Chapter 6
Human Factors Program Development and Implementation

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6.0 Study Background

This project was initiated to provide a practical demonstration of human factors/ergonomics implementation in an airline maintenance organization and, hence, to give airlines guidance on implementing their own programs. Ergonomics, and its American synonym Human Factors, is "the science that facilitates maximum human productivity, consistent quality, and long-term worker health and safety" (Burke, 1992). Human factors measures the job demands imposed by the workplace, environment, and schedule. It then compares these with the workforce's capabilities to meet these demands consistently. Where task demands exceed human capabilities, performance will break down, leading to human errors, which can manifest as safety-compromising incidents and/or on-the-job injuries. A better (safer) match between task demands and human capabilities can be achieved by changing the task demands (workplace, environment, organization design), by changing human capabilities (training, placement), or by both. Whether the organization's initial motivation for the human factors program is public safety, improved productivity, or reduced injuries, the analysis is the same. Indeed, the same analysis can be used to specify system interventions, e.g., workplace changes, or personnel interventions, e.g., training.

The motivation behind the current project arose specifically from human factors analyses conducted in 1993 on restrictive spaces in aircraft inspection tasks (see Reynolds and Drury, 1993). As part of that project, on-the-job injuries (OJIs) analyzed were found to be space-related. Hence, when we sought a site for demonstrating human factors/ergonomics intervention, it was natural to choose inspectors and to consider OJI reduction, as well as performance improvements, i.e., error reduction.

6.1 Human Factors Task Force Formation

The human factors program at Northwest Airlines was created with the mission "to redesign work environments to prevent on-the-job injuries." The program was initiated by the formation of the Human Factors Task Force made up of members of both management and the hangar workforce. The job titles of task force members included Safety Manager, IAM Safety Representative, Inspector, Lead Inspector, and Northwest Airlines Process Specialist (Training Department). Representatives from the University at Buffalo were assigned to act as task force advisors. The initial focus of the program was the inspection department at the Atlanta Maintenance Base.

The inclusion of inspectors on this task force was critical to its potential for success. Inspectors have unparalleled expertise in their jobs and domain knowledge that leads to an understanding of what changes are most necessary and to what solutions may or may not work. Inspectors on the task force were encouraged to communicate with other inspectors and to act as spokespeople for their entire crew. Typically, inclusion of work force representatives in analysis and redesign of their own jobs makes them more inclined to accept ergonomic solutions task force implements. This is because they actively contributed to the solution-development process.

6.1.1 Task Force Objectives and Guidelines

Burke (1992) emphasizes the benefits that can be obtained when a human factors task force addresses human factors issues within an organization. A team approach gives the organization maximum input from various people who will be affected by any changes. For a task group to be successful, its members must be comfortable working together and must fully understand the importance of their commitment and contribution to the task force. In recent years, Northwest Airlines has emphasized team activities. There are well-established procedures for teams to form, gain confidence, organize their activities, and implement their findings.

The initial objectives of the Northwest Airlines Human Factors Task Force were as follows:

1. Develop a process for identifying and addressing ergonomics issues within the inspection department that could later be expanded to all Northwest Airlines departments

2. Involve employees in the ergonomics process

3. Reduce the number of OJIs

4. Develop ergonomic solutions that could be implemented, with results that could be measured

5. Teach employees about ergonomics, so they could help widen the task force's focus

6. Commit to transfer the technology and the processes this task force used to other areas at Northwest Airlines.

The task force's guidelines were as follows:

1. Focus on inspection jobs and tasks in the hangar area

2. Identify the jobs and tasks to analyze

3. Establish an action plan to effect short- and long-term improvements

4. Members should commit to a one-year participation in the task force

5. The group leader to be elected by the entire task force

6. A task force member may work on this project up to 100% of his or her time

7. After its initial start-up meetings, the task force will establish its own agenda

8. The group leader will communicate a weekly report to all task force members.

6.1.2 Program Development

The steps that the Northwest Airlines Human Factors Task Force took closely followed the seven general steps in an ergonomic process, as described by Burke (1992).

1. Determine the measurement criteria and target the jobs to be studied.
   - Determine which areas should be targeted for analysis and intervention.
   - Choose the specific criteria which will help determine target areas, e.g., injury rate.
2. Gather job background information.
   - Document the job to be analyzed, including the job description, the tools necessary to perform the job, physical dimensions of the workspace, etc.
3. Identify ergonomic risk factors.
   - Identify conditions likely to act as barriers to optimal productivity and consistent quality and/or that have been associated with a high incidence of injuries.
4. Discover ergonomic interventions.
   - Brainstorm about all possible interventions to each risk factor, considering the following:

     - changing inputs/materials
     - changing output/product
     - changing machine/environment
     - changing procedures dealing with workers, e.g., training.
5. Screen interventions.
   - Choose interventions to implement based on decision criteria such as cost, benefits, utility, consequences of no action, injury rate, etc.
6. Implement interventions.
   - Orient those affected about why the intervention was chosen, what its expected impact is, and who to contact with questions/comments/concerns.
7. Track the effectiveness of the interventions.
   - Assess each intervention's effectiveness and decide whether to expand, amend, alter, or abandon the particular intervention.

Once the human factors task force was selected, it was necessary to educate its members about what human factors is and how human factors can be used to improve the workplace. The University at Buffalo conducted a one-day training seminar, using materials developed from previous FAA/AAM projects and ICAO's SHEL model of human factors. The training specifically built on the University at Buffalo's previous involvement with Northwest Airlines' Atlanta Maintenance Base and its inspection activities.

The task force selected jobs to be analyzed in the first phase of the human factors program. The following jobs were identified by inspectors as five of the longest, most-difficult inspection tasks: Electrical and Equipment Compartment Inspection (E&E Compartment), Keel Inspection, Fuel Tank Inspection, Combustion Chamber Inspection (PS4 Drain Box), and Nose and Forward Accessory Compartment Inspection (Forward Access Compartment).

Four of the jobs were analyzed using the electronic inspection audit program the University at Buffalo developed (see Koli and Drury, 1995). Inspectors on the task force conducted the audits. The audit results for the keel inspection are provided in Appendix 6-A as an example of their work. To progress from analysis to redesign for each of these audits, a list of ergonomic risk factors was identified. A few risk factors from all four tasks were combined into problems with workcards and problems with lighting. The list of ergonomic risk factors for each area is included in Appendix 6-B. The nominal group technique was utilized to rank each risk factor for each of the six main areas, for four specific tasks (E&E compartment, forward accessory compartment, keel, and PS4 Drain Box), and for two general areas (workcards and lighting).

As follows, the three risk factors with the highest rankings were chosen for closer study in each of the six areas:

- Workcards
    - Card content inaccurate
    - Breaks between cards inappropriate
    - Card contrast varied
- Lighting
    - Fixtures dirty
    - Lighting inadequate at the back of the hangar
    - No preventive maintenance program for lighting
- Keel Inspection
    - Body positioning
    - Cleaning
    - Lighting
- PS4 Drain Box Inspection
    - Body positioning
    - NDT equipment
    - Cleaning
- E&E Compartment Inspection
    - Lighting
    - Temperature
    - Equipment
- Forward Access Compartment Inspection
    - Ladder design
    - Ladder control
    - Work planning

From this list, task force members took responsibility for pursuing specific potential solutions in the following areas:

- Improved cleaning
- Ladder purchase and control
- Workcard design
- Improved task lighting.

An action plan provided a time line for these activities that ensured analysis, implementation, and measurement of results within the time frame of this FAA/AAM project.

6.1.3 Redirection of the Ergonomics Task Force

Initially, the Task Force followed-up on members' assignments to track progress according to the action plan. However, it became apparent that the Task Force as a whole was not progressing on developing solutions, as agreed. The researchers met with the task force and management to learn the reasons for the lack of progress and to help develop alternative strategies.

A number of factors that had not prevented progress in team formation, job analysis, and solution generation surfaced when it was time for implementation.

1. The workforce members of the task force felt that they had no mandate to pursue their assignments as part of their busy schedules.

2. Some of the solutions had, or appeared to have had, implications beyond the Task Force's control. For example, workcard design is a headquarters function, not easily controlled or changed at a remote base.

3. Other solutions required expenditure, e.g., task lighting, which was not immediately seen as available in the current fiscal climate.

4. Perhaps most importantly, although task force members were opinion leaders within their groups, and a senior management person acted as "champion" of the effort, neither management nor the workforce felt a groundswell of support for the Task Force's activities.

For these reasons, the task force was disbanded, and the ergonomics efforts were refocused on a different problem that could have broad-based support *and* be entirely under control at the maintenance base. Specifically, many task force members recognized communication between shifts as one area in need of improvement. Also, communication between shifts needed no 'outside' assistance to implement a solution. Instead of having task force members implement the ergonomics audit program, which worked very well to identify human factors problems, a broad-based instrument was designed to obtain input about communication issues from inspectors on all three shifts. We reasoned that such input would produce buy-in to potential solutions, thus easing implementation. Of course, broader participation meant that expectations would be raised for more people, forcing at least some implementation if management/workforce trust was to be preserved. Fortunately, improving communication of technical information between participants has a good history in human factors generally, and in aircraft maintenance specifically (see Taylor, 1992).

