Procedural Drift: Causes and Consequences

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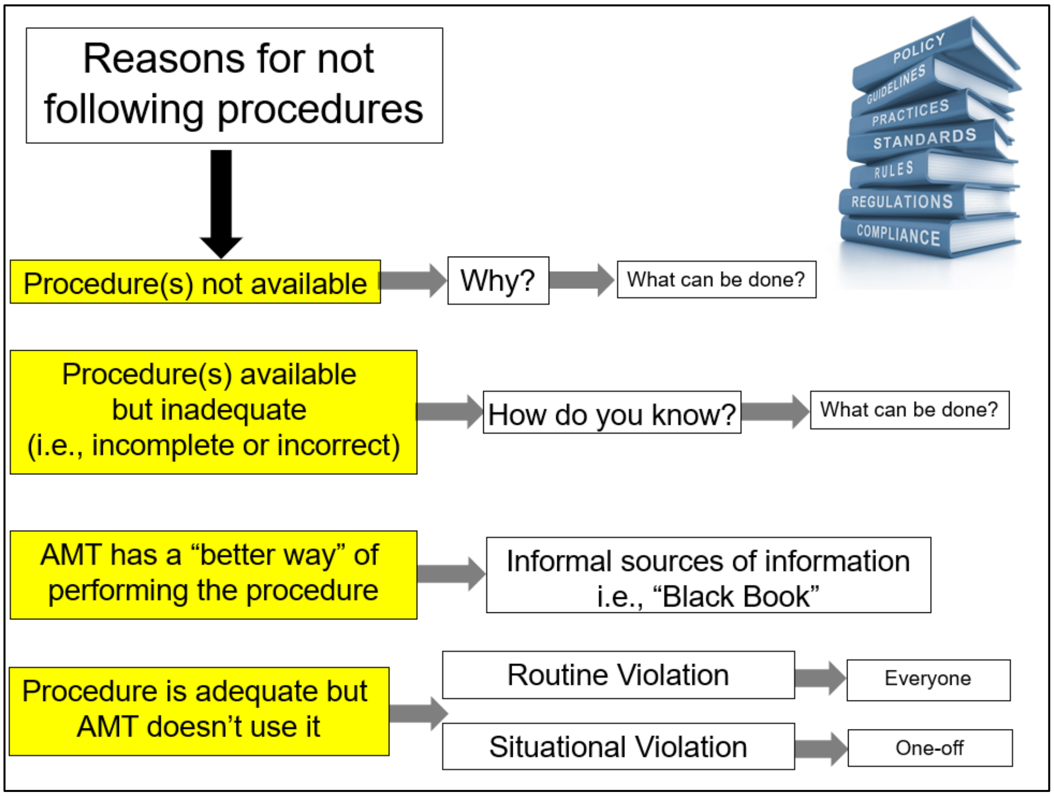
Procedures, policies, and checklists are an effective way to ensure safety-related tasks are being conducted in a standardized, pragmatic way. They are also, in most cases, a regulatory requirement. Thus, all people employed in aviation (whether they are in the cockpit, maintenance hangar, or the ramp) are following the procedures…right?

Wrong. Procedural noncompliance, or procedural drift, has been either a primary, or contributing, causal factor in the majority of aviation accidents. The term *procedural drift* refers to the continuum between textbook compliance, and how the procedure is being done in the real world. Procedural drift is not something new. We have been drifting for a very, very, long time. However, recent accidents have illuminated the ubiquity and severity of the problem, prompting the U.S. National Transportation Safety Board (NTSB) to add 'Strengthen Procedural Compliance' to its Most Wanted List of Aviation Safety Improvements (2015). This NTSB recommendation was largely in response to an Execuflight Hawker HS125-700A crash on approach to Akron, Ohio, in 2015. All onboard perished (2 crew and 7 passengers). For the author's analysis of this accident from the *procedural drift in flight operations* perspective, you can click here. The rest of this paper, however, will focus on procedural drift as it applies to aviation maintenance, although the principles can be applied to any segment of the aviation industry.

Deviations from approved procedures continue to be a leading cause of maintenance-related aircraft accidents. But why is it so hard to just follow the procedures? The answer to this question can range from very simple to quite complex (refer to the diagram below).



