

**Unexpected Pilot Performance Contributing to Loss of
Control in Flight (LOC-I)**

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Unexpected Pilot Performance Contributing to Loss of Control in Flight (LOC-I)

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Four assumptions commonly made regarding civil pilot training, which are true in all normal flight conditions and standard operations, may become invalid in the presence of developing or developed airplane upsets leading to a Loss of Control – In flight (LOC-I).

The four training assumptions are:

- 1. That the aircraft is within the normal operational envelope and in a non-agitated flight condition**
- 2. Airplane handling skills and approaches established by regulatory licensing are adequate to resolve conditions that exceed the bounds of licensing training in attitude, airspeed and/or angle of attack**
- 3. Situational awareness and caution/warning information cuing is accurately correlated by the pilot with respect to observed flight conditions**
- 4. Pilot psychological and physiological response is predictable and reliable**

In order to evaluate the validity of these four assumptions with respect to occurrence in LOC-I accidents, an analysis was made of fatal LOC-I accidents worldwide from 2001 – 2010. The accidents evaluated were classified as LOC-I by the International Civil Aviation Organization and the Commercial Aviation Safety Team, which includes government officials and aviation industry leaders. In addition to assessing the validity of the identified training assumptions with regard to these LOC-I accidents, conclusions were made based on the presence, strength of associations, and correlations identified.

I. Introduction

Empirical data from the delivery of Upset Prevention and Recovery Training (UPRT) in aircraft and flight simulators show that most professional pilots exhibit performance deficiencies in correctly responding to airplane upset conditions and associated scenarios delivered in training. We observed training operations utilizing high performance aerobatic aircraft¹, military jet training aircraft², and a Level D full flight simulator replicating a regional jet aircraft. The instruction delivered in all training platforms exhibited similar deficiencies when encountering upsets or parameters outside the normal operational domain.

In a formal investigation conducted in 2007-2008³, 115 pilots of varying experience levels participating in UPRT were evaluated for their capability to effectively respond to the following five flight conditions:

1. Nose Low Over-bank with approximately 120° angle of bank and 30° nose low pitch.
2. Wake Turbulence aggravated by rapid onset entry to generate startle response.
3. Cross-Control Stall which included ample, but unheeded, prevention opportunities.
4. Nose High Unusual Attitude of more than 45° nose high and 10 knots above stall speed.
5. Control Failure: Rudder Hard Over which simulates 80% deflection and jam.

The results of the study assessing pilot capability and training program effectiveness with regard to the measured tasks are displayed in Table 1.

Table 1

	Effective Pilot Response to Potential LOC-I Conditions	Assessed on:
Before Training	28.10%	1st flight
After Training	96.30%	5th flight
Pilots evaluated	115	

This apparent inability to safely resolve upset conditions was demonstrated by highly experienced and otherwise fully competent pilots in simulated training environments where advance knowledge of the introduction of upset conditions was provided. This pre-upset awareness contrasts with potential upset situations encountered in the operating environment where surprise has been shown to be a characteristic of encounters resulting in LOC-I¹. The unexpected and time-critical nature of a real world upset situation is likely to exacerbate inadequate performance observed in training settings.

There has been much attention focused on LOC-I as it has become the leading causal factor for aircraft fatalities and hull losses in worldwide commercial aviation⁴. Additionally, LOC-I has been prominent in several recent high profile fatal accidents such as Colgan Flight 3407 and Air France 447. In order to better understand the genesis of this LOC-I problem, an explanation for observed deficiencies in pilot performance in the upset domain was investigated. Examination of existing pilot training content and methodology revealed that certain assumptions made regarding current pilot competencies may be invalid when pilots are confronted by aircraft upset conditions in the operating environment.

There are four assumptions inherent in today's licensing training that are commonly made in defining and implementing pilot training. These four assumptions are made by regulators responsible for pilot training oversight, as well as by the providers of flight training services. It is believed that these assumptions, which are completely correct and warranted in normal flight conditions and operations, become invalid in the context of an airplane upset. It is this apparent disconnect in the application of these assumptions into a realm where they no longer apply, airplane upsets leading to LOC-I, which was investigated.

