GroundEffects™

Reporting on Industry Maintenance Error Reduction Efforts

"That is true, but for all the reasons outlined in your GroundEffects, and several more, we know the checks are missed and will go on being missed in the future."

Captain J. A Passmore
Head of Safety - British Airways
(complete quote on page 2)

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Discipline: The Importance of Mens Rea

David Marx, Consultant

Key Points

- Don't Punish based upon the error
- Intentional underlying behavior should be the focus of your disciplinary investigation

In early English Common Law, a man could not be found guilty of a crime unless two elements were present: *actus rea* (the evil act) and *mens rea* (the evil mind).

In the world of corporate mishaps (and resulting discipline), no issue has been more misunderstood than that of *mens rea*. We speak of the "unintentional" error and convince ourselves that if our technician really did not intend to drive the forklift into the aircraft, then how can any punitive disciplinary action be at all helpful? On the surface, it stands to reason that punishment will have little effect upon an individual who did not intend the mishap in the first place.

Yet, is the analysis complete once we have determined that the forklift driver did not intend to drive the forklift into the side of the aircraft? For some people yes; for me, no. I sure hope that in virtually every

The Third Maintenance Error Conference Held in February

The Third Conference on Maintenance/Ground Crew Errors and their Prevention was held on February 18 and 19 in Toronto Canada. All 114 attendees agreed that the conference was worth while and there should be further conferences.

The conference attendees were welcomed by **Jon Turner**, Director of Fleet Management Air Canada who expressed Air Canada's commitment to train their employees.

John Goglia, Board Member of the United States NTSB delivered the keynote address. In it he urged the attendees to get on with it and start to provide maintenance technicians with Human Factors training because "we are killing people."

Mike Doiron, Regional Director System Safety Atlantic, Transport Canada, gave a presenta

(Conference - continued on pg 9)

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N.T.S.B. Corporate Culture Symposium

by Dr. Gary M. Eiff and Timothy D. Ropp, Purdue University

Key Points

- Many Industries face similiar mainteance error challenges
- The governement could play a helpful role in this area

Key Points

Few individuals or companies recognize the important role corporate and work cultures play in safety and performance in the workplace. Three years of aviation maintenance human factors research at Purdue University strongly suggests that the prevailing culture of a work environment is a keystone to the development of workplace norms, worker attitudes and motivation, feelings about safety, and many other important facets which impact worker effectiveness and safety. Throughout its history, the National Transportation Safety Board (NTSB) has included scrutiny of a company's management structure, financial health, procedures, and

Reader Comments

"Data from the CAA shows that over the last ten years there have been nearly 100 reports (of cross-connected systems) from UK operators - roughly ten a year. They cover nearly all systems. The standard response is that if the functions checks were done properly the fault would show up. That is true, but for all the reasons outlined in your GroundEffects, and several more, we know that the checks are missed and will go on being missed in the future"

Captain J. A. Passmore
Head of Safety
British Airways

(Capt. Passmore was responding to the article "Test for Failure")

GroundEffects (ISSN 1094-0146) is published six times per year to discuss issues affecting maintenance safety. We offer practicable solutions to maintenance managers, regulatory authorities, and unions charged with improving safety and reducing costs.

Newsletter Editor: Wayne Glover
(425) 869-5055

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Guidelines For Effective Safety Placards

By: Wayne Glover - Editor

Key Points:

- Factors Influencing Likelihood of Technicians Reading and Complying with Placards.
- Tips for Designing Effective Placards.

Introduction

Cautions &Warnings (C&Ws) and placards have become an integral part of our complex world and are used to reduce chances of injury or damage, as well as minimizing legal exposure by fulfilling our duty to warn. At least from the view of the courts, C&Ws and placards do play a significant role in safety and liability: "18% of all product liability cases involved warning defects; either lack of, or inadequate warnings."[1] However, C&Ws and placards should never replace good equipment design, proper training and operating procedures, or good safety practices. Rather, they should be treated as one more tool in your attempts to improve safety and reduce operating costs.