6.2 Communications at the Atlanta Maintenance Base

As in any industry, effective communication within an organizational unit, and among organizational units, is critical for maintaining productivity in airline inspection and maintenance. Taylor (1992) writes, "Effective communication is no longer limited to merely acquiring the information that an individual needs to make decisions. Communication is increasingly a systems issue-it is inextricably bound to cooperation, coordination, and otherwise working together in a joint task or job for which individuals cannot succeed by working separately." Airline inspectors often help drive the heavy maintenance of aircraft. They are the first to look over an aircraft and have the task of identifying all the problems with it. Inspectors decide which problems maintenance must fix before an aircraft can leave the hangar, as well as which problems can be delayed until the next maintenance check. After the maintenance work is performed, inspectors must ensure that it was done properly. An aircraft cannot leave the hangar until all work is signed off by the appropriate authority, usually the inspectors. An inspector must be able to share information with management and other employees so that everyone understands an aircraft's current status. At Northwest Airlines' Atlanta Maintenance Base, for example, an inspector may find it necessary to communicate with the following people:

- other inspectors on the same shift
- inspectors on the two other shifts
- mechanics
- the lead inspector
- the inspection manager
- the maintenance manager
- engineers
- other management
- the flight crew.

The inspector must have the communication tools and skills to share information with other members of the organization, as necessary. Although communication is an important aspect of aircraft maintenance, it fails at times. To understand possible failure modes, a national source of error data (Aviation Safety Reporting System, or ASRS) was analyzed specifically to identify communication errors in the maintenance environment.

6.2.1 Typical Airline Industry Communication Problems (ASRS Reports)

Fortunately, human errors in aircraft maintenance are rare. Since errors are unlikely to be observed during a study such as ours, possible errors must be inferred from other sources. A review of NASA's ASRS mechanic reports identified that serious consequences can occur when inspectors and mechanics are unable to communicate efficiently with their co-workers. It is important to remember that ASRS reports are reported by individuals on a voluntary basis. In many cases, the reports have not been corroborated by the FAA or NTSB, and the data cannot be used to infer the prevalence of a particular problem within the national aviation system. The incidents discussed here occurred over many years (January, 1987-February, 1994) at many airlines. They are **not** Northwest Airlines incidents.

Some common communication problems present themselves upon a close review of the ASRS reports. First, many incidents are caused by mechanics becoming distracted in the middle of performing a task. Mechanics often do not write down what they have accomplished, or what parts of a task need to be completed. At times, a mechanic may have to allow someone else to finish a task. This may lead to difficulties when the second mechanic does not clearly understand the situation or does not realize specifically what remains to be done. Other times, a mechanic intends to come back and finish a task but forgets that the task was not completed. This could lead to serious problems if the uncompleted task is not detected before the plane takes off. This type of problem may also occur at shift changes, when mechanics cannot finish a task before their shift ends. The next shift assigned to finish the work may not clearly understand where the previous shift left off. This may result in duplication of effort on some tasks or, more seriously, the omission of some tasks completely, e.g., the second shift assumes that the previous shift has performed a certain task and does not verify this to be the case.

I was assigned to aircraft work release items....I was in the process of reinstalling the plug and covers for the turbine section when another mechanic asked if I needed any help. I asked him if he would install the ignitors. I saw him install the outboard ignitor. Then he went under the engine to what I thought was to install the inboard ignitor. While he was under the engine, I saw him install the screen back on the starter, but I did not go back and check his work, because I trust the work he does. I am the one who signed off the block on the paperwork....The inboard ignitor was never installed. (ACN #250135)

Another mechanic was assigned the open and close of the engine. He opened all plug panels and ignitors. I stopped to help him close the engine. I installed the outboard ignitor and installed the starter air deflector, only per maintenance manual 72. The inboard ignitor was never installed. I did not know [if] the inboard ignitor was left out, or [was even] out at all. (ACN #250330)

Another problem, somewhat related to the problem described above, is that generally one mechanic must sign off on the completion of a task, although more than one person may have actually worked on the task. Thus, it is difficult to pinpoint who actually completed the work when a problem arises. The mechanics who assisted may later forget, or deny, that they participated in completing the task in question.

Oil was serviced to full by another mechanic. However, he was reassigned to another aircraft before completing the log entry. At departure time, I completed [the] maintenance sign off in [the] logbook. The oil tank cap apparently was not latched in the closed position. (ACN #245568)

Maintenance inspected [the] aircraft and found all six securing screws missing from left-hand most outboard wing trailing edge panel....Further investigation shows several individuals were involved in the close-up of the aircraft at completion of the check, but no one person assumes responsibility or full knowledge of this one particular panel. However, there is a signature of a supervisor who specifically signed stating, "All panels were secured." (ACN #101899)

A third problem occurs when mechanics are given incorrect verbal descriptions of discrepancies or descriptions varying from the written description in the log book. Similarly, a mechanic can be assigned to perform a task without receiving all the correct paperwork which accompanies the task. This can lead to the mechanic making an incorrect diagnosis of the problem and, consequently, taking incorrect action to correct the problem. In some cases, inaccurate diagnosis led a mechanic incorrectly to defer maintenance that should have been completed immediately.

I was told [verbally] that the roll spoiler outboard ground caution light was illuminated. I sent an A&P down to check [it] out and defer the system. He was unable to duplicate any problem, but we, by phone conversation, decided to defer the system in case the pilots had a problem on the morning departure. [Later,] when reviewing the logbook, I discovered I had been given wrong information from maintenance control about which light had illuminated. The roll spoiler outboard hydraulic light was the light that actually was written up, and this would not be something you would defer. (ACN #243444)

These problems emphasize the importance of written communication in the airline industry. Verbal communication, although often more convenient, is more error-prone, especially when information must be remembered for long periods of time or must be passed sequentially through a number of people. The "telephone" game provides a good example of this problem: as information is passed from one person to another, the message tends to become increasingly confused. Written communication can serve as a permanent record of events and is less subject to the frailties of human memory. However, since written records may be used as an investigative tool to prove the actions a maintenance crew took, workers may feel, "It gives them something to hang you with!• There is understandable reluctance in all branches of the airline industry to write anything not specifically required to be committed to paper.

6.2.1.1 Summary of Communication Failures

Table 6.1 presents the types of communication failures contributing to the incidents reported in the ASRS database. The data in this table are representative only of the twenty-eight ASRS reports we analyzed.

Type of Failure:

Table 6.1 Communication Failures

Communicates To:

Originator	Mechanic 1	Mechanic 2	Inspector	Logbook	Flight Crew	Supervisor	Next Shift

Mechanic 1	F F F F F M M M M M	F V V V	W W W W	F F F V V	F V V
Inspector	W	F			
Flight Crew	V W W	W	V		
Supervisor	F V V V V V	V	W W	F V	

- F = failure to communicate
- V = verbal communication wrong/inadequate
- W = written communication wrong/inadequate
- M = memory failure (forgot to do something)

(*See Table 6.1*)

6.2.2 Identification of Communication Problems Within The Inspection Department

Table 6.1 shows that certain failure types are associated with different communication needs. While ASRS data is not a statistically valid random sample of errors, it can be used to identify forms of failure.

Obviously, a mechanic communicating with himself or herself at a later time can have a memory failure (M). When this happens, the mechanic usually relied on memory rather than a written note or a job aid, such as a checklist, that would have prevented memory failure. Mechanics communicating with flight crew are subject to failures of both written (W) and verbal communication (V). Communication problems in the opposite direction, i.e., from flight crew to maintenance, are either failures to communicate at all (F) or a breakdown of the written process (W). Perhaps this results from the widely different background training of Flight Operations and Technical Operations and the lack of opportunities for verbal communication between these groups. Clearly, methods of improving communications between these groups are needed, e.g., extensions of CRM and MRM to joint training.

Communication problems between mechanics, and between mechanics and supervisors, are all either failure to communicate at all (F) or a failure of verbal communication (V). This also includes shift change communication in the final column of Table 6.1. Clearly, written communication does not fail; if people use written communication, then this is adequate. The main emphasis for addressing these problems should be ensuring that mechanics and supervisors use written communication. Thus, the new focus of this project became redesigning communication forms so mechanics and supervisors can use them more easily.

Since communication is critical to the successful performance of airline inspectors, we decided to examine the communication system for inspectors currently in place at the Atlanta Maintenance Base to see if improvements could be made. We expected that an inspector's (or a mechanic's, or a supervisor's) effectiveness can be improved by providing better communication tools that make it easier to collect necessary information and to pass that information to other supervisors and mechanics.

After interviewing many inspectors, it was obvious that each inspector views the job (and the larger system) differently. The shift on which the inspector usually works (and thus the inspector's lead inspector), as well as years experience as an inspector, are just two factors that appear to affect each inspector's perceptions. Due to such wide variations among inspectors, we decided to question all inspectors to gain a broad view of the actual communication system in the inspection department. The user needs analysis was designed to identify tools currently supporting communication within the inspection department and between inspectors and other departments. The user needs analysis we used is included as Appendix 6-C. As a follow-up to the communication user needs analysis, we conducted further personal interviews with many inspectors. These interviews did not follow any pre-defined format; their purpose was simply to allow inspectors to talk about communication issues at Northwest Airlines and to provide background information to help interpret the user needs analysis responses.