The four assumptions made in the delivery of civil pilot training which may not be valid in the presence of a developing or developed airplane upset are:

1. The aircraft is within the normal operational envelope and in a non-agitated flight condition.
2. Airplane handling skills and procedures established by regulatory licensing are adequate to resolve conditions that exceed the bounds of licensing training in attitude, airspeed and/or angle of attack.
3. Situational awareness and caution/warning information cuing can be accurately correlated by the pilot with respect to observed flight conditions.
4. Pilot psychological and physiological response is predictable and reliable.

In reviewing the circumstances of fatal LOC-I accidents and associated causal factors, one or more of these assumptions appear to be violated in most LOC-I mishap cases. These four assumptions made regarding pilot training, which become invalid in the presence of escalating upset conditions, can be conversely described in terms of four resulting areas of deficiency in pilots' knowledge and proficiency in the area of upset prevention and recovery. This can lead to the exceedance of pilot corrective action or performance capabilities in the presence of an airplane upset event.

Airplane Upsets

The terms LOC-I and airplane upset are not synonymous. An airplane upset describes a flight condition which may or may not result in a LOC-I. A LOC-I is often preceded by an airplane upset, but could be the result of a non-powerplant related component failure, or other undesired aircraft states.

While specific values may vary among airplane models, the following *unintentional* conditions generally describe an airplane upset⁵:

- Pitch attitude greater than 25 degrees, nose up.
- Pitch attitude greater than 10 degrees, nose down.
- Bank angle greater than 45 degrees.
- Within the above parameters, but flying at airspeeds inappropriate for the conditions.

As described by the *Airplane Upset Recovery Training Aid*, these conditions also describe situations that may exceed the normal operating envelopes of most large transport aircraft.

Pilot Centered Nature of LOC-I

Current training practices and other safety related efforts have resulted in an overall reduction in accidents and a corresponding increase in flight safety⁶. While overall safety has improved, there has been a redistribution of the relative contributions of various causal factors. From the period of 2001 to 2008, LOC-I experienced a 29% increase in the contribution of this category towards the overall fatal accident rate⁷. During the same period Controlled Flight Into Terrain (CFIT), which had once been the primary cause of both the number of fatal accidents and fatalities in commercial aviation, has seen a decline in recent years. The advent of Ground Proximity Warning Systems (GPWS), Terrain Awareness and Warning Systems (TAWS), and even display technology such as Synthetic Vision, has begun to tame what was the principal air safety threat through technological means.

LOC-I, on the other hand has many different precursors and has resisted mitigation through technological means alone. Aircraft with “fly-by-wire” flight control systems significantly reduce the threat of LOC-I⁸, and yet they are still susceptible to pilot actions that can result in fatal accidents⁹. The pilot centered nature of the LOC-I threat means that training centered solutions may provide the best means of mitigating the threat, and also illustrate the importance of having a clear understanding of the effects that training assumptions may have on pilot competencies with regard to upset awareness, avoidance, recognition, and recovery.

II. The Four Training Assumptions

This section will expand upon the four previously introduced training assumptions which become invalid upon passing the threshold of an airplane upset. These four training assumptions are explained in greater detail here to provide a clearer understanding of the analysis conducted.

1. **Normal Envelope:** *The aircraft is within the normal operational envelope and in a non-agitated flight condition.*

This training assumption relinquishes the need for training in recovery from the following flight conditions or undesired aircraft states since it assumes that they will not be encountered:

- a. Any abnormal or non-standard control inputs or techniques that would be required to correct for airspeed above V_{NE}/V_{MO} (Velocity – Never Exceed/Maximum Operating), or below the first indication of stall.
- b. Any aircraft attitudes beyond those seen on normal operational profiles or required for standard licensing training (60° angle of bank, $\pm 30^\circ$ of pitch).
- c. Training for non-standard aircraft configurations, failures, or malfunctions not anticipated in certification is not required. As an example, engine failures and emergency gear extension are anticipated, many other conditions or multiple failure situations are not anticipated.

