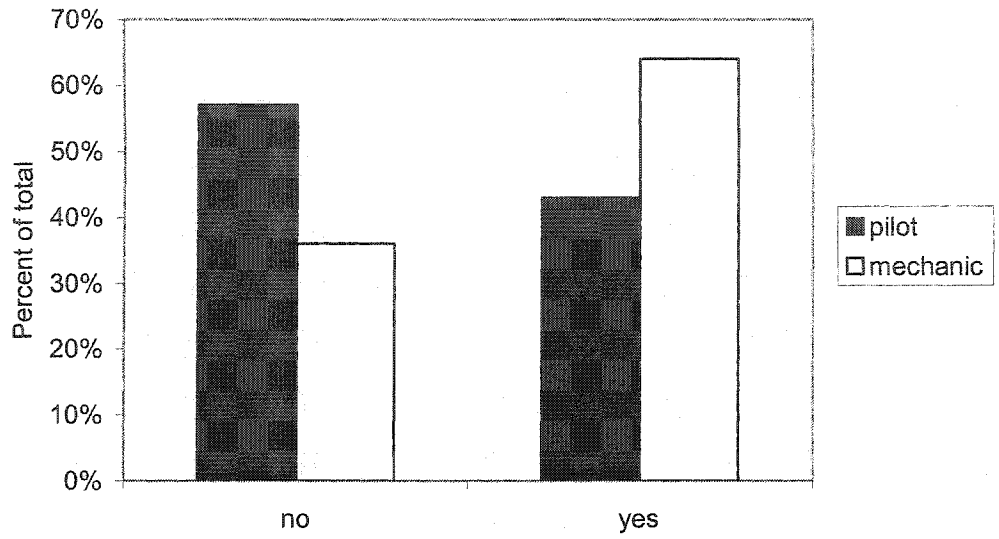

Figure 18. Does your carrier have a clearly stated policy regarding the level of detail to be included in logbook entries?

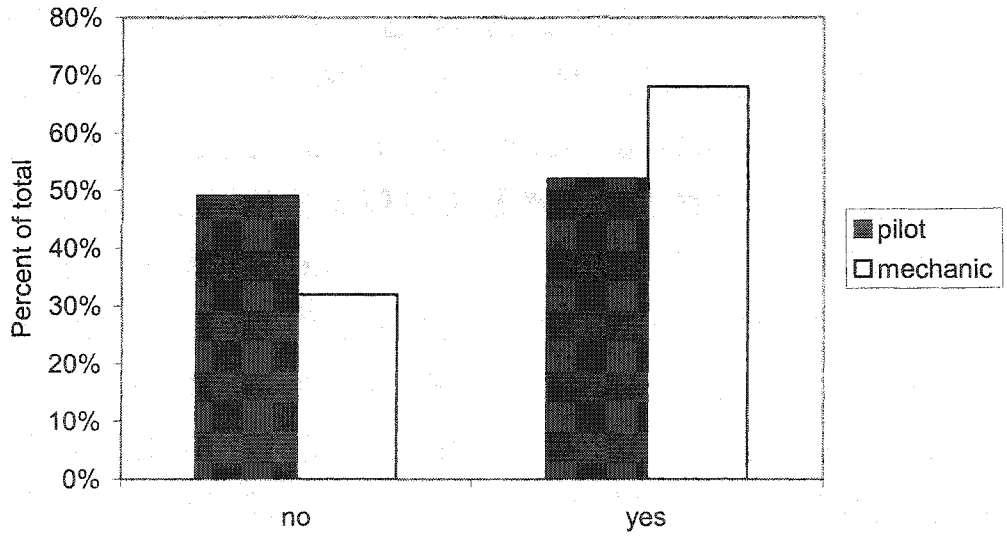

Figure 19. Is there an accepted norm or preferred practice among your peer group regarding the level of detail to be included in a logbook entry?

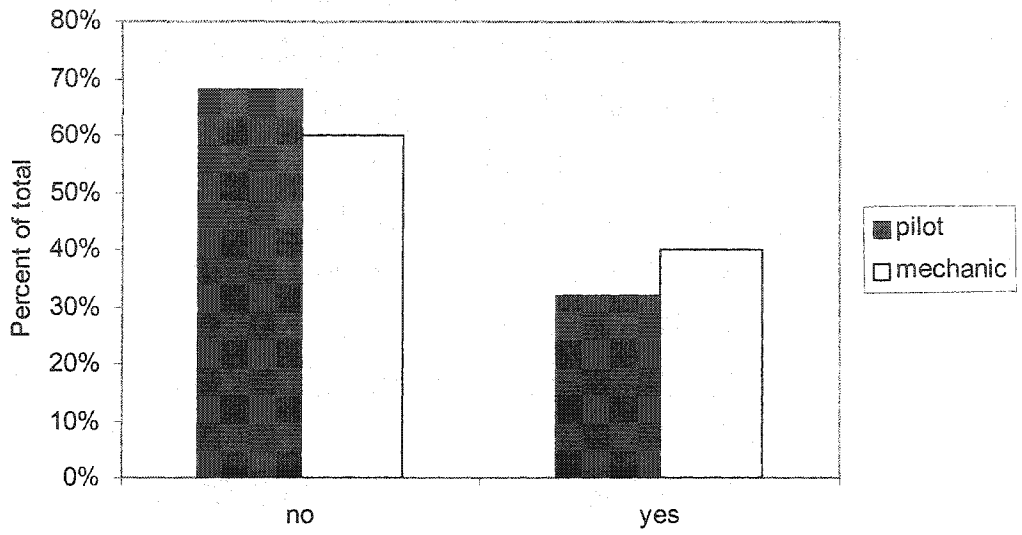

Figure 20. Percentage of pilots and mechanics indicating they received ground school or formal classroom training on how to fill out the logbook.

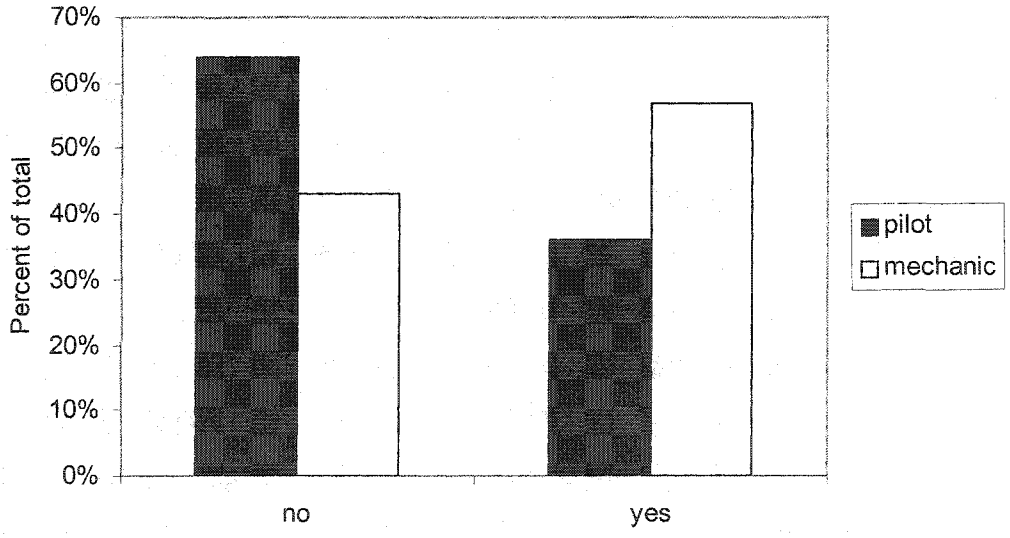

Figure 21. Percentage of pilots and mechanics indicating they received formal on-the-job training on how to fill out the logbook.