As a convention for this article, C&Ws refer to written notices placed in the equipment maintenance manual or company paperwork. A caution notifies the technician of potential damage to equipment as a result of taking, or failing to take, certain actions. Warnings notify the technician of potential injury to personnel. A placard is a plate permanently attached to the equipment providing information and/or warnings.

We use C&Ws and placards extensively to warn technicians or supply pertinent information. Adding a C&W is often the first step taken when a problem is identified. As a maintenance manager, you may be faced with the need to ask the manufacturer to add a C&W, or approve an in-house design for a C&W or placard. As with many issues in the human factors field, there is no definitive answer to designing the perfect C&W or placard. However, this article will provide you with specific

Inside This Edition

mishap, the employee is found NOT to have intended the undesirable outcome. Aviation professionals accept a tremendous duty of public care, one that simply cannot tolerate intentional damage or injury.

Yet there still remains the question of whether the individual intended the underlying action that led to the mishap. Take, for example, a seasoned line technician who has memorized his overnight check. He has successfully performed the check on the overnight for the past three years. Although it is both an airline and FAA violation to do so, he does not take the paperwork out to the aircraft. Rather, for the last three years, he has performed the check from memory and then gone into the line shack to sign off the 20 individual tasks he is assigned to do on a nightly basis for three different aircraft that visit his station (60 tasks total).

Unfortunately, a mishap has occurred. The Quality Assurance investigation reveals that the technician doing the overnight failed to observe what investigators believe was significant damage to a series of fan blades on the No. 1 engine. It appears that during the landing rollout with thrust reversers deployed, the No. 1 engine ingested some foreign objects from the runway. By his own admission, the technician failed to look inside the No. 1 engine nose cowl on this particular aircraft, although he had recorded on the paperwork that he did the check. On the morning flight out of his station, the engine suffered severe vibration once full throttle had been achieved. The pilot initiated a rejected takeoff, and now the technician is sitting in your office. He is one of your best technicians. He is generally considered conscientious and professional. And he clearly did not mean to dispatch an aircraft with fan blade damage.

So what do you do with this employee? Some argue that no discipline should be administered because he did not intend to miss the fan blade damage. Yet, the regulator is faced with a deliberate violation of internal company procedures and a deliberate violation of the federal regulations. Should the regulator let the employee off the hook? What if people were injured - would the analysis change?

The point here is that the error itself, failure to detect the fan damage, is not the proper focus of the disciplinary investigation. Nor is the magnitude of the consequences the proper focus of investigation. Rather, it is the underlying conduct (for which the technician had control) that is the appropriate subject of review. Was the technician taking a conscious risk by not taking the work cards out to the aircraft? Did three years of benign experience lull the technician into thinking that he was still as reliable as those who religiously take the work cards out to the aircraft with them each time they perform the overnight?

We all take risks in our daily activity - whether we're working around the house, driving a car, or maintaining a commercial aircraft. It might be our decision to use a table saw without safety goggles, to drive a car without fastening our seat belt. Yet it is assumed that when we are working on an aircraft we understand the consequences of risk taking - and therefore work to much more exacting standards. Risk taking will be inevitable - that is, even under the best of circumstances, the potential for human error cannot be eliminated. The important question to the human factors investigator is "Given current system and process design, what is the inherent human reliability of the task under review? What steps can be taken, through system design, training, etc. to make this task less error prone or more error tolerant?"

To the disciplinary investigation, however, the question is much more narrow in focus. What should be important to a disciplinary board is what options were available to the technician when he made the error. That is, did the technician knowingly and unjustifiably increase the probability that an error would occur?