The term *non-agitated* means that:

- d. Pilots need not be trained in correcting inputs which might oppose or defeat protective systems (such as stall shakers or pushers) since that will not occur,

- e. The aircraft is will have no sustained exceedance of CL max / critical angle of attack, and the pilot is able to counter any disturbances, both subtle and severe, to remain within these boundaries
2. **Existing Skills:** *Airplane handling skills and approaches established by regulatory licensing are adequate to resolve conditions that exceed the bounds of licensing training in attitude, airspeed and/or angle of attack.*

This training assumption states that skills currently required and acquired during pilot licensing will provide all of the skills that will be required in preventing and recovering from an airplane upset which could lead to a LOC-I. This would mean that:

- a. The same techniques and skills taught in existing Unusual Attitude training will be adequate to resolve flight conditions which exceed 60° of bank or $\pm 30^\circ$ of bank (the limits of existing licensing training requirements).
 - b. That the academic knowledge of spin recovery techniques will be adequate to implement recovery if necessary.
 - c. Skills required to execute a recovery from an approach to stall (the current requirement) will be the same as the skills required to recover from an angle of attack beyond the critical angle of attack.
3. **Adequate Cueing/SA:** *Situational awareness and caution/warning information cuing can be accurately correlated by the pilot with respect to observed flight condition.*

This training assumption presumes that:

- a. Although many flight display indications provide alternate symbology, modes, and behavior in non-standard conditions such as extreme attitudes and airspeeds associated with airplane upsets, pilots will make sense of unfamiliar presentations the first time that they are seen.
 - b. Pilots will understand aircraft behavior such as negative roll damping or lateral instability that occurs in flight regimes that may be encountered in an aircraft upset the first time such situations are encountered.
 - c. When multiple aural, visual, and tactile warning and alerting functions occur simultaneously that pilots will be able to correctly understand/prioritize all sensory inputs although they may never have been seen in combination, or at all.
4. **Reliable Response:** *Pilot psychological and physiological response is predictable and reliable.*

This training assumption supposes that:

- a. Pilots will react the same in situations posing the threat of injury or death in the same manner that they will in a non-threatening training environment without the presence of consequences or the perception of risk
- b. Correct control inputs will be applied in emergency situations which have not been encountered before
- c. The knowledge necessary to make time-critical decisions in the face of life threatening hazards is accessible when needed