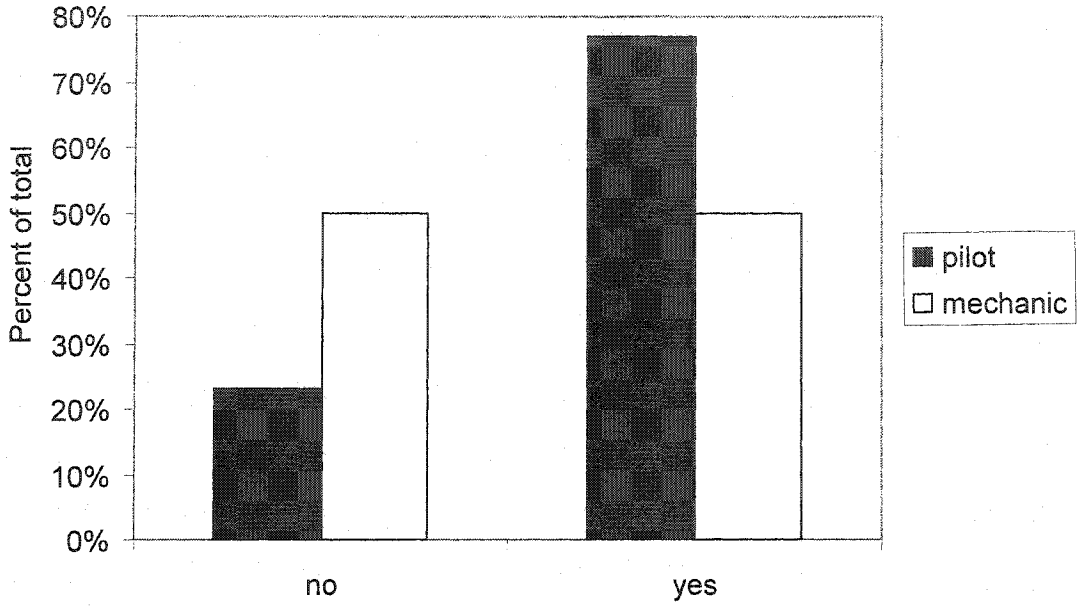

Figure 22. Percentage of pilots and mechanics indicating they learned how to fill out the logbook on their own over the course of their training and work experience.

of pilots endorsed this option, while only half of mechanics (50%) did so. This difference was significant: χ^2 (1, 319) = 26.52, p< .001, phi = .29 (see Figure 22).

Both groups were asked to indicate how much impact pilots' knowledge of the system involved in a fault had on the information they provided about that fault in their logbook write-ups. Pilots felt this factor had considerably more influence than did mechanics. Using a 5-point Likert-type scale (1= no impact, 5= significant impact), 82% of pilots endorsed a rating of 4 or higher. In fact over half (51%) indicated a pilot's knowledge of the system involved had "significant" impact (rating of 5) on the information provided in his/her write-up. Mechanics were more mixed in their opinions. The majority (38%) felt pilots' system knowledge had only "some" impact (rating of 3) on the information they gave in a write-up. Another 27% felt it had considerable impact (rating of 4), while 23% felt it had "significant impact" (rating of 5). Differences between groups were significant: t (317) = 7.04, p< .001 (see Figure 23).

Both groups were also asked if they felt increased systems knowledge on the part of flight crews would enable them to provide more detailed information about discrepancies. The majority of both groups answered in the affirmative, with, curiously, a slightly higher percentage of mechanics (72%) answering yes than pilots (64%) (see Figure 24). While this difference was not significant (χ^2 (316) = 2.19, n.s.), mechanics' strong endorsement of this option does seem to contradict their answer to the previous question, in which they indicated their belief that pilots' system knowledge was not a major influence on the information they provided in discrepancy write-ups.

Ability to follow up. Respondents were asked whether or not their organization

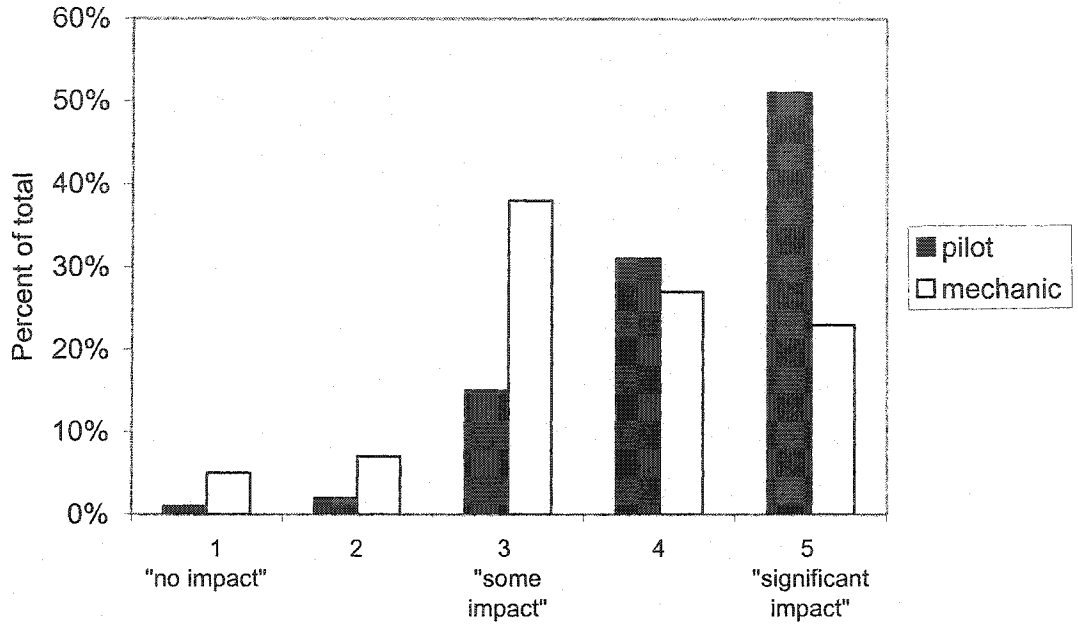

Figure 23. How much does a pilot's knowledge of the system involved in a discrepancy impact the amount of information s/he provides in the logbook write-up?

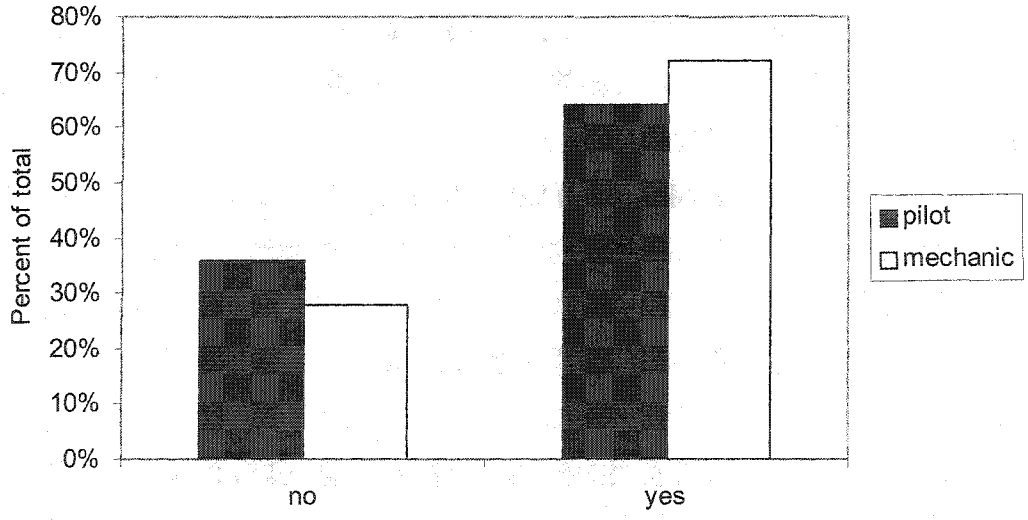

Figure 24. Do you feel increased systems knowledge on the part of pilots would enable them to provide more detail about discrepancies in their logbook write-ups?

had a policy or procedure in place that would allow them to follow up with the other crew to clarify an unclear log entry. Over three-fourths of pilots (77%) said there was indeed a procedure available through which they could follow up with maintenance on an unclear signoff. Conversely, nearly three-fourths of mechanics (71%) said there was no such policy or procedure available for them to follow up with pilots on an unclear write-up. The difference between groups was significant: χ^2 (1, 317) = 72.71, p<. 001, phi= .48 (see Figure 25).

