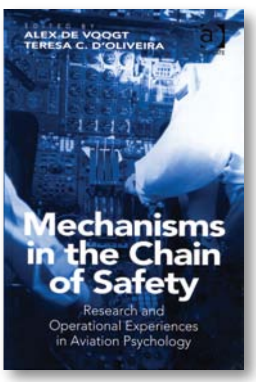
Chain Reactions

Mechanisms in the 'safety chain' are keys to effectiveness.

BY RICK DARBY



BOOKS

Input, Coping, Control

Mechanisms in the Chain of Safety: Research and Operational Experiences in Aviation Psychology

Alex de Voogt and Teresa D'Olivera, editors. Surrey, England and Burlington, Vermont, U.S.: Ashgate, 2012.180 pp. Figures, tables, references, index.

Aviation psychology has studied three main themes in the past hundred years, says Alex de Voogt in his introduction: personnel selection, or finding people who are the best fit for the industry's tasks; safety, particularly in terms of the pilot's role; and the interaction of people in a team, most notably in crew resource management. Despite the development and application of findings in all these themes, they continue to attract researchers.

"Selection methods are continuously studied, particularly in the area of air traffic control," de Voogt says. "Theories on safety are still evolving, and many aspects of aviation safety are in continuous need of attention. In addition, research on crew resource management is still gaining attention."

The papers in this book involve all three themes, but not as stand-alone topics. "Over time, these studies have been integrated and part of a single focus," de Voogt says.

The themes are organized as what the editors call "mechanisms," processes that determine effectiveness.

Input mechanisms "refer to the beginning of the chain — selection. Pilots or air traffic controllers enter a process of learning and training, assessment and evaluation. Learning processes feed into selection and crew performance."

Chapters in the book related to input mechanisms concern integration of crew resource management studies into pilot training methods; "prospective memory" — the ability to remember and perform tasks when needed without being prompted — in air traffic control; and analysis of individual air traffic controller "learning curves" during on-the-job training.

Coping mechanisms are "a behavioral tool used by pilots and crew to offset or overcome stress and adversity. Research on coping mechanisms has helped to understand pilot error and challenges in crew resource management."

Chapters discuss flight crew "adaptation," the ability to identify the relevant aspects of a new situation and adjust their strategies accordingly; pilot stress sources and coping behaviors; evaluating manual flying skill decay; and "anticipatory processes," the ability to predict how a situation will develop and respond proactively rather than reacting as events unfold.

Control mechanisms "refer to the environment in which people operate, including the organization, the safety systems and the safety climate in which people perform."

Under this heading are chapters about error detection during normal flight operations; the role of the global positioning system in accidents and incidents; a proactive integrated risk assessment technique; and safety reporting systems as a foundation for a safety culture.

De Voogt says, "Three types of mechanisms show the entanglement of selection, safety and crew resource management research. [In the book] research on stress is in the company of studies on flying skill, risk assessment techniques side with a study on safety culture, and studies on selection are joined by a chapter on learning curves."

The following summary of one chapter, necessarily omitting much of the discussion, offers a sample of the book's content.

One coping mechanism is a pilot's ability to revert to manual flying skills in lieu of, or in combination with, automation. Normal flight in modern transport category aircraft is almost exclusively automated except for takeoffs and the last moments before landing. But, as the four authors from Cranfield University in the United Kingdom note, "there are occasions when reversion to basic manual control is essential or preferable. Pilots may be forced to control the aircraft manually during abnormal situations, such as when recovering from unusual attitudes outside the automation's limits of authority or during automation failures."

'Significant control activity may not be reflected in large changes in the aircraft's attitude.'

Licensed pilots must be able to demonstrate their hand flying ability in recurrent training and simulator checks. "However, simulator time is valuable to an airline," the authors say. "There are numerous items in addition to manual flying ability which must be assessed during these brief sessions. … Consequently, the amount of time dedicated to manual handling may be minimal."

Of course, flight data recorders and analysis reveal how much the flight deviated from procedures and parameters such as tracking the glideslope and localizer of an instrument landing system (ILS). Shouldn't that make it easy to evaluate the flying pilot's manual flying skill? No, the authors say, because the control of an aircraft is "hierarchical." That is, the flight path cannot be *directly* controlled; it can only be controlled by "lower-order surrogates." For example, altitude can be controlled via elevator input, heading through aileron and rudder input, the authors say.

It is easy to measure the end product of the pilot's inputs — the aircraft's flight path — which is what ultimately matters. However, the authors say, it is crudely correlated with pilot hand flying skill.

"Unfortunately, in a large conventional transport aircraft, the relationship between control input, aircraft attitude and flight path variation is mediated by factors such as inertia, control power and the relatively high stability of the machine," the authors say. "Unlike [in] smaller aircraft, there is often a significant delay between control input and the larger aircraft's response. Consequently, further control inputs after the initial input may serve to cancel it out or reinforce the initial input before it has taken effect.