A particular focus of the communication user needs analysis was the shift turnover log. Currently, the shift turnover log is a bound book with numbered pages. Entries are made in the log each day, usually by the lead inspectors. Information in the log includes personnel issues, e.g., who called in sick, who left early, who is working overtime, etc., and aircraft issues, which are usually only a quick summary of each aircraft's status, e.g., in buy-back, shakedown, etc. An entry occasionally includes a description of a problem an inspector encountered during the shift. It is difficult to identify who made an entry in the log, and few entries are ever followed-up with another entry describing how the problem was resolved. The existing shift turnover log does not serve as a communication tool, showing the tasks with multi-shift implications, nor does it provide the information necessary for subsequent shifts to "pick up" where a previous shift left off. Thus, our communication user needs analysis was designed to identify whether inspectors use the existing shift turnover log as a helpful source of information and/or whether a different type of log would better serve inspectors' needs.

6.2.3 Results from the Communication User Needs Analysis

We received 17 responses to our user needs analysis from the approximately 30 inspectors at the Maintenance Base. User needs analysis responses are summarized in Table 6.2.

User needs analysis responses identified a general problem with inspectors' job satisfaction. Many inspectors report having difficulty obtaining information they need to perform the job. They are unwilling to share information with others, unless it is absolutely necessary. This reluctance to communicate is a serious problem and must be addressed if inspection productivity is to be improved. The inspectors also identified shortcomings in the communication system at Northwest. Inspectors do not use the shift turnover log regularly, almost always need to search for more information after being assigned a job, have experienced on-the-job problems caused by miscommunication, and deal with each other almost always verbally. The shift turnover log is seen as a managerial tool, not as a way to communicate.

It is important to note that the average years of experience of inspectors responding to the user needs analysis is 6.6, with a standard deviation of 3.6. Previous studies have indicated that it is common in the aircraft industry to have mechanics with long service and with very short service, with very few in the middle (Taylor, 1990). At the Atlanta Maintenance Base, the less-experienced inspectors tended to return completed user needs analysis (over half had only 3-5 years experience); our results reflect their particular dissatisfaction with the current communication system. This result is not altogether unexpected. Experience as an inspector often means increased knowledge, information, and familiarity. Less-experienced inspectors may require more external information to perform a task (they cannot so easily rely on internal knowledge) than more experienced inspectors. Less-experienced inspectors also may be less able to respond to verbal instructions and information. Therefore, they may be less satisfied with, and more able to recognize problems in, current modes of communication. Experienced inspectors are accustomed to the way things are done and may be reluctant change. Our results may reflect a communication system designed to meet the needs of experienced inspectors, and of those with managerial responsibilities, while de-emphasizing the increased information demands of those with less experience.

User needs analysis responses also indicate that many inspectors perceive a lack of what is termed *situational awareness* in human factors; they do not understand how their specific tasks fit into the larger picture of airline maintenance. Inspectors may be unaware of what is happening beyond their own work assignments and of how their assignments affect (and are affected by) other departments. For example, jobs are often assigned to inspectors in what they perceive as a random manner, e.g., large jobs may be assigned only early in a shift, more difficult jobs may be delayed until easier ones are completed, etc. Many times, there seems to be little consideration of how job scheduling affects the maintenance department.

Table 6.2 Summary of User Needs Analysis Results

Question	Summary of Results
Number of Years Experience	average = 6.6 years median = 5 years
Sources of Information	lead inspector, manuals, managers (inspection, maintenance), engineering, other inspectors
Nature of Information Received	mostly verbal, some written
Destinations of Information	lead inspector, mechanics, other inspectors, managers (inspection, maintenance), anyone who asks
Nature of Passed Information	mostly verbal, some written
Is All Information Available	No - 11 (65%) Yes - 5 (29%) NA - 1 (6%)
Do You Read Shift Turnover Log? How Often?	No - 9 (53%) Yes, When Acting Lead - 5 (29%) Yes, (Almost) Every Day - 3 (18%)
Do You Write in Shift Turnover Log? How Often?	No - 9 (53%) Yes, When Acting Lead - 3 (18%) Yes, When A Problem Arises - 2 (11%) Yes, (Almost) Every Day - 3 (18%)
Purpose of Shift Turnover Log?	lead turnover information, personnel notes, status of aircraft, communication between shifts, written account of daily activities
Information to be Included in Shift Turnover Log?	more information about the aircraft status of long-term projects more cautions and warning important work in progress what tasks managers want done on a shift
Should STL Be On Sceptre, a Book, or Both?	Book Only - 11 (65%) Sceptre - 2 (12%) NA - 4 (23%)
Time Between Shifts, and Is It Sufficient?	Time Is Sufficient [5-20 min.] - 12 (70.5%) No Time Needed - 4 (23.5%) Time Is Sufficient, But Inefficiently Used - 1 (6%)

Attendance at Regular Crew Meetings? No - 7 (41%)
Yes - 8 (47%)
NA - 2 (12%)

Are Regular Crew Meetings Beneficial? No - 4 (23.5%)
Yes - 8 (47%)
Sometimes - 4 (23.5%)
NA - 1 (6%)

Problem Caused by Miscommunication? No - 3 (18%)
Yes - 10 (59%)
NA - 4 (23%)

6.2.4 Results From Personal Interviews with Inspectors

During site visits to the Atlanta Maintenance Base, we spoke personally with many inspectors about communication at Northwest Airlines. These conversations generally support the results from the user needs analysis, although they provide more insight into inspectors' specific communication needs. Some points inspectors made in these conversations include the following.

1. Inspectors acknowledge that they almost always communicate verbally with their lead inspector and with other Northwest employees. Most inspectors had never really considered the consequences if, at some later time, there was a problem with an inspection they conducted. Although workcards and non-routine cards provide a written account of the completed tasks, there is important, not legally required information that is never permanently recorded. Without written records, it is impossible to remember exactly what occurred and what steps had been taken. Even if an inspector did everything correctly, there would be no way to prove this in an investigation.

The following incident is taken from the ASRS database: this is **not** data collected at Northwest Airlines. It illustrates the potential danger in failing to maintain accurate written records of all maintenance activities.

A 'visiting' mechanic was assigned to repair an engine. While performing the work, he accidentally dropped a rag into the gearbox cavity. After searching, unsuccessfully, for the rag, the mechanic notified (verbally) the lead mechanic of the problem. The lead mechanic ordered a boroscope of the engine, which did not show that the rag was inside. Although the mechanic continued to say that the rag was still inside the engine, the lead mechanic ordered that the repair be completed so that the plane could be released for a flight. The mechanic was sent home before the leak check on the engine was completed. On its initial flight, the plane was forced to turn back to the originating airport due to a low oil pressure warning. The engine was removed for further repair. During the investigation, the rag was found to have clogged the scavenge pump filter screen. The mechanic was interviewed twice by airline quality assurance, and the incident was written up in a report submitted to the FAA. (ACN #233249)

From an analysis of this incident it is clear that: if the mechanic had made a written entry in the maintenance log concerning this incident, there would have been little question that his actions were totally appropriate. He could have recorded that he dropped the rag inside the engine and was unable to locate it. The lead mechanic was informed of the incident and eventually decided on his own that the rag was no longer inside the engine because his search had not located the rag.

Without the written log, it is difficult to determine the actual events surrounding this incident. The lead mechanic could insist that the mechanic was unsure if the rag actually was inside the engine or that he was never informed of the problem, especially since the mechanic signed off on the repair. Alternatively, if the problem had not manifest immediately, the mechanics involved in this incident may then have been unable to provide accurate information to the quality assurance people investigating the incident.

2. The weekday day shift and early part of the weekday afternoon shift currently have far better information resources available. During weekdays (Monday through Friday, 8:00 a.m. - 5:00 p.m.), each department in the organization is fully staffed. Management, engineers, planners, and the most experienced inspectors are all readily available for consultation. During the second half of the afternoon shift, on the night shift, and on weekends, it is difficult and time-consuming to get information from these resources. For example, an inspector on the weekend shift must call an engineer at home for consultation on a technical problem. The engineer, if he or she happens to be at home, generally first tries to solve the problem over the telephone or, if appropriate, to postpone addressing the problem until the next weekday shift. The engineer may be required to come into the hangar in an emergency, but this is generally the last resort.

3. Inspectors receive most of their information, including work assignments and any important items from the previous shift, from their shift lead. Therefore, they receive only information that the shift lead chooses or remembers to pass along. For example, an entry in the ASRS Database (ACN #196273) describes the following incident, which illustrates potential danger in filtering critical information through the lead inspectors.

Several mechanics noted [that the] #1 engine [was] making a loud unfamiliar noise. This information was passed on to the lead and supervisory personnel by second shift mechanics so as to alert third shift mechanics who were to work the aircraft that night and early morning. I, the third shift mechanic, was assigned to work this particular aircraft. However, I received no information concerning this particular loud engine noise until about ? am that morning, and then it was passed on to me by another mechanic, not [by] the lead man who assigned me to work on the aircraft. Based upon the information that was made available to me, a pilot write-up [of an] indication problem, [I] replaced [the] #1 engine tac indicator.... Had I been informed about the true condition of the engine, I would have treated the write-up quite differently.

4. Updates to maintenance manuals usually have a cover letter that each inspector must sign off. These documents are maintained in a notebook kept in the inspection office. Inspectors are expected to check the book daily and to read and sign off any new entries. This is easy when the workload is light and when there are few updates. However, when inspectors are busy or when there are a lot of updates, many inspectors fall behind. No supervisor or lead inspector ever seems to question inspectors about failing to keep current with the updates. An inspector may learn about updates only when they happen to relate to a particular problem he or she is addressing.