In a follow-on question, respondents were asked if they had ever actually used the policy or procedure available at their carrier to follow up with the other crew. Given that most mechanics felt there was no such method available to them, it is perhaps not surprising that the majority (70%) stated they had not ever used it. Meanwhile, the overwhelming majority of pilots (77%) indicated that they had indeed made use of their company procedure for following up with maintenance. Differences between groups were significant: χ^2 (1, 263) = 57.58, p< .001, phi = .47 (see Figure 26).

In sum, both mechanics and pilots gave the communication between them a fair grade, although their ratings suggest there is room for improvement. Both groups reported encountering occasional unfriendliness from each other. However, both reported making the effort to initiate direct contact with one another. Pilots felt they were the initiators more often than mechanics, while mechanics felt they initiated contact more often than pilots gave them credit for. While both crews reported to occasionally conferring at the gate about how a discrepancy should be written into the logbook, a significant number of mechanics reported never conferring with pilots at all.

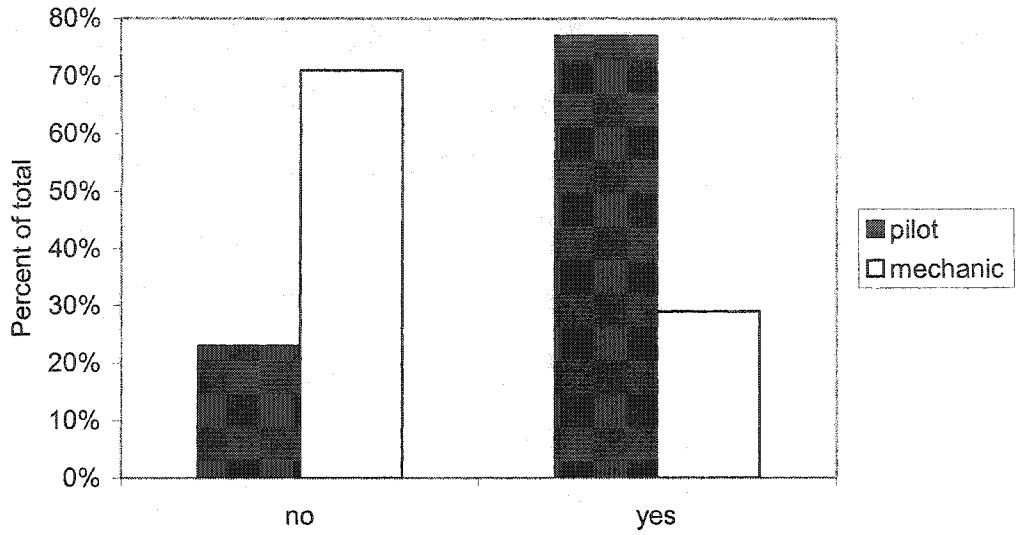

Figure 25. Does your company have a policy or procedure that allows you to follow-up with the other crew regarding an unclear log entry to get more information from them?

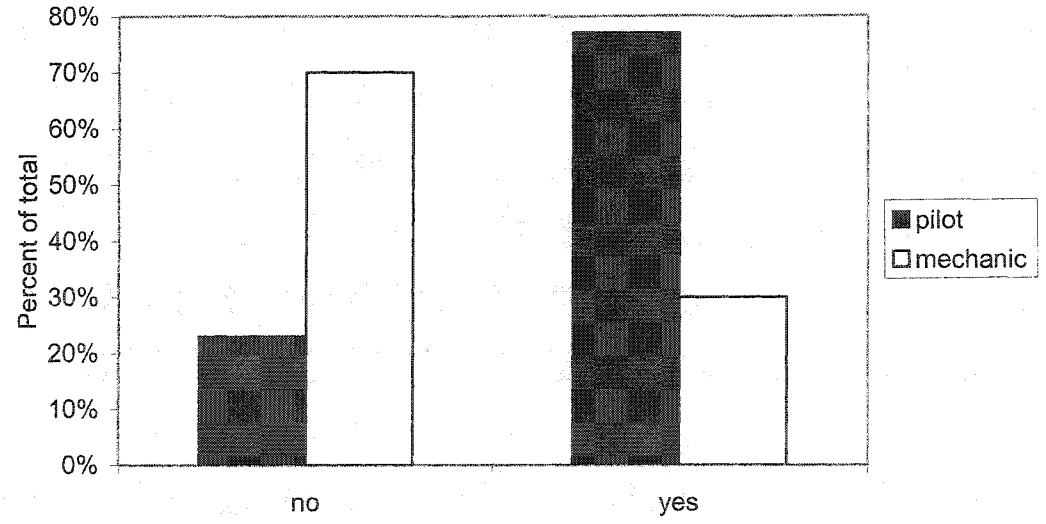

Figure 26. If your company has such a policy or procedure, have you ever used it?

Mechanics were more likely to report the existence of company guidelines on what to include in the logbook. Mechanics also reported more accepted norms among their peers regarding the content of entries. Pilots reported less formal training on filling out the logbook than did mechanics, who were more likely to report receiving on-the-job training. Pilots also felt more strongly that their knowledge of the systems involved in a fault influenced what they included in their write-up of it. However, both groups agreed that increased systems knowledge on the part of flight crews would enable them to give more detailed information about discrepancies.

The majority of pilots reported having a procedure by which to follow-up with mechanics on unclear log entries, and that they did use it, while the majority of mechanics reported they did not have any comparable way to follow-up with pilots.

Impact on Communication

As previously described, a number of questions were included to assess the potential impact of poor information exchange between pilots and mechanics on each crew's ability to accomplish necessary tasks. How does the information these two groups provide each other in the logbook impact their ability to do their respective jobs?

Ability to Do Job

When mechanics were asked to rate, on a 5-point scale, the degree to which a pilot write-up containing little or no detail impacted their ability to troubleshoot or repair a given discrepancy, nearly half (48%) said it "somewhat" (rating of 3) did so. Another 29% said it considerably impacted them (rating of 4). And 12% of mechanics said a poor pilot write-up "completely" impacted their ability to troubleshoot.

In a similar fashion, pilots were asked to rate how a maintenance signoff with minimal or no detail impacted their ability to make a determination about the airworthiness of an aircraft. Just over a third (35%) said it "somewhat" impacted them (rating of 3), while a third (33%) said it considerably impacted their ability (rating of 4). However, 21% of pilots indicated such signoffs minimally (rating of 2) impacted them (see Figure 27). Differences between the two groups were significant: $t(316) = -2.58$, $p = .01$, and would seem to indicate that mechanics feel they are more negatively affected by minimal pilot entries than vice-versa.

More concretely, how does the information provided by the other crew impact the amount of time each actually spends accomplishing their respective tasks? Mechanics were asked to rate the degree to which the information received from pilots influenced the time they spent troubleshooting a problem. The majority of mechanics (44%) indicated it "somewhat" (rating of 3) influenced the time they spent, while 31% indicated such information considerably (rating of 4) influenced time spent troubleshooting.

Pilots were similarly asked to indicate the degree to which the information provided in maintenance signoffs influenced the time they spent preflighting an aircraft. While 41% indicated that this information "somewhat" (rating of 3) influenced the time they spent, fully one-third of pilots (33%) indicated information from maintenance had little or no influence (rating of 2 or less) on time spent preflighting an aircraft. The difference between groups was significant: $t(316) = -3.53$, $p < .001$, suggesting that a lack of detail in a logbook entry had significantly more impact on mechanics' task time than on that of pilots (see Figure 28).