Consider this scenario. On the overnight you are assigned to do a detailed inspection for cracks around rivet heads on a portion of the external side of a 737 fuselage. It is night and the aircraft is parked on the tarmac. If we learned anything from the Aloha 737 disaster, we've learned that this scenario is at best now a classic case of poor human factors design. Nevertheless, in accordance with your airline's policy you and your colleagues have been performing these external skin inspections for the last five years in this same manner. You diligently bring out a work stand to get you close to the structure and you bring large lamps to provide adequate lighting. Yet should an inspection error occur that leads to an in-flight depressurization, many organizations would take disciplinary action against the you merely for your involvement in an error with such considerable operational consequences.

Growing human factors wisdom is that we should instead strive to understand "why" the error occurred. So we use a tool like Boeing's MEDA investigation technique to better understand the contributing factors to the error. In this case, an investigator may determine that the rushed overnight, poor lighting and fatigue all helped to decrease the inherent reliability of this task. For these contributing factors, the organization must stand accountable.

Yet even though the technician did not intend to miss the crack, in every mishap investigation there still remains the question of whether the individual technician also bears some of the blame. Not because he or she made an error, but because we all have some control over our personal human reliability. In the vast majority of errors, it will be found that the technician was merely working within the norm of the air carrier's maintenance organization. In such a case, the erring technician was merely the unlucky one to be hit by the "normal and expected" human error. For merely making an error (without any "evil intent"), no discipline should ever be applied. Instead, the science of human factors should be marshaled to ensure that the task is designed to achieve peak human performance.

> Appropriate Discipline, if any is warranted, should be based on the underlying conduct of the technician, over which he has complete control. Discipline should not be based on the resultant error or magnitude of the consequences.

Yet, query your own attitude toward the technician who stands on the ground to do this same inspection with his flashlight pointed up at the rivets that are six feet away. This technician may make the same error as the technician who diligently followed the procedure and used an adequate work stand and the proper lighting. Neither technician intended to "miss" the cracked structure. Yet, while theoretically not guaranteed of failure, there can be no doubt that the mere flashlight-equipped technician significantly and unjustifiably increased the risk that the error would occur.

Mishaps don't typically occur because of malicious intent to cause damage. Nor do mishaps typically occur because of reckless behavior. Mishaps do occur because, even under the best of circumstances, human reliability will never be 100 percent. And when the unlucky person working within established, high-reliability norms falls victim to error, resulting disciplinary action may do more harm than good to system safety. However, notwithstanding the idea that human error is a "normal" part of system operation, human errors cannot be assumed to be "blame-free." By focusing your attention on the underlying conduct, your focus will shift away from the unintentional error and to the intentional underlying behavior that is really important. Unfortunately, you will occasionally find that your technician has breached his own duty to aviation safety and personally subjected the safety of flight to unreasonable peril. It is in this case that discipline may truly serve aviation safety.

So next time one of your employees is involved in a mishap, ask what they were doing when the mishap occurred. It will serve to decrease the knee-jerk reactionary discipline so prevalent today (i.e., punish the error), and instead focus your attention on the intentional underlying conduct of the technician that truly requires examination.

disciplinary policy as important considerations in their accident investigations. It is not uncommon for the investigation to divulge that cultural issues play a central role in the error chain events causing the accident.

Recognizing the important contribution workplace culture has on safety, the NTSB recently held a symposium on Corporate Culture and Transportation Safety in Arlington, Virginia. Over five hundred fifty representatives from aviation, railroad, marine, highway and pipeline industries attended the symposium to listen to experts, share success stories, and explore strategies for developing corporate "safety cultures".

The first day of the symposium was dedicated to exploring the concept of corporate culture and the attributes of good and bad cultures. It also included success stories of companies who have nurtured work environments which have had a dramatic impact on their safety records. Dr. James Reason lead the presentations with an explanation of how successful corporate cultures are actually composed of many interactive elements. Dr. Reason identified four elements which are necessary attributes of a successful safety culture. Such a safety culture is a reporting culture, a just culture, a flexible culture, and a learning culture. Dr. Ron Westrum discussed how corporate environments can be classified into cultural "models" and the dynamics which develop each culture. The three models used for this discussion included the pathological, bureaucratic, and generative cultures. The dynamics of nurturing safety cultures were further explored by the three additional speakers, Dr. Robert Ginnett, Dr. Charles Marske, and Dr. Najmedin Meshkati.