5. Inspectors receive much information, from updates and elsewhere, that they see as irrelevant to their current responsibilities. For example, they often receive service alerts for DC-10s and Boeing 727s; only DC-9 maintenance is performed at the Atlanta Maintenance Base. Inspectors feel overloaded with information and are concerned that they are not always able to filter out relevant DC-9 information.

6.2.5 Results from Conversations with Management

We also met with managers connected with the inspection department to discuss their perceptions of the communication system at Northwest Airlines. Many managers had never recognized that communication problems existed, although our user needs analysis results helped convince them that there was room for improvement. From discussion of the user needs analysis results, we made the following recommendations.

1. It is important to train inspectors how to communicate. Inspectors must learn what is expected, so they understand what information must be communicated and why it is important. Inspectors should be trained in both verbal and written communication skills. Training also helps standardize communication so every inspector is able to pass and receive useful information.

2. Inspectors must be challenged to understand the importance of good communication. They must understand benefits that are to be gained by improving communication. Any new communication procedures must not add to inspectors' workload or be at all difficult for them to use.

3. Communication tools must be developed for shift turnovers, for passing general information such as management memos and aircraft alerts, for recording detailed problems and follow-ups, as necessary, etc. The medium of communication, e.g., logbook, verbal, blackboard, etc., must be chosen that best meets different communication needs. It is important to provide only the information inspectors need and not to overload them with unnecessary information. Information should be presented in a form that is easy to use and that allows inspectors easily to elicit specific details, as necessary.

4. New communication tools must meet the needs and the expectations of all involved with the inspection department, including managers, leads, and inspectors. These individuals need to have input into redesigning the communication system.

5. At the Atlanta Maintenance Base, there are three distinct inspection groups: support shops, engine shops, and major maintenance. The communication system, especially the shift turnover log, should be standardized for all these groups. Such standardization would make it easier for inspectors to move among groups, effectively obtaining necessary information, and allowing better, more-effective cross-utilization of personnel.

6. The maintenance department holds a daily 8:00 a.m. production meeting; the inspection department is invited to attend this meeting. The information from this meeting should be used to help schedule tasks for the afternoon and night shifts. The day shift attendee at this meeting must relay information through a shift turnover log to the other shifts. It should become standard practice to use the shift turnover log to communicate such information.

6.3 Possible Solutions to Communications Problems

After we completed the broad-based user needs analysis of workers and management, we considered possible solutions for improved communication at the maintenance base.

6.3.1 Communication Tools

As discussed above, communication could be facilitated by implementing a new communication system. However, in choosing the most appropriate tool for improving communication, it is necessary to consider who is trying to communicate with whom and what is being communicated. The human factors principle of fitting the tools to the user applies here no less than in designing hand tools. It may be necessary to use different communication tools to satisfy different types of communication requirements; in fact, it is improbable that one communication tool could address all communication needs.

6.3.1.1 Available Communication Tools

A **formal written log**, e.g., the shift turnover log, is a permanent written record of activities within the inspection department. The document can serve legally as evidence for scheduling/staffing considerations and job control, and as a written account of problems inspectors encountered. A formal written log is usually bound so that pages and the information on them cannot be removed.

Informal written notes can substitute for the current reliance on memory and verbal communication. Inspectors may forget to pass on information to the lead inspector or to inspectors on the next shift. Writing down information relieves the inspector of relying on memory for the transfer of information. Informal notes can be addressed to an individual or to an entire crew.

Tape recorders can replace informal written notes (discussed above). Many inspectors do not like to write down information because the process of doing so is cumbersome and time-consuming. Allowing each inspector to make personal notes and notes to others on a tape recorder eliminates the need for written notes. The tape can then be transcribed into a written log and/or passed to the oncoming shift for the next inspector. This allows an inspector to replay verbal information during a shift. Tape recorders are best suited for recording information for self-reminding or for another individual in a closely related occupation.

Computer software tools can be developed to meet inspectors' communication needs. Tools such as electronic mail, electronic bulletin boards, electronic turnover logs, electronic databases, etc., can transfer information among people. A computer tool allows more than one person to access information simultaneously; this is not feasible with a formal written log since there is only one copy. Electronic tools provide flexibility in the presentation of information. For example, each inspector may request only information directly pertaining to the task at hand, and the inspector will not have to read irrelevant information (see comments in #5 of Section 6.2.4).

Blackboards/Whiteboards are quite useful for recording information that only needs to be used for a short time. Blackboards/Whiteboards should be utilized for communicating information to an entire crew since the information becomes general knowledge. Information could be left on the board for each of the three shifts to see and then be erased. It is important not to erase information that might be needed later, unless it is transcribed into a permanent written log. For example, inspector work assignments are generally written on a whiteboard during every shift. This board is erased at the end of every shift, and work assignments are not recorded. It is therefore difficult quickly to trace previous work assignments; one must research completed workcards to do so.

Formal crew meetings are useful for presenting information to all inspectors. Meetings permit two-way discussions about the information, as well as the opportunities for questions. Since the same information can be presented to all three shifts, this ensures that all inspectors receive the same information. However, crew meetings are often ineffective in meeting inspectors' communication needs. Inspectors often ask questions at these meetings that are never answered, and the meetings can turn into gripe sessions.

Although **informal verbal communication** is used in many information exchanges, it is not well-suited for many tasks. Verbal communication is short-lived. If the person receiving verbal information forgets something, it is very difficult for his or her memory to be refreshed. An inspector could be in the position of having to call an off-duty inspector at home to have information repeated. On the other hand, an inspector may refer to a written record of information as many times as necessary. Thus, written communication is less demanding on an inspector's memory. In addition, relying on memory for recording information is ineffective if the information needs to be kept for a long time. For example, an inspector who discovers and resolves a particular problem on an aircraft may not recall details of what occurred five months later, when the FAA is questioning him or her about a critical incident with that aircraft. Generally, verbal communication to more than one individual is difficult because it is nearly impossible to relay verbally exactly the same information, in exactly the same manner, more than once.

Inspectors use **non-routine workcards** (NR W/Cs) to identify areas on an aircraft that require maintenance. The workcards are a formal recording procedure that allows inspectors to communicate their findings to the mechanics who will perform the needed repairs. Each non-routine workcard is then bought back to the inspector, who rereads the original write-up to ensure that the work is completed as specified.

Table 6.3 illustrates how various tools can be used to meet communication needs between various inspection and maintenance personnel.

As ASRS report analysis indicates, the issue in choosing an appropriate communication tool is one of ensuring ease of use so that necessary communication occurs. Table 6.3 shows a matrix of which tools can be useful for which tasks. For example, a small tape recorder, such as a micro-cassette dictating machine, provides easy and rapid memory augmentation. In some organizations, inspectors have such a device taped to their flashlight so as to have it instantly accessible. This is an example of improving ease of use and, hence, of decreasing the probability of missed communication.

Another example is a board which can be used for rapid communication with many people. Although Table 6.3 indicates that a board can be used by leads and managers, it can also serve as a source of situational awareness when it carries notes from inspectors or mechanics. Again, the primary function of this tool is to promote ease of use.

Table 6.3 Communication Tools Matrix

	log	**notes**	**recorders**	**computer tools**	**blackboard/ whiteboard**	**meetings**	**verbal**	**N-R W/Cs**
inspector to self	*	*	*	*				
inspector to inspector (same shift)	*	*	*	*		*	*	*
inspector to inspector (other shift)	*		*	*			*	*
inspector to mechanic (same shift)	*	*		*		*	*	*
inspector to mechanic (other shift)	*			*		*	*	*
inspector to lead inspector (same shift)	*	*	*	*		*	*	
inspector to lead inspector (other shift)	*	*	*	*			*	

inspector to manager	* * * *
lead inspector to lead inspector (other shift)	* * * * *
lead inspector to inspector (same shift)	* * * * *
lead inspector to inspector (other shift)	* * * * *
lead inspector. to crew (same shift)	* * * * *
lead inspector to crew (other shift)	* * * * *
lead inspector to manager	* * * * *
manager to lead inspector	* * * * *
manager to inspector	* * * *
manager to crew (all shifts)	* * * * *
mechanic to lead inspector	* * * *
mechanic to inspector	* * * *

As Table 6.3 shows, computer systems are available to facilitate almost any activity, but their ease of use is not always appropriate for the demands of communication. If people need to be trained and then must later remember how to access the tool, or how to direct a notice, then the tool's frequency of use will drop. Fortunately, advances in human-computer interaction (HCI) have improved interface design, particularly for infrequent users.

The other major cluster of tool use is in handwritten logs. The shift turnover log is the basis for human factors intervention in this project.

6.3.2 Proposed Shift Turnover Log

The proposed shift turnover log was designed to improve communication among inspectors from different shifts. The present shift turnover log is used mainly by the lead inspectors and does not contain much information that inspectors can utilize. It does not record activities that took place during a shift or help the next shift know what they need to accomplish.

The proposed shift turnover log is intended for use by all inspectors. It allows an inspector to record activities during a shift, leaving a written account of what needs to be accomplished and helping prevent rework. Rework in inspection, i.e., more than one inspection of the same area, is often caused by miscommunication between two inspectors. This is especially true when an inspection is carried over from one shift to the next, and the second inspector does not understand where to start and stop the inspection. In this situation, an inspector typically does "a bit more" so there is no doubt the workcard was covered.