Reasons for not Following Procedures. Copyright ©2017, Robert Baron

Procedure(s) not Available

There are documented procedures for just about all maintenance tasks. However, there are cases where either a documented procedure does not exist, or the procedure exists but is not available. In either case, the question must be asked (preferably proactively rather than reactively); why is the procedure not available? Is there even a written procedure for the task? There are many cases where an aircraft maintenance technician (AMT) must conduct a task when no written procedures are available from the manufacturer. This can lead to knowledge-based errors, which can result from the AMT using "head knowledge" only, as he/she attempts to conduct the task solely from past experiences, or familiarity by having done a "similar" task. This can lead to flawed assumptions, and consequently, a maintenance error.

On the other hand, procedures may be readily available, but due to inadequate dissemination of information, they are not finding their way onto the AMT's computer screen. This could be indicative of an organizational problem. The solution for this lack of communication should not focus on ascribing blame to management or an individual, but rather to investigate the "how and why" of the problem and then work collaboratively to correct it.

Procedure(s) Available but Inadequate (i.e., incomplete or incorrect)

In this situation, there is no problem with procedure availability, however the procedure itself may be erroneous or flawed (i.e., incomplete or incorrect). If the procedure is inadequate, the AMT might follow the procedure, only to find that an error has been made in the execution of the task.

In 2003, a Colgan Air Beechcraft 1900D, with just the pilots aboard (who were fatally injured), crashed shortly after takeoff due to a reversal of the elevator trim system. Although there were a number of links in the causal chain, one of those links included a pictorial error in the aircraft maintenance manual. Specifically, the elevator trim drum graphic was incorrectly depicted, which if followed, would cause a reversal of the action of the elevator manual trim system. That is exactly what happened. Compounding matters further, a functional check, which would have detected the error, was not accomplished.

Some studies have been conducted in the area of maintenance documentation quality. NASA researcher Barbara Kanki and her colleagues found that procedural errors, which are defined as any information-related error involving documents, have been implicated in 44% to 73% of maintenance errors. The three most problematic areas identified were inspection and verification issues (34%), incompleteness of the documents (27%), and incorrectness of the documents (22%). Similarly, in a study of 458 ASRS reports submitted by AMTs, Kanki and her colleagues found that the most frequently cited maintenance document deficiencies were missing information (48%), incorrect information (19%), difficult to interpret (19%), and conflicting information (19%). Another study, by Wichita State University researcher Bonnie Rogers and her colleagues, investigated Publication Change Requests (PCRs) by AMTs on the types of errors found in aircraft maintenance manuals published by four manufacturers. Results showed that the majority of PCRs related to procedures found in Flight Controls, Landing Gear, and Powerplant systems. The highest percentage of PCRs involved Procedural Errors (42.5%) followed by Language (29.9%), Technical (16.5%), Graphic (8.1%), and Effectivity (n/a). Common procedural errors were categorized as Step(s), Ordering, Alternate method, Check/Test/Inspection, Caution/Warning. Language errors included typographical errors (Typos), grammatical errors (Grammar), a need for clarification of the information (Clarity), and inaccurate information within a step (Incorrect).

Clearly, manufacturers' maintenance documentation may, in and of itself, be part of the overall problem related to procedural drift. However, these documentation deficiencies should not be viewed as a shift of blame from the AMT to the manufacturer. Until documentation issues such as missing information, incorrect information, difficulty in interpretation, and conflicting information are resolved, it will be difficult to sell the idea of following approved procedures to AMTs on a far-reaching basis. Manufacturers and AMTs need work together on this. AMTs should continue to identify and provide PCRs to manufacturers, and manufacturers should realize that their documentation can be a significant contributor to procedural drift. Keep in mind that many of the procedures in a maintenance manual have been written by engineers who may have never performed the procedure on an actual aircraft. The result is a procedure that may be unrealistically transferable to the practical working environment. This in turn could account for an AMT making up his/her own way of performing the procedure.

AMT has a "Better Way" of Performing the Procedure

In this case, a written procedure may be available, but the AMT performs a task in a way that is different from the steps outlined in the procedure. In many cases, the AMT feels that he/she has "a better way of performing the procedure," including skipping steps that the AMT may deem "unnecessary."

In 2003, an Air Midwest Beechcraft 1900D experienced a loss of control on takeoff from Charlotte-Douglas International Airport (CLT) in Charlotte, North Carolina, U.S. The NTSB investigation revealed that overloading and an aft CG combined with incorrect rigging of the elevator were causal to the accident. The incorrect rigging was attributable to an AMT skipping steps in the full rigging procedure because he deemed the steps "unnecessary." A functional check was not conducted, nor was it required, at the time of the accident. A functional check would have detected the maintenance error, and subsequently became a requirement after this accident. All occupants (2 crew and 19 passengers) received fatal injuries.