Building on this foundation of understanding about the nature and structure of corporate cultures, three companies presented their success stories as proof that such cultures could be developed and that they had a dramatic impact on safety. Carroll Suggs of Petroleum Helicopter, Patricia Andrews of Global Aircraft Services, and Dr. Paul Tebo of DuPont all shared with the audience how their companies dramatically changed the safety record of their organizations by implementing and nurturing corporate safety cultures.

> 550 Representatives from aviation, railroad, marine, highway, and pipe-line industries attended the NTSB Corporate Culture and Transportation Safety Conference

One of the most interesting facets of the symposium was the second day's breakout group featuring discussions of what impedes the development of safety cultures, how we can overcome these obstacles, and what the Government (NTSB, FAA, etc.) can do to help. Since the symposium attendees were divided into modal groups (e.g. air, ground), each of the breakout groups explored issues which were salient to their industries. At the conclusion of the symposium, each group shared their findings with all of the attendees and it was shocking to see the similarities between these widely varied industries. While obvious operational differences exist among the various transportation industry modal groups represented at the symposium, it became clear that safety is a shared responsibility and that many of the same safety issues affect all sectors of the transportation industry.

As the various groups explored human error and safety issues in their work environments, they began to see that many issues once thought exclusive to their own organization and industry were, in reality, a common problem for everyone. It became apparent that if safety in the transportation industry as a whole was to be improved, cultural practices and the sharing of relevant safety information needed to be fostered among industry segments.

It was also clear from the breakout group presentations that organizations in all industries are dramatically affected by the established corporate culture - by those in charge of fostering "the way we do things here"- regardless of the customers, products or modes of delivery. Accidents, injury, and death due to pathological or even non-existent corporate cultures underscored the need to develop generative safety cultures. There was a glaring need to open the lines of communication and share vital safety information across all sectors of the transportation industry - from the airlines to the pipelines. More importantly, it is vital that organizations no longer view safety as "another necessary expense" to be implemented as a floor-level program. A safety culture starts from the top down. This is not an idea concocted by academic research or consultants. It comes from those actually doing the work, including managers from all industries.

Find this difficult to believe? The following is a list of shared concerns and ideas which were common to all of the groups regarding corporate culture and safety in the transportation industry. What is most striking is the fact that these shared ideas and solutions came from managers from all of the various transportation sectors: aviation, rail, marine, highway and pipeline.

Changes Needed to Immediately Improve Safety Culture

- Top-down consensus to adopt a new safety culture

and change the old one. This includes changing executive safety behavior as well as line level employees.

- Willing investment in risk management cultures not because it has been justified, but because it is the right thing to do.

- Industry-wide willingness to share safety data.

- Formation of partnerships with government and other industry sectors.

- Effective measurement standards for safety cultures.

Present Obstacles To The Development of Safety Cultures

- Dollar issues. How can a safety culture be cost justified? Should it be?

- Short sighted goals of top managers. Short term, position tenure on management "fast tracks" leads to 3 -5 year bottom-line goals, instead of long term company/industry performance goals.

- Poor measurement standards and lack of accurate identification methods of risk/safety management activity.

- Lack of trust between industry and government, inter and intra-industry, and even within companies themselves.

How Government Can Help

- Maintain consistent focus on safety education and communication networks.

- Concerted move toward sharing safety issue experiences.

- Recognize and reward existing and well cultivated safety cultures.

