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Improving Human Factors Training: Perceptions of Retired Aircraft Maintenance Technicians

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Human Factors training is a major concern for airlines and Maintenance Repair Organizations. This study taps into the reservoir of knowledge and experience of retired Aircraft Maintenance Technicians (AMTs) with respect to aviation maintenance human factors. A survey was given to retired AMTs with 20-30 years of maintenance experience to rank the relative importance of each of the FAA’s Dirty Dozen of human factors in maintenance accidents. Follow-up focus groups were conducted to further explore recommendations on how to prevent human factor accidents related to maintenance. This paper discusses the findings from the original survey and preliminary findings from the first focus groups.

As aircraft maintenance technicians conduct either scheduled or unscheduled maintenance, errors and mistakes occur. According to the Federal Aviation Administration (FAA), about 80 percent of maintenance mistakes involve human factors (Adams, 2009). The risk of experiencing more human error is a definite byproduct of a demanding maintenance work schedule. How to prevent these airline maintenance related human factor induced errors from occurring is a continual challenge. Gordon Dupont developed the Dirty Dozen in his work with Transport Canada. The Dirty Dozen (Table 1) has been published in a series of safety posters along with discussions of available safety nets to provide a tool for training, for situational awareness, and as a checklist of human factors issues in aviation maintenance (Dupont, 1997). These posters continue to be used in aviation maintenance training and human factors awareness.

Table 1.

Gorden Dupont’s Dirty Dozen (Dupont, 1997)

<table>
<thead>
<tr>
<th>Most Common Causes of Maintenance Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lack of Communications</td>
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<tr>
<td>• Complacency</td>
</tr>
<tr>
<td>• Pressure</td>
</tr>
<tr>
<td>• Stress</td>
</tr>
<tr>
<td>• Lack of Teamwork</td>
</tr>
<tr>
<td>• Lack of Assertiveness</td>
</tr>
<tr>
<td>• Norms</td>
</tr>
<tr>
<td>• Lack of Knowledge</td>
</tr>
<tr>
<td>• Lack of Resources</td>
</tr>
<tr>
<td>• Fatigue</td>
</tr>
<tr>
<td>• Distraction</td>
</tr>
<tr>
<td>• Lack of Awareness</td>
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</table>
In 2006 and 2007, the FAA conducted two major surveys among aviation safety inspectors and the international maintenance community to determine human factors that required immediate attention. The survey focused on issues such as fatigue, training, leadership, error reporting, and documentation. The Dirty Dozen were presented to the safety inspectors to rank as challenges. “The top three were pressure, complacency, and norms” (Johnson & Hackworth, p.34). The FAA has a three day employee training course (Human Factors in Aviation Maintenance) that is now required.

Maintenance Resource Management (MRM) is another recent conceptual phenomenon that goes after the human side of accidents and has bled over into the various facets of the global aviation system (Taylor and Christensen, 1998). Its many applications are poignant and delve into the various aviation environments that are unique to the aircraft maintenance technician.

MRM is part of the soft skills that have come to the forefront in the aviation and especially the airline maintenance business. This concept allows employees to better understand their function within a company’s operation and its efforts to obtain a safe and error-free maintenance product. One factor that increased attention on MRM was the ValuJet accident in 1997 that resulted in more surveillance and sharpened focus on maintenance program requirements, as well as airworthiness responsibilities between operators and the third-party repair stations with which they outsource maintenance (Al-Amoudi, 1998).

MRM, one of the best-kept industry secrets, is the newest tool in the airline maintenance management arsenal. The demand for this type of training became apparent following the Aloha Airlines flight on April 28, 1988, in which approximately 18 square feet of the upper cabin separated from the aircraft. Initial investigation of the accident revealed fatigue damage and disbanding of the metal structure that was in part caused by improper maintenance, inspection, and supervision. It was found that maintenance human factors may have played an important role in this accident (Gauntt, 2000).