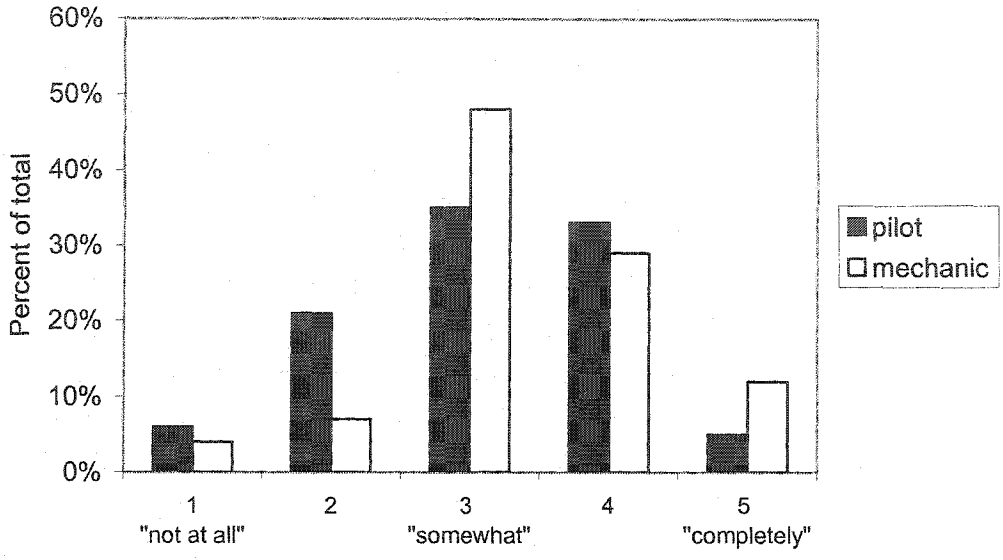

Figure 27. How much does receiving minimal information from the other crew in the logbook influence your ability to accomplish tasks, i.e., to troubleshoot a fault (mechanics) or to determine the airworthiness of the aircraft (pilots) ?

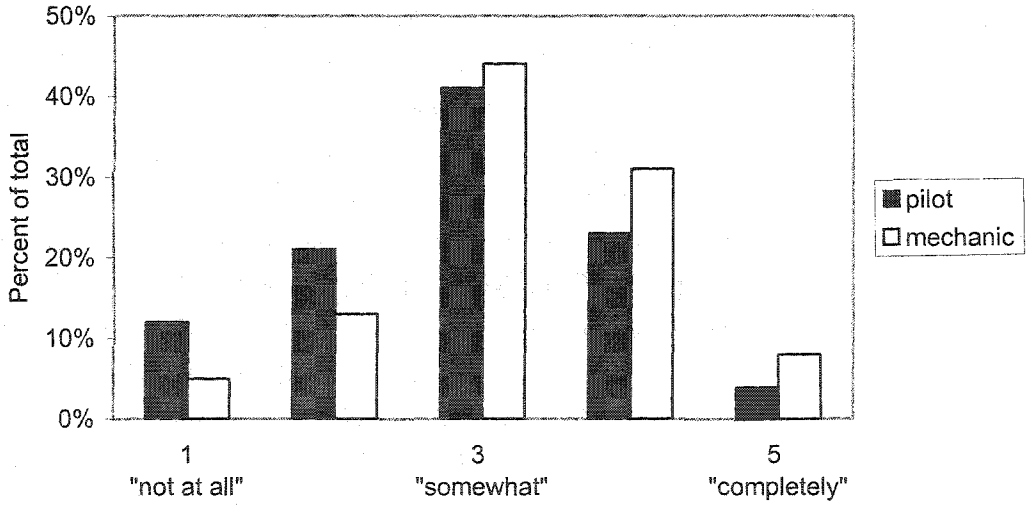

Figure 28. How much does the information you receive in the logbook impact the actual amount of time you spend performing tasks, i.e., troubleshooting a fault (mechanics) or preflighting the aircraft (pilots) ?

Role of Technology

The technology involved in fault reporting has changed considerably in recent years. Aircraft manufacturers have attempted to streamline the process by codifying fault types and listing these codes in fault reporting manuals (FRMs). Typically such codes are based on the Air Transport Association (ATA) codes assigned to various aircraft systems. Using the FRM, pilots look up a fault using a text description, find the appropriate numeric code, then enter that code into a paper or electronic logbook. Multiple codes can exist for the same problem, with each code representing a different degree of severity, set of circumstances, combination of faults, etc.

How helpful are such codes? Both groups were asked whether, even with such fault codes, there remained discrepancies that were best communicated verbally between pilots and mechanics. The overwhelming majority of both crews (85% of pilots, 78% of mechanics), answered in the affirmative (χ^2 (1, 315) = 2.73, n.s.) suggesting that it may not be possible to anticipate and develop codes for all possible faults, and that even with codes some faults are better told than written (see Figure 29).

To further explore the role of technology, respondents were presented with a hypothetical scenario: what if the technology that would tell maintenance every fault or malfunction experienced by a flight crew was perfected and installed in every aircraft in a carrier's fleet? Would there still be, under such circumstances, any need for pilot reports of discrepancies? In other words, would pilots still want to give a description of those events to maintenance and would mechanics still want to receive them?

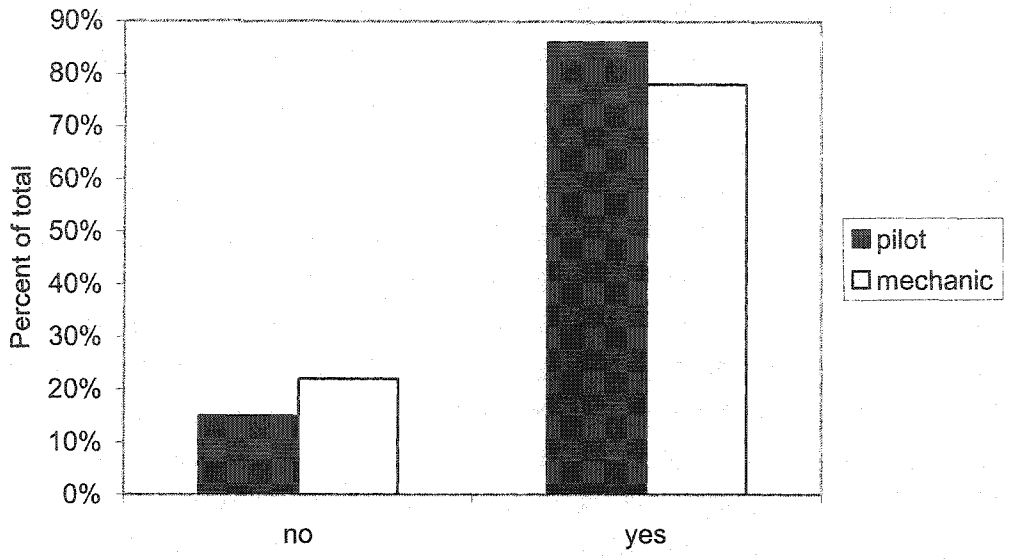

Figure 29. Are there discrepancies that, even with the existence of fault codes, are best communicated verbally between pilots and mechanics?

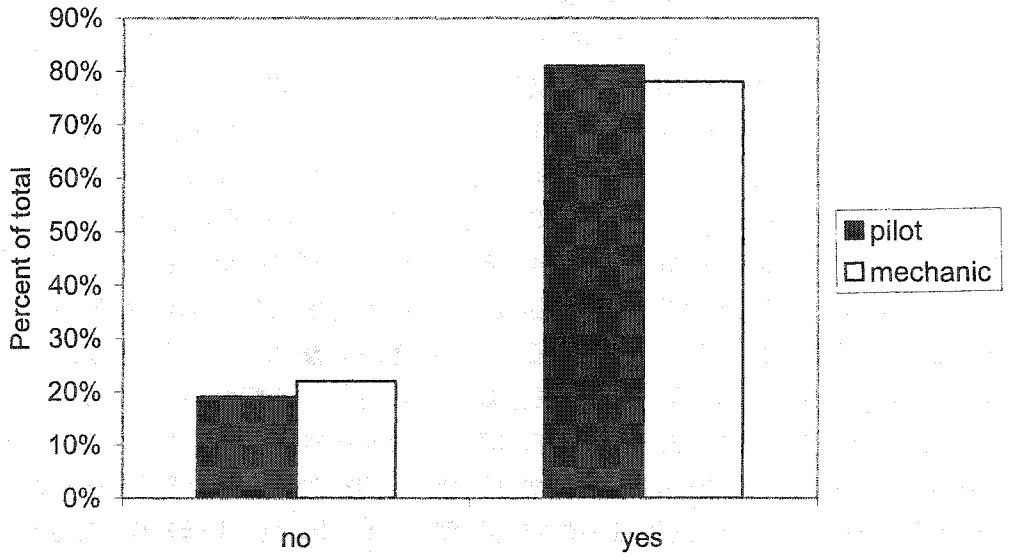

Figure 30. If the technology that could tell maintenance every fault the flight crew experienced during a flight was perfected and installed in every aircraft, would you still want to make/receive pilot descriptions of these events?