6.3.2.1 First Draft General Information: Proposed Shift Turnover Log

This proposed shift turnover log (Figure 6.1) will allow inspectors easily to obtain necessary information about an aircraft to which they are assigned. This log is organized into five separate, bound books. Each book has sequentially numbered pages to prevent any pages from being removed.

The first book is the general shift turnover log. It can be used, as the current log is used, to pass information between shift leads.

Information included in this log includes any personnel information such as assigned overtime, call-ins, and field-trips, as well as any general problems. The shift lead inspector should complete this log for the following shift.

The other four logs correspond to the hangar bays (Figure 6.2). Each book, including the pages, is color-coded to match the bay color. The book should contain enough pages for it to be used during the estimated duration of the aircraft's stay in the hangar: three pages for each day, plus a few extra. A new book can be started for each new aircraft; therefore, each book contains the complete inspection history for one aircraft. The log can be filed when the aircraft leaves the hangar. Inspectors assigned to a particular aircraft should complete this log.

The specifications and instructions for the proposed shift turnover log are included as Appendix 6-D.

Figure 6.1 Inspection Shift Turnover Log (First Draft)

General Shift Information

Date: **To Be Read By:** **Morning** **Afternoon** **Night** **Shift**

Lead Inspector: **Manager:**

Filled In By:

Personnel Information

Call-Ins

Name	Reason	Time

Overtime

Name	Reason	Number of Hours

Field Trips

Name	Destination	Departure Time	Return Time

Special Instructions/General Problems

Problem	Needed Action/Alert	Resolution	Date	Time

Figure 6.2 Inspection Log: Blue Bay (First Draft)

Aircraft number: **Day:** **Shift (Please circle):** **Morning** **Afternoon** **Night**

Inspectors Assigned:

Aircraft Status (Please Circle): **Line** **Initial Shakedown** **Inspection** **Buyback**

General Information/Notes:

Long Term Projects

Project	Status	Needed Action/Alert	Inspector

Other Projects/Problems

Insp.	Project/Problem	Needed Action/Alert	Resolution	Date	Time

6.3.2.2 Evaluation of First Draft

A sample of the inspectors was asked to evaluate the proposed shift turnover log. Responses of the seventeen inspectors are summarized in Table 6.4.

Table 6.4 Evaluation of Proposed Shift Turnover Log

User Needs Analysis Question	Average	Std. Deviation
How useful is a separate log (for lead inspectors) for personnel information and general problems? 0 - Of No Use 4 - Useful 8 - Extremely Useful	5.44	2.49
How useful is a separate log for each hangar bay? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.09	2.72
How useful is the practice of maintaining a separate log for each aircraft? 0 - Of No Use 4 - Useful 8 - Extremely Useful	3.88	2.5
Rate the ease of understanding of the proposed shift turnover log: 0 - Not At All Easy 4 - Easy 8 - Very Easy	4.53	2.18
Rate the usefulness of the information in the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.24	2.14
How often would you read all sections of the proposed turnover log? 0 - Never 4 - 3 times/week 8 - Every Shift	4.63	2.8

How often would you read the section of the log for the aircraft that you are assigned to? 6.33 2.54
0 - Never 4 - 3 times/week 8 - Every Shift

How often would you make an entry into the turnover log? 4.21 2.93
0 - Never 4 - 3 times/week 8 - Every Shift

Rate the amount of information in the general section of the proposed turnover log: 4.09 1.85
0 - Not Enough Info. 4 - Right Amt. of Info. 8 -Too Much Info.

Rate the amount of information in the aircraft section of the proposed turnover log: 4.29 1.99
0 - Not Enough Info. 4 - Right Amt. of Info. 8 - Too Much Info.

Rate the type of information in the general section of the proposed turnover log: 3.81 1.78
0 - Of No Use 4 - Useful 8 - Extremely Useful

Rate the type of information in the aircraft section of the proposed turnover log: 3.83 1.85
0 - Of No Use 4 - Useful 8 - Extremely Useful

How does the proposed turnover log compare to the current turnover log? 5.38 1.51
0 - Less Useful 4 - As Useful 8 - More Useful

How often would you use the proposed log, as compared to your use of the current log? 4.85 1.61
0 - Sig. Less 4 - About the Same 8 - Sig. More

How do you like the format of the general section of the proposed turnover log? 3.91 1.11
0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use

How do you like the format of the aircraft section of the proposed turnover log? 3.64 1.31
0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use

How useful is the current shift turnover log? 4.35 1.63
0 - Of No Use 4 - Useful 8 - Extremely Useful

How useful is the proposed shift turnover log? 4.64 1.38
0 - Of No Use 4 - Useful 8 - Extremely Useful

These results indicate that the proposed shift turnover log offers many improvements over the current version. A One-Sample Wilcoxon test was performed to determine whether the median response for each question was significantly different from the 0, mid-point(4), or end-point of the rating scale(8). After performing this analysis, we find that the inspectors felt that the use of a separate log for recording personnel issues and general problems was significantly better than useful (median = 5.65, p=.038). They also indicated that they would read the turnover log for the aircraft to which they were assigned more than three times per week (median = 7.0, p=.009). Inspectors also felt that the proposed turnover log was more useful than the current turnover log (median = 5.225, p=.002) and that they would use the proposed turnover log more often than they use the current turnover log (median = 4.5, p=.037).

Other trends in the data, although not statistically significant, are that the inspectors generally found the proposed log easy to understand and that both the general and the aircraft sections contain the right amount of information. Unfortunately, inspectors indicated that they would be likely to make an entry in the log only three times per week, not every day as the log would require. Comments from the user needs analysis indicated that many inspectors feel that maintaining the log is the lead inspector's duty. There are clear issues of culture, expectations, and training surrounding any change in the shift turnover log.

The inspectors indicated that the proposed shift turnover log does not meet their needs for information, as indicated by the less-than-useful ratings given to the type of information the log contains. They do not find the proposed shift turnover log's layout particularly easy to use. Finally, inspectors rated the usefulness of the proposed shift turnover log (Questions 17 and 18: mean 4.64 compared to 4.35) as only slightly higher than the usefulness of the current shift turnover log; a Mann-Whitney analysis indicates that this difference is not statistically significant.

6.3.3 Version 2 of the Shift Change Log

6.3.3.1 Design of Second Version of Shift Change Log

From these results, it appears that inspectors approve of the idea of developing a new format for the shift turnover log and will utilize an improved log, especially its sections pertaining to their specific work assignments. However, more work is necessary to find a layout that will meet inspectors' information needs.

After analyzing the results, we concluded that inspectors supported the idea of maintaining a separate log for each hangar bay; however, they were not satisfied with the information on or the format of the proposed log. More work was needed to design a log better meeting the inspectors' information needs. We decided to use a team approach for the next phase of shift turnover log design. We held meetings with each inspection shift to discuss how the log should be designed. Inspectors were encouraged to contribute to the process by indicating the information they would like to see included in the turnover log.

Unfortunately, of the 10 to 15 inspectors in each meeting, only a few provided input for redesigning the shift turnover log. Their overall suggestions were to simplify the proposed shift turnover log and to reduce the writing required to complete it. One inspector suggested that the log should include only a simple heading (aircraft number, date, shift) and a blank space for inspectors to write; this is basically the same as the current turnover log (it is not being utilized effectively).

Although user needs analysis results had indicated otherwise, most inspectors reacted negatively to the idea of a redesigned turnover log. Some of their opinions were the following: 1) inspectors would not use a redesigned log unless it was mandated by upper management; 2) separating the log by hangar bay would make the log too difficult for leads to use; 3) leads are the only ones who need a shift turnover log; 4) inspectors depend on leads to pass along information; and 5) it is not the inspectors' responsibility to pass information during a shift turnover. These comments were symptomatic of inspectors' general attitudes, implying that communication between shifts is not the most serious problem within the inspection department.

In addition, the shift schedule (7:00 a.m.-3:00 p.m., 3:00 p.m.-11:00 p.m., and 11:00 p.m.-7:00 a.m.) does not allow for overlap of oncoming and outgoing shifts. Many inspectors felt that a shift turnover log (either verbally or written) would require too much time and would place too many additional requirements on the inspectors. What the inspectors fail to realize is that this is the exact reason an effective shift turnover log is essential.

Inspectors also indicated that it is the lead inspector's responsibility to perform a shift turnover. The lead should extract the important information from each crew member and pass this information to the next shift. The oncoming lead is responsible for reading the information in the log and distributing it, as necessary. Although many inspectors indicated that they require information passed between shifts, they believe that someone else is responsible for providing this information.

Many inspectors indicated that they would find a log for the particular aircraft to which they were assigned helpful. This would allow them quickly to 'get a feel' for the aircraft's status. These inspectors also stated that it is most important for leads to understand what is happening, and the proposed shift turnover log should be designed for leads, not for other crew members. This is troubling; as one sees in the ASRS reports, it is critical for inspectors working on an aircraft to have a good understanding of the problems previous shifts encountered.

In addition, many inspectors have regular opportunities to serve as the lead for a shift, e.g., when the permanent lead takes a day off, and many inspectors eventually become permanent leads. Although inspectors do not feel responsible for knowing information in the turnover log, they are expected to have a full understanding of it when they act as lead for a shift. An effective turnover log could ensure that an acting lead inspector is quickly able to extract necessary information. If all inspectors regularly read the redesigned log, there will be less information to absorb when he or she becomes a temporary lead inspector.