Some AMTs are still doing things "their own way" even when the documentation is considered effective and comprehensible. A major reason for this may include shortcutting to save time on perceived "unimportant steps." Other reasons may include complacency and norms. These are factors that can be somewhat easier to mitigate at the person level as compared to organizational factors such as pressure, fatigue, and lack of resources, which can require a paradigmatic shift in the overall safety culture of a company.

Then there is the issue of informal sources of information, such as the “Black Book.” AMTs will literally rewrite, or modify, procedures and store them in their so-called Black Book. There are a few reasons for this. One reason is the procedure itself is flawed, incorrect, or just doesn’t make sense (i.e., Step A cannot be done unless Step D is done first). In this case, it is understandable that an AMT would need to modify the procedure.

On the other hand, a more ominous reason, and more likely, is that the AMT has figured out “a better way of getting it done.” Typically, the reason centers on time-efficiency, shortcuts, or skipping what the AMT considers “unnecessary steps.” In any case, the procedures have been written into the AMTs informal Black Book, but of course the AMT will categorically deny any existence of said book.

The informal source of information doesn’t necessarily have to be in the form of a Black Book, either. It can also be in the unwritten form of tribal knowledge (procedures that are being conducted contrary to manufacturers specifications and being informally handed down from “generation to generation” of AMTs).

Procedure is Adequate but AMT Doesn’t use it

This situation can be most problematic. These types of violations can fall under two broad categories*; routine* and *situational*. A *routine violation* (also known as a norm), happens at a collective level. “If everyone else is doing it, then why shouldn’t I?” An example of this would be AMTs not conducting a borescope inspection because “it never leaks.” This type of mindset can spread quickly, and is sometimes referred to as a normalization of deviance. On the other hand, a *situational violation* is typically a one-off, where an AMT does not strictly adhere to a procedure because of an unpropitious working condition (i.e., time pressure, fatigue, or availability of resources).

In 2007, an American Airlines MD-82 experienced an in-flight engine fire requiring a turnback and emergency landing in St. Louis (STL). The NTSB investigation revealed that a component in the manual start mechanism of the engine was damaged when a mechanic used an unapproved tool to initiate the start of the #1 (left) engine while the aircraft was parked at the gate at STL. The deformed mechanism led to a sequence of events that resulted in the engine fire, to which the flight crew was alerted shortly after take-off. There were no injuries or fatalities.

The above is an example of a typical situational violation. The term “violation” applies because the AMT has full volition of his/her actions and thus full accountability. This contrasts with no conscious awareness of committing an error, such as forgetting to put an oil cap back on an engine. From a disciplinary standpoint, these distinctions are important.

Conclusion

From the organizational level, an effective Safety Management System (SMS) can help to identify procedural drift through mechanisms such as employee reporting, safety performance monitoring, and incident/accident investigation. But this is not a magic bullet. Much of the drift is happening clandestinely, and many of the erroneous outcomes only become known reactively, as has been exemplified in the accidents/incidents mentioned in this article. The key to reducing procedural drift is to work proactively to identify the *precursors to drift*, and then address them accordingly. This begins with a healthy safety culture, which begins at the top of the organization.

Management should be very cognizant of its influences on line personnel. Company leaders may be the driving force that creates that pressure, fatigue, and lack of resources that lead to errors at the AMT level, such as procedural deviations and violations. Also, keep in mind that simple exhortations such as “make sure you always do a functional check” will not be effective. Organizations need to emphasize to their AMTs, in an ongoing and holistic manner, the critical importance of following approved procedures.

From the AMT level, an awareness of the consequences of intentional procedural deviations and violations is a great start. This should be covered in human factors courses and hopefully reinforced on a continuous basis. Even then, many AMTs that succumb to procedural drift have been taught the importance of strictly following procedures. Many times, these procedural deviations are well-intentioned with no maleficence intended, and yet they wind up causing some of the worst maintenance-related accidents. Ask yourself, “if something bad happens, can I live with it?”

Keep in mind that some of the biggest problem areas are skipping steps, signoffs without verification, or continuing a job without the correct tools or equipment. Also, I would be remiss if I did not make special mention of the consequential effects of skipping required functional/operational checks. Not only is this step a required component of many tasks, but it is also, in many cases, the last chance to trap any maintenance errors that may have been made in the job completion process. I estimate that at least half of all maintenance-related accidents occurred with a corresponding omission of a functional/operational check. Think about that the next time you decide to skip this check in the interest of time. Those extra few minutes could save you your job, an aircraft, and even a few lives. Do you catch my drift?

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