

TOO MUCH PLANE FOR ONE MAN TO FLY

CHECKLISTS

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It all started in 1935 with Boeing's entry in a design competition for a new bomber for the United States Army Air Corps. The Model 299 (which was eventually mass produced as the famous B-17) was a superior design to its competitors, and the flight demonstrations before the evaluating board were considered to be merely a formality. On October 30th, the aircraft took-off and began a smooth climb, when it suddenly stalled, crashed and burst into flames.

The investigation revealed the elevator lock had not been released before flight. Newspapers dubbed Model 299 as "too much plane for one man to fly". When, at a later stage, Model 299 was re-proposed to the US Government, Boeing's pilots had to invent some way of making sure that nothing was overlooked.

Checklists for pilots were the solution.

Today, flight operations professionals are well aware of the importance of a well designed checklist system. Although various approaches exist and sometimes conflict, a number of key issues have become accepted, such as the difference between standard operating procedures and personal techniques, the fallibility of human perception and the weakness of human memory, the need for a flow-pattern in cockpit actions and the need to include enough buffers for detection and recovery from incorrect aircraft configurations.

Checklists are at the foundation of operational standardization and flight safety. A checklist is a device designed to support the pilots to avoid forgetting vital items and actions while following standard operating procedures.

The focus of this article lies on flight operations by commercial air transport companies. But it is equally valid for any type of flight operation, and arguably for any other high-risk activity or industry.

CHECKLIST

The crash of this Boeing 299 was the result of disregarding the checklist.



More Lessons Learned

A study revealed that as of 1991 there were 228 accidents in the NTSB database in which checklist misuse was at least a contributing factor.

Although many could be discussed here, the accident of Delta Airlines Flight 1141 on August 31, 1998 reveals a systemic breakdown of safety barriers where the proper use of the checklist as the last line of defense would have prevented the accident. The Boeing 727-232, with 108 people on board, crashed immediately after take-off. The investigation revealed that the wing flap and slats were not properly configured prior to the attempted take-off. It was determined that the crew was not alerted because of a technical failure of the takeoff configuration warning system. In addition, the NTSB determined that contributing factors were Delta's slow implementation of necessary modifications to its operating procedures, checklists and training necessitated by significant changes following rapid growth and merger. At the same time, the FAA did not pursue the known deficiencies in Delta's operation aggressively enough.

However, what is really disturbing in the context of this article is, according to the CVR recordings, the First Officer replied "fifteen, fifteen, green light" to the "Flaps" item on the "Before Takeoff Checklist". The investigation proved that the flaps were never set. The First Officer's response

was most likely just a reflex response to the checklist item. In spite of organizational and technical factors, the proper execution of the checklist would have prevented the 14 fatalities and 26 serious injuries.

Checklist Fundamentals

Since checklists are an essential and fundamental concept for aviation safety, it is obvious that requirements are defined for manufacturers and operators, initiated at the level of the International Civil Aviation Organization (ICAO) and implemented in national regulations.

PANS-OPS (ICAO Doc. 8168) states that "Operators shall establish checklists as an integral part of standard operating procedures (SOPs). Checklists should describe the actions relevant to specific phases of operations (engine start, taxi, take-off, etc.) that flight crews must perform or verify and which relate to flight safety. Checklists should also provide a framework for verifying aircraft and systems configuration guarding against vulnerabilities in human performance." The same ICAO document provides very useful design guidelines and criteria for checklists.

ICAO Annex 6 Part I 4.2.5 "Checklists" states checklists "shall be used by flight crews prior to, during and after all phases of operations, and in emergency, to ensure compliance with the operating procedures con-

tained in the aircraft operating manual and the airplane flight manual. [...] The design and utilization of checklists shall observe Human Factors principles.”



These ICAO Standards and Recommended Practices (SARPS) are brought into the legal and operational world of commercial operators by EU-OPS 1.210(b): “An operator shall establish a check-list system to be used by crew members for all phases of operation of the airplane under normal, abnormal and emergency conditions as applicable, to ensure that the operating procedures in the Operations Manual are followed”.

OEMs provide checklists in their Aircraft Flight Manuals, which are approved in the context of the type certification. When an operator introduces an airplane into operation, these checklists need to be reviewed to reflect the organization’s corporate culture as it is lived by the flight operations and the training department.

Checklists provide assurance that flight safety critical tasks are performed correctly at the time and in the order required by providing two types of redundancy:

- Set-up redundancy: when the pilot configures the aircraft from memory and then uses the checklist to verify no items were omitted or wrongly set, or
- Mutual redundancy: when one pilot monitors the other in the execution of standard operating procedures.

Checklists Only Work if you Use them Correctly.

In studies pilots have been observed to short-cut checklist work or to memorize a checklist. Both behaviors are prone to omissions of items of the checklist. Using the checklist is work. Cockpit management should plan for enough time to perform it consistently.

When checklists are used frequently, routinely and over a longer period of time, a flow pattern develops. A crew member might get the impression to be doing the same thing, each time, every time, exactly the same way, and might eventually omit the use of the checklist. Under normal circumstances this flow pattern may be repeated reliably. However, even automated actions are subject to memory lapses, and any particular step may eventually be missed. There is an even bigger chance of this happening when the flow pattern is interrupted by a distraction. It takes a concentrated effort to “get back in the flow”. Without a checklist, the pilot must rely on a conscious cognitive memory process to recollect the sequence of steps. The chance of an error of omission is considerable.

Another problem with flow pattern checks is habituation. Checks performed following a deeply ingrained flow pattern will repeatedly present a desired result to the flight crew.

Eventually the observation may become so habitual that the expected result is registered without actually being present.

In summary, misuse of checklists may take the form of not using the checklist and performing tasks from memory, or by taking a shortcut, either omitting checklist items altogether or by not verifying the required status or condition specified by the checklist. Building a strong safety culture within the organization will help the flight crew understand the need for the correct and continuous use of checklists.

Airplanes are not “too much plane for one man to fly”, but simply too complex for any one man’s memory. Your checklist does not forget – so make diligent use if this simple yet powerful tool.



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ROUTINE

When used frequently, a pilot might get the impression to do the same thing routinely.