There also seems to be a large mismatch between the inspectors' need for information and the effort they are willing to make to obtain it. On the original communications user needs analysis, inspectors indicated that they rarely if ever have enough information, that they often must search for information to perform their jobs, and that they would like information to be readily available. However, when inspectors were asked to provide more information about events occurring during their shift through the shift turnover log, most were extremely reluctant to do so. They felt that completing a written log at the end of each shift would be too time-consuming and difficult. Inspectors seem to want to receive information from the previous shifts, but not to provide information to the next shift.

Inspectors are reluctant to write down any information not specifically required. They feel that their signatures on workcards fulfill their legal record keeping requirements. They do not want to record additional information in a log which could be used against them in an investigation; they do not realize that information in a written log could protect them in an investigation. This is also part of a current national debate: can maintenance and inspection personnel be disciplined merely for providing information which could help the system?

Many inspectors seem unwilling to make an effort to improve the communication process. They are unhappy with how management treats them and, thus, have little motivation to improve the situation. Most simply want to perform their jobs and to take on as little responsibility as possible. Inspectors are distrustful of management and do not believe that management wants to aid the inspectors by trying to improve communication. During small group (or one-on-one) discussions, inspectors offered suggestions for improving internal communication in the inspection department. During the shift meetings few people were willing to discuss a need for improved communication. Even individual inspectors who want to improve their jobs do not want to appear sympathetic to management's needs or wants. Some inspectors had a hard time believing that management had not sent us. Sociotechnical problems between management and inspectors must be resolved before any proposed shift turnover log can meet information needs of both groups. As is true of many human factors issues in aircraft maintenance and inspection, searching for a consensus solution to a technical problem reveals broad social issues when it is time for implementation.

Based on input we received in evaluation meetings, we simplified the shift change log for its final version. We did this to address inspectors' (other than leads') unwillingness to provide shift information, although the changes somewhat reduce the information's utility to the reader. Figures 6.3 and 6.4 show the second draft of the shift change log.

Figure 6.3 Lead Inspector Shift Turnover (Second Draft)

General Shift Information

Date: To Be Read By: Morning Afternoon Night Shift

Lead Inspector: Manager:

Filled In By: on the Morning Afternoon Night Shift

Personnel Information

Call-Ins

Name Reason Time

Overtime		
Name	**Reason**	**Number of Hours**

Field Trips

Name	**Destination**	**Departure Time**	**Return Time**

Special Instructions/General Problems

Problem	**Needed Action/Alert**

Figure 6.4 Inspector Shift Turnover Log (Second Draft)

Aircraft Number: **Date:** **Shift (Please Circle):** **Day** **Afternoon** **Night**

Inspectors Assigned: **Projected A/C Departure Date:**

Problem Workcards

Card Number	**Problem**

General Problems

6.3.3.2 Evaluation of Version 2 of the Shift Change Log

We used the same evaluation form as in Section 6.3.2.2 to obtain feedback on Version 2 of the new shift change log. Nineteen inspectors evaluated the log shown in Figures 6.3 and 6.4. Table 6.5 summarizes these results in the same way Table 6.4 summarized those for the first version.

A One-Sample Wilcoxon test showed that inspectors still appreciated the idea of separating personnel information from aircraft information (median = 5.025, p = .011), that they found information in the proposed log more than useful (median = 4.95), p = .003), that they would read all sections of the log more than three times per week (median = 5.300, p = .036), that they would read the section of the log for the aircraft to which they were assigned almost every shift (median = 7.375, p = .001), and that they would make entries into the log more than three times per week (median = 6.00, p = .023).

Inspectors also thought that information in the log's general section is more than useful (median = 4.562, p = .015), and that information in the aircraft section is more than useful (median = 4.600, p = .012). They preferred the proposed to the current turnover log (median = 5.450, p = .001) and would use the proposed log more than they use the current log (median = 5.150, p = .005). Inspectors found the new format of both general and aircraft sections better than easy to use (median = 4.650, 4.738, p = .015, .016). Finally, they indicated that the proposed log is more than useful (median = 5.200, p = .002).

Table 6.5 Evaluation of Proposed Shift Turnover Log

User Needs Analysis Question	Average	Std. Deviation
How useful is a separate log (for lead inspectors) for personnel information and general problems? 0 - Of No Use 4 - Useful 8 - Extremely Useful	5.08	1.56
How useful is a separate log for each hangar bay? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.09	2.10
How useful is the practice of maintaining a separate log for each aircraft? 0 - Of No Use 4 - Useful 8 - Extremely Useful	3.50	2.27
Rate the ease of understanding of the proposed shift turnover log: 0 - Not At All Easy 4 - Easy 8 - Very Easy	4.70	1.69
Rate the usefulness of the information in the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	5.05	1.34
How often would you read all sections of the proposed turnover log? 0 - Never 4 - 3 times/week 8 - Every Shift	5.35	2.57
How often would you read the section of the log for the aircraft that you are assigned to? 0 - Never 4 - 3 times/week 8 - Every Shift	6.98	1.64

How often would you make an entry into the turnover log? 0 - Never 4 - 3 times/week 8 - Every Shift	5.96	2.19
Rate the amount of information in the general section of the proposed turnover log: 0 - Not Enough Info. 4 - Right Amt. of Info. 8 -Too Much Info.	4.16	1.01
Rate the amount of information in the aircraft section of the proposed turnover log: 0 - Not Enough Info. 4 - Right Amt. of Info. 8 - Too Much Info.	4.14	1.02
Rate the type of information in the general section of the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.77	1.25
Rate the type of information in the aircraft section of the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.83	1.29
How does the proposed turnover log compare to the current turnover log? 0 - Less Useful 4 - As Useful 8 - More Useful	5.48	1.42
How often would you use the proposed log, as compared to your use of the current log? 0 - Sig. Less 4 - About the Same 8 - Sig. More	5.20	1.51
How do you like the format of the general section of the proposed turnover log? 0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use	4.86	1.49
How do you like the format of the aircraft section of the proposed turnover log? 0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use	4.93	1.52
How useful is the current shift turnover log? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.12	1.69
How useful is the proposed shift turnover log? 0 - Of No Use 4 - Useful 8 - Extremely Useful	5.26	1.43

It is possible to use data in Tables 6.4 and 6.5 directly to compare the two versions of the shift change log. A two-sample turnover test was performed to compare results from the evaluations of the first and second drafts. Table 6.6 presents the results of this analysis.

These results indicate that inspectors rated the second draft significantly higher in both information content and format (at the $p < .01$ significance level). Since these were the first draft's main weaknesses, the second draft appears better able to meet inspectors' communication needs.

Although the result was not significant, inspectors felt that the second draft was more useful (mean = 5.26 versus 4.64 in first draft) and that they would be more likely to make frequent entries in the second draft (mean = 5.96 versus 4.21). These data support the findings that the second draft is better suited to inspectors' communication needs. We therefore proposed that this version become the base's standard shift change log.

6.3.4 Other Communication Solutions

During 1995, Northwest Airlines management will implement two programs to improve communication with its workforce. First, they will introduce a bulletin board for posting company news and announcements. Each shift will have its own copy of each announcement, and each inspector will sign off after reading each posting. This system is designed to ensure that all inspectors are aware of important company business.

Table 6.6 Comparison of First Draft and Second Draft

User Needs Analysis Question	1st Draft Mean	2nd Draft Mean	P Value
How useful is a separate log (for lead inspectors) for personnel information and general problems? 0 - Of No Use 4 - Useful 8 - Extremely Useful	5.44	5.08	0.61
How useful is a separate log for each hangar bay? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.09	4.09	1.0
How useful is the practice of maintaining a separate log for each aircraft? 0 - Of No Use 4 - Useful 8 - Extremely Useful	3.88	3.50	0.64
Rate the ease of understanding of the proposed shift turnover log: 0 - Not At All Easy 4 - Easy 8 - Very Easy	4.53	4.70	0.79
Rate the usefulness of the information in the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.24	5.05	0.19
How often would you read all sections of the proposed turnover log? 0 - Never 4 - 3 times/week 8 - Every Shift	4.63	5.35	0.43
How often would you read the section of the log for the aircraft that you are assigned to? 0 - Never 4 - 3 times/week 8 - Every Shift	6.33	6.98	0.40
How often would you make an entry into the turnover log? 0 - Never 4 - 3 times/week 8 - Every Shift	4.21	5.96	0.11
Rate the amount of information in the general section of the proposed turnover log: 0 - Not Enough Info. 4 - Right Amt. of Info. 8 -Too Much Info.	4.09	4.16	0.90
Rate the amount of information in the aircraft section of the proposed turnover log: 0 - Not Enough Info. 4 - Right Amt. of Info. 8 - Too Much Info.	4.29	4.14	0.79

Rate the type of information in the general section of the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	3.81	4.77	0.081
Rate the type of information in the aircraft section of the proposed turnover log: 0 - Of No Use 4 - Useful 8 - Extremely Useful	3.83	4.83	0.081
How does the proposed turnover log compare to the current turnover log? 0 - Less Useful 4 - As Useful 8 - More Useful	5.38	5.48	0.85
How often would you use the proposed log, as compared to your use of the current log? 0 - Sig. Less 4 - About the Same 8 - Sig. More	4.85	5.20	0.51
How do you like the format of the general section of the proposed turnover log? 0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use	3.91	4.86	0.038
How do you like the format of the aircraft section of the proposed turnover log? 0 - Not Easy To Use 4 - Easy To Use 8 - Very Easy To Use	3.64	4.93	0.011
How useful is the current shift turnover log? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.35	4.12	0.68
How useful is the proposed shift turnover log? 0 - Of No Use 4 - Useful 8 - Extremely Useful	4.64	5.26	0.19

Management will also schedule meetings with inspectors, and inspectors will determine the frequency of these meetings. These meetings will help management better understand each inspector's needs and concerns. Inspectors issues and concerns will be recorded on a form that includes to whom the issue is assigned and an expected resolution date. The form will be posted on the bulletin board so that everyone is aware of progress made toward resolving the issues.