Airline maintenance complexes have very large and diverse personnel requirements that a MRM program can positively impact. Airlines have used MRM in training maintenance and ground personnel on how to recognize their own limitations, which, in turn, may affect or influence individual and team performance. The successful MRM programs have upper management support, training for all maintenance departments, continuous clear communication feedback, and a uniquely tailored MRM implementation plan.

Several successful in-house programs were established with large commercial carriers such as Continental Airlines, US Airways, and United Airlines. Alteon (a Boeing Company affiliate) conducts free 2-day MRM seminars to airlines and any organizations who desire error-reductions (Maynes, 2005). If in-house MRM programs are not available to airlines, outside MRM contractors such as Grey Owl and Flight Safety International are two suppliers of such programs (Gauntt, 2000).

A need exists to develop a more effective human factors training program based on real causes of aircraft maintenance accidents. In order to do this, the real-world views of experienced AMTs are necessary. We are losing a wealth of knowledge from AMT retirees that could be used
to influence the next generation of human factor training programs. Steps need to be taken to capture this knowledge so that it can be incorporated into future training. If this is not done immediately, it will be lost forever, and future training will lack the valuable insight that the experience from this group could provide.

**Purpose of the Study**

The purpose of this study was to describe the perceptions of retired aircraft maintenance workers concerning human factor causes of aircraft accidents (maintenance-related specifically). This was accomplished by first surveying retired AMTs concerning their views of the influence of various Human Factors (specifically the Dirty Dozen used by the FAA) in causing aircraft maintenance accidents. Two follow-up focus groups were conducted with selected AMTs to discuss the survey results and to describe in detail their views related to training on these issues.

**Methodology**

This is a descriptive study to provide a profile of the human factors perceptions of retired aircraft maintenance technicians. The population for this study was retired American Airlines Aircraft Maintenance Technicians who meet monthly at a Transport Workers Union (TWU) union hall. The group of TWU retiree association members normally has a 25-150 membership and they are on an average, age 55 and above, normally white, male, ex-worker with 5-30 years maintenance experience at American Airlines. Retirees normally meet monthly to keep up on issues affecting their retirement. It was at one of these normal monthly meetings that the initial survey was passed out.

Initial data was collected through a short survey. Fifty surveys were handed out during a meeting of retired mechanics with 29 surveys completed. The goals of the survey were to identify participants for focus groups, and to discover how the AMTs would rank the importance of each of the Dirty Dozen based on their years of experience on the hangar floor.

Two follow-up focus groups were chosen from among the survey participants who volunteered. Questions presented to the focus group centered on the top four human factor causes. The focus group was asked about what these factors look like in the work environment and what strategies are or could be used to overcome these causes. Participants were also asked about human factor training and the good and bad techniques of the trainers. Results from the focus groups will be used to develop the next level of human factors training for maintenance workers at American Airlines.

**Research Questions**

The primary research questions for this study focused on how retired AMTs rank human factor causes of accidents using the FAA Dirty Dozen. Specifically, what strategies/safety nets do retirees believe should be used at the hangar floor to help prevent human factor causes of accidents? How do retirees feel about the development of the next phase of human factor training? What topics are important and relevant to the next generation of AMT training?
Findings and Analysis

Preliminary results

Survey results. Survey taken May 2010 showed that 90% of the respondents had 20 years or more of aircraft maintenance experience. Participants were asked to choose the top four human factors problems from the Dirty Dozen list and place those selections in the High box, and then the least significant four in the Low box, and then the remaining four were then entered in the Medium Box. All responses were considered however only the four top responses in the High, Medium, and Low categories were noted in Table 2. The numbers in each box indicate the total number of responses for each factor considered High, Medium, or Low. Lack of Assertiveness made the top four for each the Medium and Low categories while Fatigue was in the top four for each the High and Medium categories. It is interesting to note that Lack of Communication and Complacency failed to make the top four in any category even though Complacency was in the top three items from the major FAA surveys mentioned earlier.

Table 2.