"As a result, significant control activity may not be reflected in large changes in the aircraft's attitude, and less so in its flight path. … Consequently, two pilots may describe similar flight paths but control the aircraft in a very different manner. It is, therefore, unlikely that basic flight path measures alone will have the sensitivity required to investigate fine variations in manual flying skills."

As a better alternative, they suggest directly measuring the pilot's control inputs in large aircraft through a process called "frequency-based measures." They cite a study of 12 trainee pilots undergoing a 40-hour jet orientation course on the Boeing 737NG: "The results showed that variation in the flight path was reduced as the cadet pilots progressed through the course. However, at the later stages of the course, the control strategy changed and was characterized by more frequent but smaller-amplitude control inputs."

In another study, of pilot deviations from the optimum flight path while flying an ILS approach, the deviations in the flight path were minor — even in asymmetric thrust conditions. But when the control inputs were measured, "it was revealed that very different control strategies were employed between the symmetric and the asymmetric approaches. … The significant differences in the pilots' performance could only be determined by the manner in which they controlled the aircraft and not from simply investigating the relatively coarse, flight path–derived measures."

Concerns are often expressed about pilots of large transport category airplanes losing their "edge" in manual flying because they do so little of it. (The authors say that this depends somewhat on the carrier, its equipment, its routes and its operational principles: "Two of the most prominent low-cost carriers in the U.K. have distinct operational philosophies, one encouraging routine manual flight over use of the [automation] and the other the exact opposite.")

In a study involving 66 professional airline pilots, "[researchers] examined the relationship between pilots' manual handling performance and their recent flying experience, using both traditional flight path tracking measures and frequency-based control strategy measures." The study identified "significant" relationships between recent flying experience and manual control strategy.

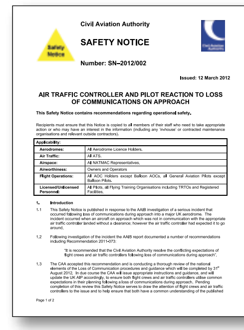
"The results showed that flight path–derived measures were again relatively insensitive to the amount of recent flying undertaken by the pilots," the authors say. "In the ILS segment of flight, only the glideslope standard deviation of error showed any significant correlation with recent manual flying experience … . However, the inner-loop parameters [those involving "pre-programmed" behavior independent of feedback from, for example, instruments and the outside view] proved to be much more sensitive to recent flight experience, with several frequency-based measures showing a significant association. During the straight-and-level and ILS flight segments, the analyses demonstrated that pilots who had flown more sectors in the previous week tended to use lower-frequency control inputs in pitch and exhibited a narrower spread of pitch input frequencies to the control system." In other words, they got the job done with less effort. Presumably, that would also allow them to concentrate more attention on situational awareness.

REGULATORY GUIDANCE

Failure to Communicate

Air Traffic Controller and Pilot Reaction to Loss of Communications on Approach

U.K. Civil Aviation Authority (CAA) Safety Notice SN-2012/002. March 12, 2012.


Civil Aviation Authority
SAFETY NOTICE
Safety Notice
Number: SN–2012/002
Issued: 12 March 2012
AIR TRAFFIC CONTROLLER AND PILOT REACTION TO LOSS OF COMMUNICATIONS ON APPROACH

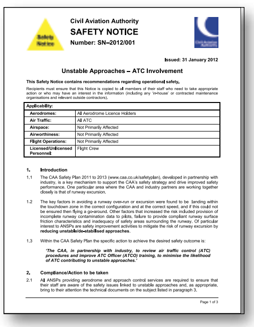
Following the investigation of an incident when an approaching aircraft was not in communication with the appropriate controller and landed without a clearance — the controller had expected a go-around — the U.K. Air Accidents Investigation Branch recommended that the CAA "resolve the conflicting expectations of flight crews and air traffic controllers following loss of communication during approach."

A full review is pending, but this notice "serves to draw the attention of flight crews and air traffic controllers to the issue and to help ensure that both have a common understanding of the published procedures." While the rules cited in the notice apply only in the United Kingdom, the suggestions may be of interest to pilots and controllers generally.

"Loss of communication on approach presents a complex challenge, and air traffic controllers must be acutely alert to the possibility that the aircraft may either land without a landing clearance or go around," the notice says. "Controllers should use all tools at their disposal to contribute to their situational awareness and should continue to make 'blind' transmissions to the subject aircraft, as it may have experienced only partial communications failure, and such transmissions can assist that crew's situational awareness. Transmitting blind should also help alert other pilots to the situation."