The recent NTSB sponsored Corporate Culture symposium provided much in the way of practical information and insight into the nature and development of corporate cultures. The NTSB should be applauded for taking a realistic and proactive approach to fostering safety in the transportation industry by promoting the development of supportive and generative "safety cultures" as salient corporate models. It is quite clear from industry participation that there is an industry-wide commitment to safety and an interest in promoting corporate cultures which foster safety. However, it is up to those driving the corporate culture and direction of a company - top level decision makers - to utilize this information effectively in order to develop an environment within which such a culture might be established. In order to work, the idea of safety must become a way of life. It must become a true "culture" and not a funded program that must constantly justify its existence.

Dr. Eiff is a professor in the Avionics department of Aviation Technology at Purdue University. He is one of the principals in the Purdue Aviation Human Factors Research program. He is also a licensed A&P.

Timothy Ropp is a graduate student at the Aviation Technology department at Purdue. Mr. Ropp is also a licensed A&P.

GENERAL AVIATION INDUSTRY AWARDS PROGRAM

Mr. Leonard Beauchemin was selected as the National Aviation Maintenance Technician (AMT) of the year. The award was presented by Mr. Guy Gardner, FAA Associate Administrator for Regulation & Certification, during the National Air Transportation Associations's (NATA) Convention and Trade Show.

Mr. Beauchemin was selected for his exceptional leadership within the maintenance community and his professionalism. After graduating with honors in 1981, Mr. Beauchemin joined Canadair Challenger as a technician and supervisor. While there, he administered the first interaction management training program developed for maintenance technicians. In 1991 Mr. Beauchemin accepted a position at Eastman Kodak as Manager of Technical Support. He was designated by Eastman Kodak as an employment development coach leading both aviation and non-aviation company employees through the Essential Leadership Skills training program.

The Award is intended to reward outstanding contributions to the aviation industry by a technician. Through national recognition of the important role technicians play in aviation safety, industry and public attention is focused on the vital contributions made by all aviation technicians.

Congratulations Len.

Editors note: The August issue of GroundEffects will feature an article from Mr. Beauchemin presenting his views on technician professionalism and safety.

criteria that experts agree will maximize the effectiveness of any C&W or placard.

Not surprisingly, there are differences in opinion regarding the effectiveness of C&Ws. One study noted: "Results of laboratory experiments, field studies, and accident analyses continue to demonstrate the difficulty of enhancing safety through warnings. On-product warnings, and other common safety measures, typically fail to meet minimal requirements for effectiveness due to limitations inherent in their use."[2] However, another study showed a 37% compliance rate with the subject placard. This suggests that properly designed and located C&Ws and placards can be effective in influencing behavior. Given the conflicting studies, the usefulness of a C&W and warning placard should not be over emphasized, nor should they be discarded as useless.

Discussion

A placard provides information and/or warnings to the technician about a possible negative consequence which may result from taking (or failing to take) specific action. A placard is permanently attached to the equipment and is typically color coded indicating if the placard is an informational placard or a safety placard. The remainder of this article will discuss the design of a safety placard placed on the equipment.

An effective safety placard is one that changes behavior and which reduces the undesired consequences. To best accomplish this change, the safety placard must: (1) be perceived as a warning from the perspective of the receiver (the person you intend to warn); (2) be understandable to the intended reader (pictographs, when done well, can prove useful in a multi-lingual environment); (3) convince the reader there is a potential danger; (4) present the information needed to avoid the danger; and, (5) change the technician's behavior and mitigate the danger posed by the situation.

Theses factors influence the likelihood of a safety placard being read:

1. The threat of injury must be perceived as high. People are more likely to read placards when they perceive there is a real danger. This may work against you in an area perceived to be benign.
2. People must be seeking information. People must believe there is a reason for them to need the information being proffered by the placard. For technicians familiar with an area or task, this may be difficult as they may not perceive the need for any safety information.
3. Familiarity with the product and/or area. Familiarity reduces the likelihood that the person is looking for new information. The more times a person does something incorrectly without being hurt or punished, the more likely the person will continue the undesired action.
4. Proliferation of warnings. An abundance of placards flooding the technician with information may lead to 'filtering' where the technician no longer reads any of the placards.