Other possible solutions inspectors suggested include the following.

1. Allow each inspector to carry a small tape recorder throughout the day so that an inspector can record information, notes, and messages as events happen. The tapes can be passed to the inspector taking over on the next shift. This second inspector can listen to the previous inspector's notes as often as necessary. The tapes can be transcribed into the written log of daily activities for permanent record keeping.

2. Develop a shift turnover log in the form of a simple checklist, allowing inspectors quickly to complete the log with minimal writing. Eventually, a bar code system could allow even simpler completion.

3. Use one-on-one shift turnovers in which incoming inspectors walk around the hangar with outgoing inspectors to ensure that all necessary information is relayed.

4. Use a blackboard/whiteboard temporarily to record information that may be useful for all inspectors. Information often passes to inspectors through informal, impromptu meetings, often over a particular problem one inspector encountered. When absent, a particular inspector may never know that he or she missed hearing important information. When this problem is again encountered, it may be completely new to some inspectors, although others previously discussed and resolved it. Inspectors would find it helpful for this type of information to be written down so that they all may review it.

6.4 Guide to Airlines on Establishing Human Factors Program

One of the outcomes of this study was to be a guide for airlines on how to establish and implement their own human factors/ergonomics programs. The information on task force formation, training, and procedures was written as a guide in Chapter 2 of the FAA's *Human Factors Guide for Aviation Maintenance*.

That chapter presents the following seven-step process:

- Establish mission and structure
- Form human factors task force
- Train task force
- Analyze jobs
- Design solutions
- Reanalyze changes
- Transfer technology.

This material was presented and used as the basis for a workshop at the FAA/AAM Annual Human Factors in Maintenance meeting in Albuquerque, New Mexico, during November 1994. C. G. Drury summarized progress of the current project in a presentation entitled "Integrating Human Factors into Maintenance Program." Project results since that time (Sections 3 and 4 of this report) provide additional feasible structures for human factors implementation. A broader program with limited objectives, but wide involvement, may serve as a viable first project to gain visibility for human factors in a maintenance organization. Lessons learned from the communications/shift log study reported in Sections 3 and 4 are being incorporated into Chapter 2 of the *Guide* and will form the basis of a proposed new *Guide* chapter covering communications processes.

6.5 Conclusions

This project demonstrates that a human factors program in an airline maintenance environment succeeds only when it adapts to the maintenance base's specific environment. Our initial methodology of using a workforce/management team to target specific jobs did not produce successful implementations, despite its success in many other industries. Our airline partner's specific needs required a different approach based on involving the maximum number of people, instead of a small task force, and limiting the scope to one issue, i.e., communication, rather than searching broadly for ergonomic mismatches.

Focusing on communication brought potential solutions under direct control of employees at the site, while still demonstrating potential for improved human error rates. The use of outside data, in this case the ASRS reports, provided specific instances of human factors needs which could be related to local conditions and suggested practical improvements.

The specific choice of the shift turnover log showed how involvement of both human factors professionals and the inspection workforce can produce a practical refined job aid. The new log meets more communication needs than its predecessor and has good acceptance in the user community.

6.6 References

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Taylor, J. C. (1992). Communication Guidelines for Maintenance. Interim Report for the FAA Office of Aviation Medicine.

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Appendix 6-A

Ergonomic Audits of Inspection Tasks

TO: :John Lane

FROM: :John W. Ditty

Task Description: :Keel Inspection

Date: :4/27/94

Time: :10:00 a.m.

Station: :Atlanta

Hangar Bay: :RED

Aircraft No. :9153

M/E No. :

Q/A No. :

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN PRE-INSPECTION/ DOCUMENTATION

A. Information Readability

1. Dot matrix printers with a 5X7 matrix of dot characters is minimally acceptable for reading purposes. If used, check for character specifications:

Minimum Character Height = 3.1 mm to 4.2 mm

Maximum Character Height = 4.5 mm

Width/Height ratio = 3:4-4:5

IMP: Do not use lower case letters, since features can get easily confused.

2. Standards not prescribed. State "TIME" & "QUALITY" standards to ensure consistent print quality.

B. Information Content

Text

3. Feedforward information not provided to the inspector. Present information on

a: previous faults detected

b: locations of prior faults

c: likely fault-prone areas for the specific task & current aircraft under inspection.

C. Information Organization

4. Incorrect sequencing of tasks in the workcard. Tasks need to be sequenced in the natural order in which the task would be carried out by MOST inspectors.

5. Avoid carryover of tasks across pages at ILLOGICAL points. Tasks should begin and end on the same page. For longer tasks, break into several subtasks with multiple sign-offs. Each subtask should begin and end on the same page.

6. Excessive number of tasks per action statement. More than 3 actions/step increases the probability of action slips.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN PRE-INSPECTION/ COMMUNICATION

1. No ongoing program to maintain adequacy of communication channels.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN PRE-INSPECTION/ VISUAL CHARACTERISTICS

1. Fluorescent bulbs: "Fair" to "Good" color rendition properties. Color rendition is the ability to distinguish true colors correctly. This is especially useful in detecting corrosion faults. For best results, consider incandescent bulbs.

2. Flicker exists. Consider:

a. appropriate shielding of ends of fluorescent lamps

b. regular replacement of fluorescent lamps.

3. Lighting fixtures dirty. Keep lighting fixtures free/clean from dirt/paint.

4. No "Shades/shields" on illumination source. This may cause "direct" or "disability" glare.

5. Illumination sources not working. Consider regular replacement of light sources.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN PRE-INSPECTION/ ACCESS

ACCESS-STEP LADDERS

ACCESS - TALL STEP LADDERS

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/DOCUMENTATION-PHYSICAL HANDLING AND ENVIRONMENTAL FACTORS

1. Current light conditions inadequate for quick and easy reading of workcard.
2. The inspector does not sign-off workcard after each subtask. This may lead to errors of omission.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/TASK LIGHTING

1. The average task illumination is 152.50 fc. and the variance is 2318.75. The recommended task illumination should be 200.00 fc. The variance is exceptionally high.

2. Handlamps deliver a max. of 85 fc. of light. This illumination level is inadequate for "Fine Inspection." Handlamps also lack aiming control. Consider using of Standing Lamping (Halogen 500 watts-1200 fc.).

3. Consider headlamp for hands-free illumination: except in explosive environments, e.g., fuel tank inspection.

4. The portable/personal lighting equipment interferes with the inspection task.

5. The operator felt difficulty in handling with respect to the size of the lighting equipment.

6. The operator felt difficulty in handling with respect to the weight of the lighting equipment.

7. The operator experienced glare from the task surface. Consider:
   a. reducing glossiness of material
   b. screening of sunlight penetrations
   c. repositioning the light source
   d. use diffusing light sources, e.g., fluorescent lamps

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/THERMAL CHARACTERISTICS

1. The current DBT is 0.00 de.g., cent. The recommended temperature is between 20-26 degrees centigrade.

2. The current task has been identified as having HIGH physical workload. The DBT is 0.00 cent. and the clo value for clothing is 0.79 clo. The recommended DBT values for HIGH workload and clo values between 0.75-1.0 are 14-20 de.g., cent. Consider change in clothing.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/OPERATOR PERCEPTION OF THERMAL ENVIRONMENT.

1. The operator found the summer temp. at the workplace to be slightly warm.

2. Operator wanted the summer temp. at the workplace to be cooler than the current temp.

3. Operator is generally not satisfied with the temp. at workplace during summer.

4. The operator found the winter temp. at the workplace to be slightly cool.

5. Operator wanted the winter temp. at the workplace to be warmer than the current temp.

6. Operator is generally not satisfied with the temp. at workplace during winter.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/AUDITORY CHARACTERISTICS

1. The maximum sound level at this task is 105 dbA. Noise levels above 90 dbA indicate the need for management intervention and control.

2. This task involves verbal communication. The average noise level is 95.60 dbA. The distance of communication is 4.00 feet. The noise level for communication at a distance of 3.5-6.0 feet should not exceed 60 dbA.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/NON-DESTRUCTIVE TESTING

1. NDT equipment was not easily maneuverable during inspection.

Displays, Controls, and Knobs

2. The inspector experiences division of attention. Consider using two inspectors for the NDT inspection.

3. Visual checks are not highlighted by aural signals. Auditory signals help by providing redundancy gain.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/ACCESS-ACTIVITY

1. Inspection affected by parallel work, e.g., opening or closing of panels, cleaning other inspections, or repair. Also check for obstruction due to equipment, e.g., tool boxes, lighting equipment, access equipment, etc.