In the cockpit, flight crews "should note that air traffic control might not be aware of the loss of communications, so [they] should *not* anticipate that appropriate measures to facilitate a landing have been implemented. Therefore, flight crews should be alert to the possibility that vehicles, personnel and/or other traffic may be occupying or entering the runway."

Unstable Relationships


Civil Aviation Authority
SAFETY NOTICE
Number: SN–2012/001

Issued: 31 January 2012

Unstable Approaches – ATC Involvement

This Safety Notice contains recommendations regarding operational safety.

Recipients must ensure that this Notice is copied to all members of their staff who need to take appropriate action or who may have an interest in the information (including any 'in-house' or contracted maintenance organisations and relevant outside contractors).

Applicability:	
Aerodromes:	All Aerodrome Licence Holders
Air Traffic:	All ATC
Airspace:	Not Primarily Affected
Airworthiness:	Not Primarily Affected
Flight Operations:	Not Primarily Affected
Licensed/Unlicensed Personnel:	Flight Crew

1. Introduction

1.1 The CAA Safety Plan 2011 to 2013 (www.caa.co.uk/safetyplan), developed in partnership with industry, is a key mechanism to support the CAA's safety strategy and drive improved safety performance. One particular area where the CAA and industry partners are working together closely is that of runway excursion.

1.2 The key factors in avoiding a runway over-run or excursion were found to be landing within the touchdown zone in the correct configuration and at the correct speed, and if this could not be ensured then flying a go-around. Other factors that increased the risk included provision of incomplete runway contamination data to pilots, failure to provide compliant runway surface friction characteristics and inadequacy of safety areas surrounding the runway. Of particular interest to ANSPs are safety improvement activities to mitigate the risk of runway excursion by **reducing unstable/de-stabilised approaches.**

1.3 Within the CAA Safety Plan the specific action to achieve the desired safety outcome is:

'The CAA, in partnership with industry, to review air traffic control (ATC) procedures and improve ATC Officer (ATCO) training, to minimise the likelihood of ATC contributing to unstable approaches.'

2. Compliance/Action to be taken

2.1 All ANSPs providing aerodrome and approach control services are required to ensure that their staff are aware of the safety issues linked to unstable approaches and, as appropriate, bring to their attention the technical documents on the subject listed in paragraph 3.

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Unstable Approaches — ATC Involvement

U.K. Civil Aviation Authority (CAA) Safety Notice SN-2012/001. Jan. 31, 2012.

The CAA and industry partners are working together closely on preventing runway excursions, the notice says.

"The key factors in avoiding a runway overrun or excursion were found to be landing within the touchdown zone in the correct configuration and at the correct speed, and if this could not be ensured, then flying a go-around," the notice says. "Other factors that increased the risk included provision of incomplete runway contamination data to pilots, failure to provide compliant runway surface friction characteristics and inadequacy of safety areas surrounding the runway. Of particular interest to ANSPs [air navigation service providers] are safety improvement activities to mitigate the risk of runway excursion *by reducing unstable/de-stabilized approaches*."

Elaborating on that theme, the notice continues:

"Modern turbojet and turboprop aircraft are designed to have highly efficient, low-drag aerodynamic characteristics. This helps reduce fuel consumption but does result in such aircraft needing longer distances for descent and deceleration. Aircraft in flight, particularly large aircraft, possess a great deal of energy that must be dissipated appropriately during descent, landing and rollout. Aircraft must meet certain criteria on approach to be able to land safely, and managing an aircraft during the descent and approach phases essentially becomes a task of energy management. Landing long or landing at excessive speeds can result in an overrun, and excessive sink rates or failure to capture the correct vertical profile can contribute to hard landings or controlled flight into terrain. In a destabilized approach, the rapidly changing and abnormal condition of the aircraft may lead to loss of control."

A stable approach can become unstabilized by inappropriate controller actions such as:

- "Distance (time) provision where insufficient track miles are provided for the flight crew to achieve the correct vertical profile and/or aircraft energy during descent;
- "Changes of runway [that] can increase flight deck workload and can significantly affect track mileage to touchdown and may not allow sufficient time for the crew to re-plan the approach;
- "Changes in the type of approach, particularly from precision to nonprecision [that] can affect the planned descent profile. Typically a nonprecision approach requires the aircraft to be stabilized in the landing configuration by the final approach fix. It also requires more preparation and planning by the crew;
- "Vectoring that does not allow the correct descent profile to be flown in relation to the instrument landing system (ILS), and vectoring which causes the aircraft to intercept the glide path before the localizer. Most aircraft will not lock into the glide path in this condition, causing the aircraft to 'fly through' the glide path;
- "Incorrect track distance to touchdown, resulting in flight crew being unable to calculate their descent and speed profile; [and,]
- "Inappropriate use of speed control which adversely affects the crew's capability to manage the aircraft's energy and its descent profile."