The overwhelming majority of both groups (81% of pilots, 75% of mechanics) responded in the affirmative. There was no significant difference between them: χ^2 (1, 313) = 1.65, n.s., suggesting that regardless of the completeness of the technology introduced, human input in the reporting of discrepancies remains highly valued by both crews (see Figure 30).

DISCUSSION

There were a number of important findings in this study. With regard to Content, both pilots and mechanics demonstrated an awareness of what general information was helpful to include in their logbook entries. However, mechanics indicated they frequently did not receive such helpful information from pilots. An examination of the factors influencing what each crew chose to include in their log entries reflected some significant differences. Pilots reported less concern about scrutiny of their entries by authorities than did mechanics. Indeed, while pilots felt they were making their entries for maintenance, mechanics felt they made their entries primarily for the FAA.

There were also a number of significant Contextual findings. Key factors related to Culture included the finding that pilots received less formal training on filling out the logbook than did mechanics. Standards regarding the content of pilot write-ups appeared to be less clearly defined, either through formal policies or accepted practices, than they were for mechanic signoffs. And when faced with an unclear log entry from the other crew, pilots reported having a much greater ability to follow-up and clarify that entry than mechanics did. In terms of Logistics, pilots reported spending significantly less time making a logbook entry than mechanics, although they appeared to have more time in

which to do so. It appeared that pilots and mechanics were often unable to talk to each other directly because they were not at the aircraft at the same time.

In examining the impact of poor information exchange, it was found that logbook entries lacking in detail had a significantly greater effect on mechanics' ability to accomplish key tasks, as well as on the time they spent completing them, than on those of pilots. Each of these findings will be discussed in further detail in the following sections.

Content Findings

The finding of dissatisfaction with logbook entries was consistent with the both the findings of Young et al. (1999) and BASI (1999). In their study, Young et al. surveyed both pilots and mechanics from all areas of aviation (general aviation, corporate aviation, the military, regional carriers and major airlines) about their use of the aircraft logbook. The goal was to identify an overall level of satisfaction across the two groups. They found that almost half their sample (pilots and mechanics combined) indicated that there were problems with logbook entries. The most commonly cited problems were entries lacking detail, failure to write-up discrepancies at all, and vague fault reporting codes.

The study by BASI (1999), in contrast, focused exclusively on mechanics. Researchers surveyed mechanics working at regional carriers throughout Australia. When asked to rate how helpful pilot write-ups were in identifying and troubleshooting a discrepancy, the majority of mechanics said they were only "somewhat" helpful to them. This led the authors to conclude that pilot entries were often inadequate, although they did not identify why.

Like the Young et al. study, the present study surveyed both pilots and mechanics, though with the goal of identifying any differences in satisfaction levels between them. Results indicated that mechanics were significantly less satisfied with logbook entries than pilots. As in the BASI study, mechanics rated pilot write-ups as only somewhat helpful. More importantly, the present study went a step further and attempted to identify *why* pilot entries were not as helpful as they could be. The main reasons appeared to be that they frequently lacked meaningful detail or, in some cases, lacked any detail at all. This finding replicated and expanded the findings of Young et al., and suggests that the most common problems with logbook entries are consistent across aviation domains.

However, both groups appeared to be aware of what information would be most helpful to provide each other. Pilots and mechanics were asked to identify, from a longer list, the five details about a discrepancy that would be most helpful to maintenance. Pilots narrowed this list down to the same five details as did mechanics. Similarly, mechanics and pilots were asked to identify which details about a repair would be most helpful to pilots. As above, mechanics named the same five details as pilots. This would seem to indicate that each of these crews has an appreciation of what basic details are useful to provide the other.

And yet, one of the most striking findings in the present study concerned the frequency of "inop" write-ups. Ninety-one percent of mechanics reported receiving entries from pilots in which a component was described as "inop" with no additional detail at least half the time. Forty-percent of mechanics in fact said they received them often. Pilots emphatically disagreed with this assertion, with 97% reporting they made

such write-ups only sometimes at best. Indeed, fully one-third of pilots said they never wrote up an item as "inop". Clearly there was a difference of opinion on this issue.

While it might be argued that this finding represents the tendency to over-report a behavior in others while under-reporting it in one's self, the significance of the finding suggests there is a legitimate difference in the experiences of these two groups. It might also be argued that cultural factors may have colored mechanics' perceptions of pilots, leading them to remember negative interactions more easily than positive ones. However, neither mechanics nor pilots gave particularly negative ratings to the other's behavior beyond how they filled out the logbook, suggesting this finding is not simply a reflection of frustration spilling over from other issues.

There were some important differences in the factors influencing what each group wrote in the logbook. Concern about the FAA reading a signoff emerged as an important influence on what mechanics wrote. While pilots felt they were making their write-ups for maintenance, mechanics felt they were making their signoffs primarily for the FAA. At the same time, however, mechanics expressed an awareness that their entries could also be read by almost anyone else – i.e., pilots, the company, and other mechanics. Pilots were aware that, after mechanics, other pilots could read their entries when reviewing an aircraft's maintenance history. However they expressed less concern about authorities such as the FAA or the company reading what they wrote, suggesting they felt less at risk for any enforcement action being taken against them as a consequence.

Interestingly, while the majority of pilots reported they frequently received signoffs from maintenance with little detail (i.e., only a reference to the Maintenance

Manual section where a repair could be found), they consistently rated maintenance signoffs as very helpful. Furthermore, the majority of pilots stated that they infrequently read a signoff and wanted more information. This may be due to the fact that, in the strictest legal sense, the most important piece of information a pilot needs to see in the logbook is the signature of a mechanic. By signing his name in the logbook (along with his FAA certificate number and the date) a mechanic certifies that an aircraft can be returned to service. The pilot's main legal responsibility is to ensure that the aircraft is airworthy, and the mechanic's signature affirms this.

This would appear to be supported by the finding that a significant percentage of pilots reported that a maintenance signoff lacking in detail (but containing a mechanic signature) had little impact on their ability to determine the airworthiness of an aircraft. Such a signoff had even less influence on the time most pilots spent performing their pre-flight inspection. In contrast, the majority of mechanics stated that a lack of detail from a pilot had a notable impact on their ability to troubleshoot a fault and had a measurable impact on the amount of time they spent troubleshooting. Thus it would appear that often the level of detail a pilot seeks from a maintenance signoff differs significantly from the level of detail a mechanic seeks from a pilot write-up.

Context Findings

Pilots reported receiving significantly less formal training (either in the classroom or on the job) on how to fill out the logbook than mechanics. Rather, the overwhelming majority of pilots reported being self-taught in making write-ups. Furthermore, pilots were significantly less likely than mechanics to report the existence of any specific

company policy on what must be included in their entries. They were also less likely to report the existence of any accepted standard among their peers to guide them.

As discussed previously, the way each group is trained on and interacts with the aircraft can lead to distinct differences in their knowledge of and familiarity with systems onboard. Pilots in the present study clearly felt their knowledge of aircraft systems impacted what they were able to tell maintenance about a problem. When asked to rate the degree to which a pilot's knowledge of the systems involved in a discrepancy influenced what s/he included in his/her write-up of it, 82% of pilots said it had a major influence. In their open-ended responses, many pilots also expressed concern about providing irrelevant information when writing up a discrepancy and sending a mechanic down the wrong troubleshooting path, wasting valuable time and energy.