These factors can best be controlled by training technicians to read, understand and comply with all warning placards every time they enter an area. As the designer of the placard, you can contribute to the likelihood of technicians reading the placards by following the effective placard design standards discussed below.

Factors influencing the effectiveness of the safety placard:

1. Wording of Instructions: The placard should not instruct the technician what action to take if the appropriate action is obvious. However, for non-obvious or hidden dangers, provide the necessary information for the technician to understand the danger and the required action.
2. Stated Consequences. Studies show that stating the consequences of failing to follow the instructions (e.g. electrocution) does affect both risk perception and likelihood of compliance.[3]
3. Format of Warning Sign. Format should follow a company or industry standard to reduce confusion. However, studies have shown that content of the warning was far more important than the size and color of the placard or words.[4]

SAMPLE SAFETY PLACARD

Scenario: You have discovered that technicians can come in contact with a rotating tube. Past experience with rotating tubes suggests the potential hazard would be catching hair or loose clothing. This area is accessed only occasionally, and always by trained personnel. However, you feel the potential for serious injury requires a safety placard. There are several entry points into the area with the tube.

Equipment Design Considerations:

A design change which prevents the problem is nearly always the best solution. However, in this case, because the area is accessed only occasionally and always by trained personnel, a design solution is deemed inappropriate for cost reasons. Therefore, the burden rests on an effective safety placard to prevent injuries.

Placard Design Considerations:

One possible safety placard design is shown below followed by a discussion of the important design considerations.

Protect Hair and Loose Clothing

WARNING
Protect Hair and Loose Clothing Overhead Rotating Tube

Overhead Rotating Tube

WARNING

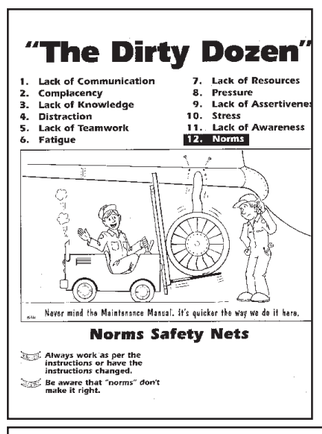
- The first line of a safety placard should contain the appropriate term: “CAUTION” or “WARNING”. Use “WARNING” for potential injury to people; “CAUTION” for potential damage to equipment.
- The second line, “Protect Hair and Loose Clothing”, should contain the action required by the technicians to protect themselves and/or the equipment. This is the critical information the technician needs to know to take the proper precautions – don’t hide this information somewhere in the body of the placard. This line should be succinct and action oriented.
- The third line, “Overhead Rotating Tube”, can contain information useful to the technician to understand the danger (realizing that the technician has already taken the protective action specified in line one and now is ready for more information). Line two would be insufficient without line one because simply identifying an overhead rotating tube merely tells the technician where to look and what to look for. Because the potential hazards posed by the rotating tube are not obvious, the statement does not supply sufficient information to reduce the likelihood of personal injury. Therefore, clearly state the non-obvious dangers of catching hair or loose clothing.
- Minimize words on the safety placard – do not deluge technicians with interesting but non-essential information.
- The safety placard should conform to accepted coloring and marking standards such as NASA-STD-3000/Vol. IV Revision A (pg. 9-88 thru 9-94) or other acceptable industry standards. The key point is standardization. Safety placards are no place for creativity.
- Position the safety placard at all entry points into area.

Using this information, you can effectively design safety placards

for use in your area to maximize the safety of your workers, equipment and potentially minimize your legal liability.

Footnotes

[1] Laughery, Sr., Wogalter, and Young, Human Factors Perspectives on Warnings, The Human Factors and Ergonomics Society, 1994, pg. 191
[2] ibid. pg. 4.
[3] ibid. pg. 8.
[4] ibid. pg. 27.