Categorize the “Dirty Dozen” human factor causes of maintenance-related accidents in terms of High, Medium and Low.

<table>
<thead>
<tr>
<th>High box</th>
<th>Medium Box</th>
<th>Low box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure-18</td>
<td>Lack of Resources-16</td>
<td>Lack of Teamwork-17</td>
</tr>
<tr>
<td>Lack of knowledge-16</td>
<td>Lack of Assertiveness-13</td>
<td>Norms-16</td>
</tr>
<tr>
<td>Distraction-15</td>
<td>Fatigue-12</td>
<td>Stress-12</td>
</tr>
<tr>
<td>Fatigue-14</td>
<td>Lack of Awareness-11</td>
<td>Lack of Assertiveness-12</td>
</tr>
</tbody>
</table>

Note. Only the four highest factors in each category were included which explains why the total don’t reflect all choices from the 29 participants.

Next, respondents ranked the Dirty Dozen inside the three categories of High, Medium, and Low (see Table 3). It is important to note that there are numerous differences between the results of the two questions. Ranking any set of items from 1 to 12 will inevitably result in a great deal of diversity based on personal experiences. Complacency was not considered a major influence for either ranking and that Fatigue, while in the top four in both the High and Medium box in Table 2, it did not score high enough to be included in any of the boxes from Table 3.

Table 3.

Rank from highest to lowest the human factor cause inside the High, Medium, and Low Boxes.

<table>
<thead>
<tr>
<th>High Box</th>
<th>Medium Box</th>
<th>Low Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Awareness-8</td>
<td>Lack of Assertiveness-9</td>
<td>Lack of Communication-5</td>
</tr>
<tr>
<td>Pressure -7</td>
<td>Lack of Resources-7</td>
<td>Norms-7</td>
</tr>
<tr>
<td>Distraction-7</td>
<td>Pressure-9</td>
<td>Lack of Knowledge-4</td>
</tr>
<tr>
<td>Lack of Teamwork-5</td>
<td>Lack of Teamwork-5</td>
<td>Stress-5</td>
</tr>
</tbody>
</table>
Focus Groups. On June 11, 2010, the first Focus Group met. Four members were present. All had twenty years or more experience with one individual the recipient of a golden wrench award (prestigious lifetime mechanic award winner). Other members of the group included an extensive variety of mechanic experience, consisting of three Quality Assurance inspectors, two line maintenance mechanics and one shop level mechanic.

On June 17, 2010, the second Focus Group met. This focus group was based on the knowledge of investigator- awareness of recent past retirees. Four members were present with one member unable to participate due to medical problems. All participants had twenty years or more experience with one individual having being recently retired after working with the investigator for over fifteen years. Maintenance experience of the group consisted of two Quality Assurance inspectors, two line maintenance mechanics, and one shop level mechanic.

Focus Group 1 comments included.
- Pressure is external and can come from maintenance supervisors (foreman, your boss) who allow the aircraft maintenance schedule to override safety sometimes.
- Fatigue caused by long hours, side jobs, inadequate sleep (off shift hours circadian system upset), overtime (needed and manufactured) and the extra effort of field trips. Mechanics are “burning the candle at both ends”.
- Foremen suggest shortcuts to get the plane off and this sets the environment up for lack of knowledge

Focus Group 2 comments included.
- Pressure is sometimes self-induced. Stress includes you wanting to do the best job and not wanting to mess it up.
- Fatigue is the effect of not managing overtime rightly- “They worked 20 hour [shifts]…nobody twisted anybody’s arm [forced you to take overtime].”
- Pressure might bring a lack of awareness. “I remember a supervisor [management] walking off the end of a wing.”

Acknowledgement

The complete results of this study will be included in the dissertation of Kim Robinson. Investigator would like to thank Transport Workers Union 514 in Tulsa for allowing the survey and focus groups events to occur at their union hall. The views of the research report do not reflect the views of Transport Workers Union, American Airlines, and the City of Tulsa.
References