Yet, when asked to rate how often they were uncertain what to include in a write-up, the majority of pilots reported rarely or never being uncertain what to include. And indeed, as reported in the Content findings, pilots did demonstrate a clear awareness of what information would be helpful to include in a discrepancy write-up. This would seem to suggest that despite their reported lack of formal training, the lack of clear guidelines, and any concerns about their own systems knowledge, pilots do in fact have a good idea of what information is useful to tell maintenance about a discrepancy in their write-up. In spite of this, however, mechanics reported that they frequently did not receive helpful information from pilots.

While they reported having significantly more time between flights than mechanics, pilots spent significantly less time filling out the logbook. Pilots also

reported that what they wrote in the logbook about a discrepancy was to a degree influenced by input from Maintenance Control. Maintenance Controllers are engineers who specialize in a given aircraft type and who have access to company and manufacturer's manuals. Pilots can contact them in flight or on the ground for assistance in troubleshooting a fault. Perhaps, when they are uncertain about their own systems knowledge, pilots defer to Maintenance Control recommendations on what to write-up rather than trusting their own instincts about what to put in the logbook.

In addition, the majority of pilots reported that if they wanted additional information about a maintenance signoff, there was a clear procedure in place that allowed them to do so. And most pilots reported they had used this procedure at one time or another. Few mechanics, on the other hand, reported having a procedure for getting additional information about a write-up.

Typically a pilot is able to get more information about a signoff by calling Maintenance Control. They can give a pilot the additional detail s/he needs about a fix without having to track down the mechanic who performed the work. In contrast, if a mechanic needs more detail from a pilot entry, he does in fact need to speak to the pilot who wrote it. Contacting a pilot once s/he has left an aircraft is often a more complex process, as it can require the involvement of several departments to determine a pilot's current location. The pilot may be in the air piloting another flight, in another country, or on a legally required rest period during which s/he may not be disturbed. Given the time-consuming nature of this process, it is not typically feasible during the daytime and is generally used, if at all, by line mechanics working overnight. The majority of

mechanics in the present study reported not having such a policy and never having used it if they did.

Mechanics overwhelmingly indicated they wanted information about discrepancies from pilots, even in the face of advanced technology such as automated fault reporting. They felt that there were details that could only be provided by a pilot witnessing an event before, during, and after it happened. Pilots agreed that they were in a unique position to provide salient information about a fault and the circumstances surrounding it, and very clearly wanted to give such information to maintenance.

Both groups agreed that often the best way for them to communicate about a discrepancy was face-to-face. A number of mechanics and pilots commented that certain faults were easier to "show and tell" than to explain in writing, even with the availability of fault codes. However, both groups reported that they were in the same place (at the aircraft) at the same time only about half the time. When pilots and mechanics are unable to talk to each other about a discrepancy, the only way that information gets communicated is through the logbook. This reality serves to highlight the importance of detailed write-ups in accurately identifying and repairing malfunctions on an aircraft.

It would appear that pilots and mechanics use the aircraft logbook in meaningfully different ways. Pilots, for example, make entries in the logbook for the purpose of notifying maintenance of a discrepancy, and to make subsequent flight crews aware of any problems they encountered with the aircraft. Pilots read the logbook before a flight to review the recent maintenance history of an aircraft, and, most importantly, to verify its airworthiness before taking it in the air. Typically a mechanic's signature closing out

any discrepancies serves this purpose. Thus, reading the logbook is essentially a verification process for a pilot. S/he verifies that all write-ups have been signed off by maintenance. If they have, the pilot can move on to the next task. Should a pilot want more information about an entry, however, such information is obtainable through contact with Line Maintenance, Maintenance Control, or Dispatch.

Mechanics, too, read the logbook initially for verification. They check the log for the presence of any pilot entries. If there is a write-up from a pilot, however, the mechanic must then take some action to resolve the problem. The information provided by the pilot serves as the first step in a lengthier process of identifying, troubleshooting, and resolving the discrepancy. Should a mechanic want more information about a write-up, such information is often difficult to obtain as it involves tracking down the pilot who made the entry. Upon completing a repair, a mechanic makes an entry in the logbook for the purpose of legally documenting the repair for the authorities, and to let pilots know that the aircraft is airworthy.

CONCLUSION

Communication between airline mechanics and pilots is crucial, as both groups share responsibility for the safety and legal airworthiness of commercial aircraft. One of the most critical issues about which these two crews must communicate is the status of any discrepancies on an aircraft. Despite its importance, few studies have been conducted on the communication between pilots and mechanics.

While in theory pilots and mechanics should meet face-to-face to discuss discrepancies, they often do not. In such cases information about discrepancies is

communicated via written entries in the aircraft logbook. The present study sought to determine just what information these two crews need to receive from each other in logbook entries. It also examined how such information is used and how a lack of information might impact each crew's ability to accomplish their respective tasks. Furthermore, it attempted to identify factors that influence whether or not such information is provided, along with the circumstances that may prevent these crews from meeting in person.

Results indicated there were significant differences in how each crew used the aircraft logbook. This clearly impacted the level of detail each needed to receive from the other in their entries. However, there were important differences in the factors that influenced what pilots and mechanics included in logbook entries. Results also identified factors in the operating environment that may preclude direct meetings between them. These findings highlight the importance of effective communication between pilots and mechanics in reporting discrepancies via the aircraft logbook.

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Appendices

Appendix A

Maintenance Survey

MAINTENANCE SURVEY

✈ Demographics ✈

Please tell us about your work experience:

Which maintenance licenses/ratings do you hold? (check all that apply):
Airframe ___ Powerplant ___ Inspection Authorization ___ Other (specify): _____

Are you a lead mechanic? Yes ___ No ___

Where do you currently work (check one): Line Station___ Maintenance Base ___

If/when you work line maintenance, what is the typical number of gates you cover at one time?
(circle one): 1 2 3 4 5

Which aircraft types do you currently work on? (list all that apply):_____

_____

Which flight ratings (if any) do you hold? (check all that apply):
Student ___ Private___ Commercial ___ Instrument___ Multi-Engine___ CFI___
Other (specify)_____

Gender: Male____ Female____ Age: _____

✈ Survey Questions ✈

For each of the following items, please circle the number that best describes your experience:

1. How helpful is the pilot's logbook write up to you in troubleshooting or repairing a discrepancy?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

2. How helpful are previous maintenance signoffs to you when troubleshooting a recurrent or ongoing problem?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

3. How helpful do you believe the maintenance signoff is to flight crew in determining the current status of an aircraft?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

GO ON TO NEXT ⇨

4. How often do you go over the allotted space in signing off a discrepancy? (i.e., continue a signoff onto the next page/coupon/sheet).

1	2	3	4	5
never		sometimes		always

5. How often do you read a pilot write-up and want more information?

1	2	3	4	5
never		sometimes		always

6. How often do you have difficulty reading a pilot write-up due to poor handwriting?

1	2	3	4	5
never		sometimes		always

7. How often do you have difficulty reading a previous maintenance technician's signoff due to poor handwriting?

1	2	3	4	5
never		sometimes		always

8. How often are you uncertain about what information to include about a repair when signing off an item in the aircraft logbook?

1	2	3	4	5
never		sometimes		always

9. How often do you encounter pilot write-ups of a system or component as "inop" with no additional detail?

1	2	3	4	5
never		sometimes		always

10. How often in a signoff do you provide detail about a fix beyond citing the maintenance manual section(s) where the repair procedure can be found?

1	2	3	4	5
never		sometimes		always

11. How often do you confer with the flight crew about how a discrepancy should be written up in the logbook?

1	2	3	4	5
never		sometimes		always

12. How often do you **initiate** face to face contact with pilots at the gate?

1	2	3	4	5
never		sometimes		always

GO ON TO NEXT ⇨

13. How often do **pilots** initiate face to face contact with you at the gate?

1	2	3	4	5
never		sometimes		always

14. Typically, how often do you arrive onboard an aircraft **before** the flight crew departs?

1	2	3	4	5
never		sometimes		always

15. How often do you encounter unfriendliness or lack of cooperation on the part of pilots?

1	2	3	4	5
never		sometimes		always

16. If a write-up involves a repeat problem, how often do pilots provide additional or new information about the problem beyond what was written by previous flight crews [ie, beyond referencing the item #/page #/ coupon # of the previous flight crews' write ups] ?