Conference

(continued from page 1)

tion on the cost of ground damage as being equal to 30 brand new MD-80's each year. That being the case then we have to look at the cost benefit of training to reduce these expensive errors.

One of the highlights of the conference was the panel discussion on Discipline and Human Factors moderated by **David Marx**. **Dutch Drescher**, Northwest Airlines, **Steve Predmore**, Delta Airlines and **Gordon Dupont** Transport Canada, provided diverse opinions on the topic which appeared to coincide with the diverse opinions of the attendees.

Bill Shepherd, FAA and **Bill Johnson**, Galaxy Scientific gave a joint presentation on the Human Factors Guide developed by Galaxy for the FAA. The CD ROM version is user friendly and provides information on what Human Factors are.

Gisele Richardson, Richardson Management Associates Ltd., as the luncheon speaker, provided a friendly scolding to the industry in that we are very punitive and behind many industries in providing HF training to its employees.

Lee Norvell, FAA gave a presentation outlining the media material available to assist in Human Factors.

Jim Taylor, University of Southern California gave a presentation on the importance of evaluating any Human Factors program.

Day two found delegates dividing into one of the following four workshops:
Human Performance in Maintenance or Maintenance Resource Management moderated by **Richard Komarniski**.
Human Performance in Ground Crew moderated by **Larry O'Brien**.
Human Performance in the Military, moderated by **Paul Jenkins.**
Human Performance in Maintenance Part 2, moderated by **Gordon Dupont**.
Bill Foyle, as moderator in the wrap up, summarized the opinion expressed by many delegates when he said "we are preaching to the converted and we must get the message out to those who aren't here."

The next conference will be held in March 1998 at Gatwick, United Kingdom.

For information about these confer-

EFFECTIVE PILOT/ TECHNICIAN COMMUNICATION IMPROVES TROUBLESHOOTING AND SAVES TIME

Bernard Wulle, Assistant Professor and Michael Lapacek, Graduate Student
Purdue University

Key Points:

- An in-house Purdue University study suggests that direct turnover of squawks between pilots and technicians dramatically improves troubleshooting and reduces repair time
- Preliminary results from an extensive field study supports the pilot study findings

When reading pilot squawks and the maintenance corrective action to those squawks, many interesting and creative remarks are found. For example, one actual pilot squawk read: “left inside main tire almost needs replacement,” technician response, “almost replaced left inside main tire.” Another pilot squawk read: “evidence of hydraulic leak on right main landing gear,” technician response, “evidence removed.” These are just two examples of relatively common communication between pilots and technicians regarding aircraft discrepancies. While these write-ups may be humorous, they appear to also be part of a more serious problem in regard to pilot/technician communication. Two recent Purdue University studies, one a completed in-house program and one an on-going field study, focus on the effect this pilot/technician communication has on the ability of the technician to quickly and accurately identify a maintenance problem.

Maintaining a safe fleet of aircraft in an efficient and cost effective manner is not an easy task. Combine that with write-ups similar to those in the first paragraph and many questions are raised. How much extra time is spent troubleshooting unclear pilot squawks? Is safety at risk when the maintenance technician’s corrective action is “no fault found”, or “could not duplicate”? Do pilots and maintenance technicians communicate in the most effective manner? Are there stereotypes about pilots or maintenance technicians that impact interpersonal relations and work culture? If there are harmful stereotypes, can they be effectively nullified? Are there better methods for communicating maintenance discrepancy information? Last and certainly not least, how much are these issues costing the aviation industry and can these costs be reduced?

A team of researchers at Purdue University has been attempting to answer these questions and develop practical solutions to aid in communicating maintenance discrepancy information between flight crews and technicians. To do this, two research studies have been conducted. The first was an in-house study conducted using Purdue University students, faculty, and aircraft. This study looked into issues which included the effect of pilot age and experience on quality of pilot write-ups, and pilots’ and technicians’ mutual attitudes. Another issue studied was the effectiveness of verbal communication of aircraft maintenance discrepancy information between the pilots and maintenance technicians.