2. The operator felt that access was difficult.

3. The operator felt that access was dangerous.

4. Access equipment was repositioned too frequently. This consumes a lot of operator effort. Consider using multiple access equipment.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN INSPECTION/POSTURE

1. The operator felt that the workspace was constrained.

The following extreme postures were observed during the current inspection task: Urgent intervention is requested.

2. Arms in air, back bent, and loading on leg(s).

3. Arms in air, back bent and kneeling, or laying or crawling.

4. Arms in air, back twisted, and loading on leg(s).

5. Arms in air, back twisted, and kneeling or laying or crawling.

6. Back bent and twisted and loading on leg(s).

7. Back bent and twisted and kneeling, laying, or crawling.

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN PRE-INSPECTION/ SAFETY

1. The inspection area is not adequately cleaned for inspection. Consider appraisal of pre-inspection processes like "open-up" and "cleaning".

HUMAN FACTORS MISMATCHES/RECOMMENDATIONS IN POST-INSPECTION/FEEDBACK

1. Consider inclusion of standard information like ATA codes, station #, Sup. #, employee #, etc., in the workcard. This considerably reduces the cognitive load on the inspector.

Appendix 6-B

Ergonomic Risk Factors

1) Workcards

- Card contrast changes
- Ribbon changing-establish preventive maintenance program
- Graphics-confusion using graphics/time to get graphics
- Graphics on cards-could one get too reliant on cards and not use the manual?
- Card content inaccurate?
- Graphics attached to card until buy-off
- Breaks between cards is not good
- Use of if/then statements

2) Lighting

- Fixtures are dirty
- Need a preventive maintenance program for lighting
- Lighting at the back of the hangar is inadequate
- Color of hangar bays-to ensure good reflectance, need a light color floor
- Repairs must be performed by facilities department

3) Keel Inspection

- Check task lighting-cannot read workcard

- Fuselage stand lighting
- Handling lighting equipment cords and small lights
- Temperature in the summer is too hot
- Task performed in very noisy environment
- Sheet metal work often interferes with task access
- Task performed in a restricted space
- Difficult to get back on to the ladder
- Task requires less-than-optimal posture
- Task must often be recleaned-cleaners do not understand necessary level of cleanliness required for this task
- Cleaners' work of is not inspected before task begins
- Time pressure

4) PS4 Drain Box Inspection

- NDT equipment design-probe is difficult to place/equipment is not easy to maneuver
- Scaffolds/ladders can be slippery/task is difficult to access
- Sign-offs/buy-backs on shift change
- Task light cords in the way
- Check lighting levels on task
- Task too hot when the engine is still warm
- Cleaning is often inadequate-not enough time to clean on an overnight inspection

5) E&E Compartment Inspection

- Check task lighting
- Cannot read workcard
- Need fixed task lighting for a number of tasks-need to design an appropriate lighting fixture
- Temperature high, due to equipment, in the summer
- Task requires less-than-optimal postures

6) Forward Accessory Compartment Inspection

- Task requires a high ladder-often difficult to find appropriate ladder
- Requires a different type of ladder than those available
- Check task lighting-use of headlamps
- Task is performed in a restricted space-difficult to access
- Task requires less-than-optimal postures

Appendix 6-C

General Communication

User Needs Analysis

Your help is needed to assess the quality of internal and external communications in the Hangar Inspection Department. Here is an excellent opportunity for you to help us make improvements in the Inspection Department Communications System which will give you clear information on your work assignments and make the workplace less stressful.

Please complete the questionnaire below and return to the Atlanta Safety Department by October 20, 1994.

Remember, if you do not complete and return a questionnaire, you miss an opportunity to make a difference.

1. How many years experience do you have as an inspector?

2. Where (or from whom) do you get necessary information?

3. Is information given to you verbally or in written form?

4. Whom do you regularly pass information to?

5. How do you pass information (verbally or in written form)?

6. Do you regularly have all necessary information when working on a task, or are you constantly going back for more information?

7. Do you ever read the shift-turnover log? If so, how often do you do so?

8. Do you ever write information in the shift-turnover log? If so, how often, and under what circumstances?

9. What do you see as the purpose of the turnover log?

10. If you could design a shift-turnover log, what type of information would you include?

11. Should the turnover log be a SEPTRE program similar to Hangar Daily Stat, or book, or both?

12. Do you attend regular crew meetings? If so, who is in attendance at these meetings?

13. Do you feel that regular crew meetings are informative and beneficial, or are they a waste of your time?

14. Have you ever had a problem caused by miscommunication, either between you and another inspector, you and the lead inspector, you and a manager, between you and mechanics, or you and engineering in the work area? If so, please describe.

15. How much turnover time do you have between shifts? Is it sufficient? If not, how much time is needed?

If additional space is needed, please write your response on the back of the page, referencing the question number.

Thank you for your time and input.

John Lane

Safety Manager

Appendix 6-D

Specifications for Proposed Shift Turnover Log

A) General Shift Turnover Log

1) The first section of this log records general shift information:

Date: Enter the date on which the shift begins.

To Be Read By: Circle the shift for which this page has been written: morning (1st shift), afternoon (2nd shift), or night (3rd shift). Each lead inspector should complete this log for the following shift.

Lead Inspector: Enter the name of the acting lead inspector on the shift for which this page is intended.

Manager: Enter the name of the inspection manager on duty during the shift.

Filled In By: Enter the name of the lead inspector who completed this page and circle his or her shift.

Example: The day shift lead inspector should begin this log for the afternoon shift. In the first section of the log, the "to be read by" shift is the afternoon shift. The lead inspector is the afternoon lead inspector's name. The manager is the afternoon manager's name. The day shift lead should enter his or her name and circle "morning shift" in the "filled in by" box.

2) The second section of this log records personnel information. Information should be recorded as it is received. The lead inspector should enter information in the log that is to be read by the shift this personnel information affects.

Call-ins should be entered on the log for the shift the inspector was supposed to work.

Name: Enter the name of the inspector who called in.

Reason: Enter the reason the inspector called in, e.g., sick, family emergency, etc.

Time: Enter the time the call was received.

Overtime should be entered on the log for the shift on which the inspector is going to work the overtime hours.

Name: Enter the name of the inspector who is working the overtime.

Reason: Enter the reason the inspector is working overtime.

Time: Enter the number of overtime hours the inspector is expected to work.

Field Trips should be entered on the log for the shift on which the field trip begins.

Name: Enter the name of the inspector assigned to a field trip.

Destination: Enter the destination of the field trip.

Departure Time: Enter the time the inspector departed.

Return Time: Enter the time the inspector is expected to return.

Example: If Inspector A is supposed to work the midnight shift and calls in sick at 6:00 p.m., the afternoon shift lead inspector should record this information on the log the night shift lead inspector is to read. Similarly, if day shift Inspector B is asked to work late (overtime), this information should be recorded on the log the afternoon shift lead inspector is to read.

3) The third section of this log records special instructions and general problems. This information, recorded by the lead inspector, is to be read by the lead inspector on the following shift. Information intended for both following shifts should be recorded on both log sheets. The "resolution," "date," and "time" should be completed by the shift resolving the problem or completing the project.

Problem: Describe the problem or situation. Each problem on a given day should be numbered sequentially.

Needed Action

/Alert: Enter the action the oncoming shift must complete or describe the alert/warning the shift needs to be aware of. Number the actions with numbers of the problem to which they refer.

Resolution: Describe the resolution determined or implemented for the problem and include any further developments of a situation. Number the actions with numbers of the problem to which they refer.

Date: Enter the date the problem/situation is resolved.

Time: Enter the time the problem/situation is resolved.

B) Aircraft Log

1) The first section of this log records general information about the aircraft:

Aircraft Number: Enter the number of the aircraft.

Day: Enter the number of days the aircraft has been in the hangar.

Shift: Circle the shift (morning, afternoon, night) completing this log.

Inspectors Assigned: Enter names of all inspectors assigned to this aircraft on this shift.

Aircraft Status: Circle the status of this aircraft: Line (not yet in the hangar), Initial Shakedown (initial inspection in the hangar), Inspection (performing scheduled inspections), Buy-back (the buy-back of non-routine workcards).

General Information

/Notes: Enter any information about this aircraft important for the next shift to know and/or understand. Some of this information may also be reported to the oncoming lead inspector and recorded in general shift turnover log.

2) The second section of this log describes ongoing long-term projects:

Project: Describe the project being worked on, including the location on the aircraft, if relevant. Number projects sequentially. If more space is needed, continue on the back of the page.

Status: Describe the project's status, e.g., project is 30% complete or project is waiting for a specific part, etc.

Needed Action/Alert: Describe any actions the next shift must perform or describe any warnings/alerts the next shift should be aware of concerning this project.

Inspector: Enter the name of the inspector who entered this project into the log.

3) The third section of this log describes other ongoing projects/problems:

Inspector: Enter the name of the inspector who entered this project/problem into the log.

Project/Problem: Describe the project, e.g., bag-bin inspection not completed, or the problem, e.g., tail section not clean enough to inspect at 2:30 p.m., that the next shift must be aware of. Number each project/problem consecutively.

Needed Action/Alert: Describe actions the oncoming shift should take concerning the projects or problems.

Resolution: Describe the resolution to the project/problem that was developed and implemented.

Date: Enter the date the project was completed or the problem was resolved.

Time: Enter the time the project was completed or the problem was resolved.