1	2	3	4	5
never		sometimes		always

17. When you receive a pilot write-up with minimal or no detail, how does this impact your ability to troubleshoot or resolve the discrepancy?

1	2	3	4	5
not at all		somewhat		completely

18. How does the information provided by pilots in the logbook write-up influence the time you spend troubleshooting a discrepancy?

1	2	3	4	5
not at all		somewhat		completely

19. In general, how would you rate the quality of communication between mechanics and pilots at your airline?

1	2	3	4	5
poor		average		excellent

20. What impact does a flight crew's knowledge and understanding of the systems involved in a fault or malfunction have on the information they provide in a write-up?

1	2	3	4	5
no impact		some impact		significant impact

GO ON TO NEXT ⇨

21. How much total time, on average, would you say you spend entering (either on paper, electronically, or both) a single signoff? (please check one):

Less than 5 minutes ____

5-10 minutes ____

10-15 minutes ____

more than 15 minutes ____

22. What is the typical turn time you encounter during peak schedule times? (please check one):

Less than 15 minutes ____

15-30 minutes ____

30-45 minutes ____

45-60 minutes ____

more than 60 minutes ____

23. How were you trained to write signoffs in the logbook? (check all that apply):

Formal course/ground school ____
Formal on the job training ____
Picked up on your own over the course of your training/work ____

24. In a pilot write-up of a discrepancy, which of the following pieces of information are most helpful to you in troubleshooting and/or repairing the problem? Please choose the **five (5)** most helpful items and rank them in order of their helpfulness (i.e., 1= most helpful item, 2= next most helpful item, etc). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Phase of flight at which the fault/malfunction occurred	____
Altitude at which the fault/malfunction occurred	____
Airspeed at which the fault/malfunction occurred	____
Action that preceded the fault/malfunction	____
Any troubleshooting actions taken by pilots (use of QRH, etc.)	____
Whether the pilots were able to reset system/component	____
ATA code of system involved	____
Whether or not fault was intermittent	____
Whether or not problem self-corrected (without pilot input)	____
Other (please specify)_____	____

GO ON TO NEXT ⇨

25. In the maintenance sign-off of a discrepancy, how helpful do you feel the following pieces of information are to pilots in determining how the problem was resolved? Please rank these items from 1 to 5 in order of their helpfulness (i.e., 1=most helpful item, 2= next most helpful item, etc). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Root cause (e.g., electrical system, etc)	_____
Parts changed/replaced	_____
Parts repaired	_____
Components/ systems involved or affected	_____
Ability of maintenance to replicate problem	_____
Other (please specify)_____	_____

26. When signing off a discrepancy in the maintenance logbook, whom do you feel you are primarily writing the signoff for? Please rank items in order of priority (i.e., 1= the group you most intend the write up for, etc.) Please use each rank only once. Please indicate each item's rank in the blank space provided.

Item:	**Rank:**
Pilots	____
Company	____
FAA	____
Other mechanics/ maintenance technicians	____
Other (please specify)_____	____

27. Which factors influence the **amount** of information you include in a signoff? Please choose the **five (5)** most influential items and rank them in order of their influence (i.e., 1= most influential factor, 2= second most influential factor, etc.). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Time	____
Amount of space provided in which to sign off item	____
Company policy	____
Accepted practices/norms at your carrier	____
Nature of the problem involved	____
Possibility that the logbook may be read by the FAA or other authority	____
Whether the item is a new or repeat item	____
Impact of item on airworthiness/ flight safety	____
Time or cost involved in repairing the item	____
Current need for the a/c on the line	____
Fatigue	____
Culpability	____
Input from maintenance control	____
Other (please specify): _____	____

GO ON TO NEXT ⇨

28. Does your company have a clearly stated policy that provides specific instruction regarding the level of detail to be included in a logbook signoff? Y N

29. Is there a preferred practice or accepted standard among maintainers at your airline regarding the information to be included in a signoff? Y N

30. Does your carrier have a policy or procedure that allows you to follow up with a pilot on an unclear write up to get more information? Y N

    Have you ever used this procedure/policy? Y N

    Why/why not?

31. Do you feel increased knowledge of aircraft systems would enable flight crews to provide more detailed information about discrepancies? Y N

    Why/why not?

32. Are there certain discrepancies that, even with the availability of fault reporting codes, you feel cannot be fully communicated in writing between flight and maintenance and are most clearly communicated verbally? Y N

    Can you provide an example from your own experience?

33. If the technology were perfected and implemented throughout the fleet that would tell maintenance every fault or malfunction experienced by the flight crew in the course of a flight, would you still want to receive a description of those events from the pilots? Y N

    Why or why not?

34. If you have any additional comments about any items in this survey, or would like to mention any issues with logbook write-ups or signoffs that were not covered in this survey, please feel free to do so here (you may continue on the back if necessary):

Thank you for your participation!

Appendix B

Flight Crew Survey

FLIGHT CREW SURVEY

✈ Demographics ✈

Please tell us about your work experience:

What is your current position? (check one): Captain ___ First Officer ___ Second Officer ___

Which aircraft types do you currently fly? (list all that apply): _____

_____

Which routes do you mostly fly? (check one): Domestic____ International____

Do you fly routes that are predominantly (check one): Short-haul ____ Long-haul ____

Are you a check pilot? Yes ___ No ___

Which maintenance licenses/ratings (if any) do you hold? (Please check all that apply):

Airframe ___ Powerplant___ Inspection Authorization___ Other (specify)____

Do you own your own (private) aircraft? Yes____ No ____

Gender: Male____ Female____ Age: _____

✈ Survey Questions ✈

For each of the following items, please circle the number that best describes your experience:

1. How helpful is the maintenance signoff of a discrepancy to you in determining the status of an aircraft?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

2. How helpful are write ups by previous flight crews to you in determining the current status of an aircraft?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

3. How helpful do you believe the pilot's write up of a discrepancy is to maintenance in troubleshooting and fixing a discrepancy?

1	2	3	4	5
not helpful		somewhat helpful		very helpful

GO ON TO NEXT ⇨

4. How often do you go over the allotted space in writing up a discrepancy (i.e., continue a write up onto the next page/coupon/sheet) ?

1	2	3	4	5
never		sometimes		always

5. How often do you read a maintenance signoff and want more information?

1	2	3	4	5
never		sometimes		always

6. How often do you have difficulty reading a maintenance signoff due to poor handwriting?

1	2	3	4	5
never		sometimes		always

7. How often do you have difficulty reading a previous flight crew's write-up due to poor handwriting?

1	2	3	4	5
never		sometimes		always

8. How often are you uncertain about what information to include about a discrepancy when making an entry into the aircraft logbook?

1	2	3	4	5
never		sometimes		always

9. How often do you write up a system or component as "inop" with no additional detail?

1	2	3	4	5
never		sometimes		always

10. How often in a signoff does maintenance provide detail about the fix beyond listing the maintenance manual section(s) where the repair procedure can be found?

1	2	3	4	5
never		sometimes		always

11. How often do you confer with gate maintenance about how a discrepancy should be written up in the logbook?

1	2	3	4	5
never		sometimes		always

12. How often do you **initiate** face to face contact with the mechanics at the gate?

1	2	3	4	5
never		sometimes		always

GO ON TO NEXT ⇨

13. How often do **mechanics** initiate face to face contact with you at the gate?

1	2	3	4	5
never		sometimes		always

14. Typically, how often are you still onboard the aircraft when maintenance arrives?

1	2	3	4	5
never		sometimes		always

15. How often do you encounter unfriendliness or lack of cooperation on the part of mechanics?

1	2	3	4	5
never		sometimes		always

16. If a write-up involves a repeat problem, how often do you provide additional or new information about the problem beyond what was written by previous flight crews [i.e., beyond referencing the item #/page #/ coupon # of the previous crews' write up(s)] ?