The results of this in-house study showed that age and experience do appear to be a factor in the quality and effectiveness of a pilot’s squawk. The quality of the write-up was determined by an expert panel who rated each of the write-ups. The expert panel

consisted of five A&P technicians with an average of over twenty years of aircraft maintenance experience. The effectiveness of the write-ups were determined through an analysis of the corrective action taken by maintenance technicians on 203 write-ups obtained over an eight-month period. When student and low-time pilots were compared with more seasoned and experienced professional pilots, the effectiveness of the write-up was better for the professionals. 21% of all write-ups resulted in a "could not duplicate" in the corrective action taken by the maintenance technician. Of those "could not duplicates", 69% came from the low time student pilots, while only 31% came from the professional pilots. Also, those write-ups that described discrepancies deemed by the A&P panel as "complex" received the highest rated score (3.9 on a 5.0 point scale), and 100% of those came from the professional pilots.

Another portion of this in-house study resulted in some interesting findings as well. This portion used a B-727-100 aircraft (for technicians), and a B-727 full motion, six axis flight simulator (for flight crews) to simulate an airline flight line environment. In this simulation, the flight crews in the flight simulator were presented with a maintenance discrepancy and were directed to write-up the discrepancy in the logbook as if this were an actual flight. The same discrepancy given to the pilots was induced in the B-727-100. After completing the logbook write-up, two scenarios were tested. In the first scenario, the flight crew simply handed the logbook write-up to the maintenance technician, and the maintenance personnel were directed to identify and repair the discrepancy. In the second scenario, the maintenance personnel went to the flight deck and discussed the logbook write-up with the flight crew prior to being directed to identify and repair the discrepancy. Four simulations were conducted for each scenario leading to a total of eight simulations.

The differences between the two scenarios were dramatic. The technicians relying solely on the written logbook write-up spent a great deal of time troubleshooting the problem. In this scenario, two of the four technicians were unable to identify (and therefore repair) the discrepancy. The results were different for the technicians who had discussed the squawk with the flight crew. All of these technicians were able to go directly to the problem and make the necessary repairs in a relatively short period of time.

After the simulations, all the participants had comments similar to: "we need to do more of this." "More information is communicated when a face-to-face discussion accompanies the written logbook write-up." "I gained a much better understanding of the pilot's/mechanic's job." "The us vs. them attitude appeared to disappear during the discussions." This portion was conducted as an in-house study in an effort to determine if further study was needed. Even though only eight simulations were conducted, the results of this portion indicate more study is clearly necessary.

The field study expands on the in-house study. This field study is in progress and involves the delivery of 1000 surveys and observational site visitations. The surveys and observations are being conducted in five segments of the aviation industry: 1) major airlines, 2) regional airlines, 3) corporate aviation, 4)general aviation, and 5) military aviation. These five areas were chosen to understand the entire industry and to compare the five different portions of the industry. This comparison will help determine the positive and negative issues within each portion of the industry and aid in the identification of solutions and improvement strategies.

Many issues identified in the in-house study are again being investigated, but this time the investigation seeks more in-depth information on selected issues. Some of these issues include: the effectiveness of policies and procedures, pilot and technician attitudes toward each other, the impact of those attitudes on performance, and the role and importance of communication in aircraft maintenance discrepancies.

Preliminary results of the survey and site visits from the second study are providing very interesting results and these results will be discussed in a future edition of *GroundEffects*.

Professor Wulle is a professor in the flight program at Purdue University.

Mr. Lapacek is a graduate student in the Aviation Human Factors Research program at Purdue University, and currently working towards an A&P license.

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GroundEffects Newsletter
6317 157th Place NE
Redmond, WA 98052

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