1	2	3	4	5
never		sometimes		always

17. When you receive a maintenance signoff with minimal or no detail, how does this impact your ability to make a determination about the airworthiness of the aircraft?

1	2	3	4	5
not at all		somewhat		completely

18. How does the information provided by maintenance in any recent signoffs influence the time you spend preflighting the aircraft?

1	2	3	4	5
not at all		somewhat		completely

19. In general, how would you rate the quality of communication between pilots and mechanics at your airline?

1	2	3	4	5
poor		average		excellent

20. What impact does a flight crew's knowledge and understanding of the systems involved in a fault or malfunction have on the information they provide in a write-up?

1	2	3	4	5
no impact		some impact		significant impact

GO ON TO NEXT ⇨

21. How much time, on average, would you say you spend entering (whether on paper, electronically, or both) a single discrepancy in the aircraft logbook? (check one):

Less than 5 minutes ____

5-10 minutes ____

10-15 minutes ____

more than 15 minutes ____

22. What is the typical turn time you encounter during peak schedule times? (Please check one):

Less than 15 minutes _____

15-30 minutes _____

30-45 minutes _____

45-60 minutes _____

more than 60 minutes _____

23. How were you trained to write up squawks in the logbook? (check all that apply):

Formal course/ground school ____
Formal on the job training ____
Picked up on your own over the course of your training/work ____

24. In the maintenance signoff of a discrepancy, how helpful are the following pieces of information to you in determining how the problem was resolved? Please rank these items from 1 to 5 in order of their helpfulness (i.e., 1=most helpful item, 2= next most helpful item, etc). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Root cause (e.g., electrical system, etc.)	_____
Parts changed/replaced	_____
Parts repaired	_____
Components involved or affected	_____
Ability of maintenance to replicate problem	_____
Other (please specify)_____	_____

GO ON TO NEXT ⇨

25. In a pilot write-up of a discrepancy, which of the following pieces of information do you feel are most helpful to maintenance in troubleshooting and/or repairing the problem? Please choose the **five (5)** most helpful items and rank them in order of their helpfulness (i.e., 1= most helpful item, 2= next most helpful item, etc). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Phase of flight at which the fault/malfunction occurred	_____
Altitude at which the fault/malfunction occurred	_____
Airspeed at which the fault/malfunction occurred	_____
Action that preceded the fault/malfunction	_____
Any troubleshooting actions taken by pilots (use of QRH, etc.)	_____
Whether the pilots were able to reset system/component	_____
ATA code of system involved	_____
Whether or not fault was intermittent	_____
Whether or not problem self-corrected (without pilot input)	_____
Other (please specify)_____	_____

26. When writing up a discrepancy in the logbook, whom do you feel you are primarily making the write-up for? Please rank items in order of priority (i.e., 1= the group you most intend the write-up for, etc.) Please use each rank only once. Please indicate each item's rank in the blank space provided.

Item:	**Rank:**
Maintenance	____
Company	____
FAA	____
Other pilots	____
Other (please specify)_____	____

27. Which factors influence the **amount** of information you include in a logbook write-up of a discrepancy? Please choose the **five (5)** most influential items and rank them in order of their influence (i.e., 1= most influential factor, 2= second most influential factor, etc.). Please use each rank only once. Indicate each item's rank on the blank space provided.

Item:	**Rank:**
Time	____
Amount of space provided in which to write up problem	____
Company policy	____
Accepted norms/practices at your carrier	____
Nature of the problem involved	____
Possibility logbook could be read by FAA or other authority	____
Whether the discrepancy is new or repeat item	____
Impact of the item on airworthiness/flight safety	____
Time or cost involved in repairing the item	____
The current need for a/c on the line	____
Fatigue	____
Culpability	____
Input from maintenance control	____
Other (specify) _____	____

GO ON TO NEXT ⇨

28. Does your company have a clearly stated policy that provides specific instruction regarding the level of detail to be included in a logbook write-up? Y N

29. Is there a preferred practice or accepted standard among pilots at your airline regarding the information to be included in a write up? Y N

30. Does your carrier have a policy or procedure that allows you to follow up with maintenance on an unclear signoff to get more information? Y N

    Have you ever used this procedure/policy? Y N

    Why or why not?

31. Do you feel increased knowledge of aircraft systems would enable flight crews to provide more detailed information about discrepancies? Y N

    Why or why not?

32. Are there certain discrepancies that, even with the availability of fault reporting codes, you feel cannot be fully communicated in writing between flight and maintenance and are most clearly communicated verbally? Y N

    Can you provide an example from your own experience?

33. If the technology were perfected and implemented throughout the fleet that would tell maintenance every fault or malfunction experienced by the flight crew in the course of a flight, would you still want to provide a description of those events to maintenance? Y N

    Why or why not?

34. If you have any additional comments about any items in this survey, or would like to mention any issues with logbook write-ups or signoffs that were not covered in this survey, please feel free to do so here (you may continue on the back if necessary):

Thank you for your participation!

Appendix C

Cover Letter

San José State
UNIVERSITY

College of Social Sciences
Department of Psychology
One Washington Square
San José, CA 95192-0120
Voice: 408-924-5600
Fax: 408-924-5605
E-mail: psych@email.sjsu.edu

Dear Crewmember:

I am a graduate student working at NASA Ames Research Center and would appreciate your help with a study on communication between flight crews and maintenance crews. Your professional experience is invaluable in helping us understand how this process works and how it might be improved in the future.

Attached is a questionnaire asking about your experiences regarding the reporting of non-routine discrepancies in daily line operations. This questionnaire typically requires only 10-15 minutes of your time and your feedback will provide us with unique and meaningful data for recommending training and operations standards for the industry.

You should know that your participation is voluntary and that if you choose not to participate in this study, or any part of this study, it will not affect your relationship with the airline that employs you, your union, NASA, or San Jose State University, nor will you lose any services to which you are entitled. All information provided by you will remain anonymous. *We do not ask for nor should you include any personal information with your responses* (this includes your name, your airline, your location, employee number, etc.). Final results of this study may be published but no information that could identify you will be included in any publications. Final results will also be available to you upon request.

There are no foreseeable risks or direct benefits to you in participating in this survey; however, your knowledge and experience has the potential to benefit the industry by influencing future training and operating guidelines.

If you have any further questions about this study, I would be more than happy to talk to you. I can be reached at NASA Ames Research Center, (650) 604-3079, or you may contact Dr. Kevin Jordan at (650) 604-6018. If you should have any questions about research subjects' rights, or complaints about your participation, please contact Dr. Nabil Ibrahim, Associate Vice President for Graduate Studies, San Jose State University, at (408) 924-2480. Please keep this cover sheet for your records.

Thank you for your time and effort in completing this questionnaire. It is genuinely appreciated!

Pamela Munro
Principal Investigator

Barbara Kanki, Ph.D.
NASA Ames Research Center

Appendix D

Human Subjects Approval Form

San José State
UNIVERSITY

Office of the Academic Vice President
Associate Vice President Graduate Studies and Research
One Washington Square
San José, CA 95192-0025
Voice: 408-283-7500
Fax: 408-924-2477
E-mail: gstudies@wahoo.sjsu.edu
http://www.sjsu.edu

To: Pam Munro
NASA Ames Research Center
M/S 262-4
Moffett Field, CA 94035

From: Nabil Ibrahim,
AVP, Graduate Studies & Research

Date: August 28, 2002

The Human Subjects-Institutional Review Board has approved your request for exemption from human subject's review under category "B" in the study entitled:

"Issues in the Communication of Non-Routine Discrepancies Between Airline Flight and Maintenance Crews Using the Aircraft Logbook."

This approval is contingent upon the subjects participating in your research project or the subject's data collected for the research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project and concerning all data that may be collected from the subjects. The Board's approval includes continued monitoring of your research to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must immediately notify Nabil Ibrahim, Ph.D. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted. This approval is granted for a one-year period and data collection beyond August 28, 2003 requires an extension request.

If you have any questions, please contact me at (408) 924-2480.