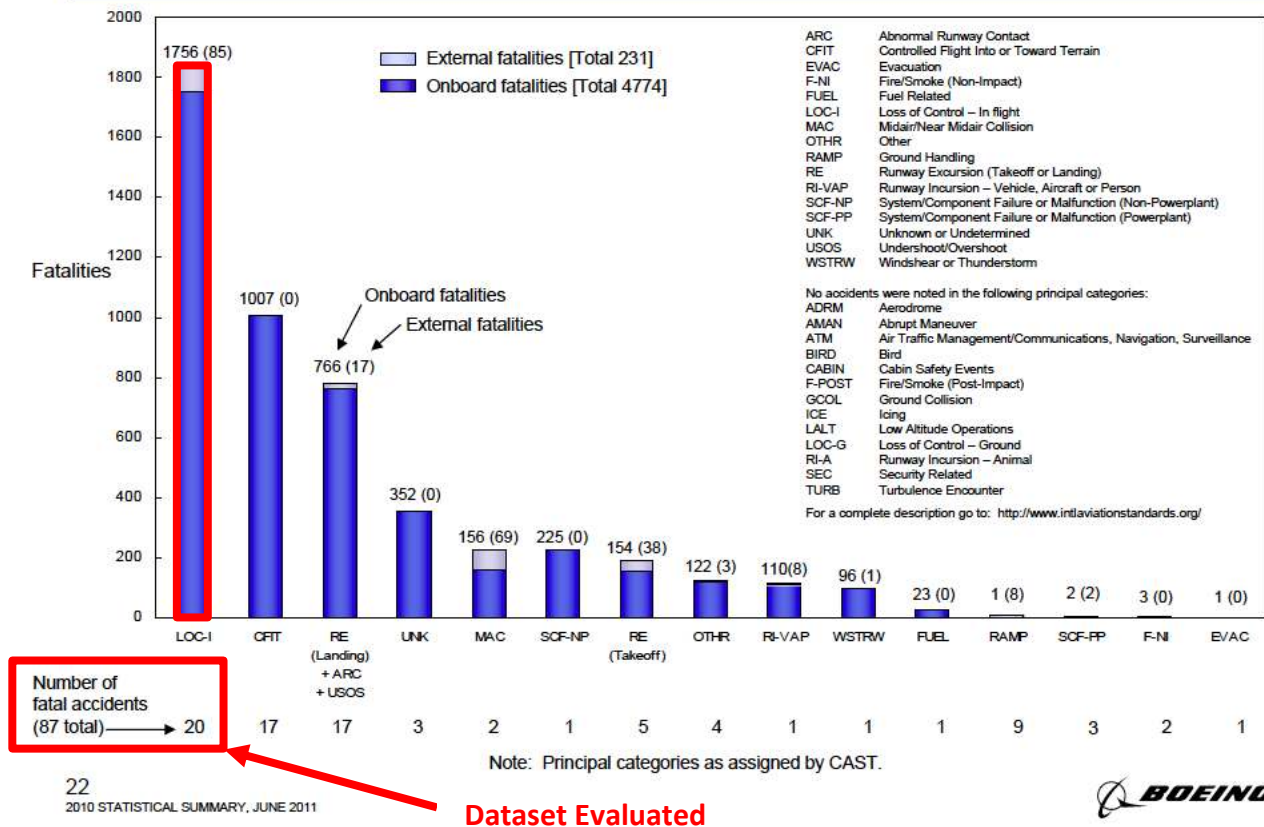
III. Accident Data

After discussing appropriate data sample sizes, selection of accident data quickly centered on the most familiar and accepted resource for LOC-I information regarding commercial jet aircraft. The *Statistical Summary of Commercial Jet Airplane Accidents*¹⁰ published each year by Boeing Commercial Aircraft contained 20 LOC-I accident events during the most recent 10 year period studied. That was in the target range we had identified for consideration. These data had the benefit of being extracted from a known and well vetted resource (Table 2).

The dataset used for evaluation was comprised of fatal accidents identified by the Commercial Aviation Safety Team (CAST) using an operational definition of loss-of-control accidents developed by the CAST/ International Civil Aviation Organization (ICAO) Common Taxonomy Team (CICTT). The CAST dataset encompasses all fatal accidents in the worldwide commercial jet transport fleet over a ten year period, and assigns accepted aviation occurrence categories. There were 20 accidents specifically attributed to LOC-I. The accident data selection criteria are described in Appendix A.

Table 2

Fatalities by CAST/ICAO Common Taxonomy Team (CICTT) Aviation Occurrence Categories Fatal Accidents – Worldwide Commercial Jet Fleet – 2001 Through 2010



IV. Data Analysis

The analysis required for this study was to evaluate for the presence of conditions which invalidate any of the four training assumptions previously described. The presence of such conditions demonstrates an association or correlation with the concept of common training assumptions becoming invalid with regard to actual LOC-I accident profiles.

The initial step in the study was defining the process of data analysis to be followed. The process identified and used involved four steps: data set selection, individual review, discrepancy identification, and consensus review.

Data Set Selection

Selection of the *Statistical Summary of Commercial Jet Airplane Accidents* published annually by Boeing Commercial Airplanes was discussed previously under the Accident Data section. Data specific to each of the 20 accidents was gathered and disseminated to the authors and an independent reviewer in preparation for the next phase.

Individual Reviews

Individual reviews of the accident data were conducted by three reviewers to provide three independent viewpoints of the information. Review results were recorded in a common matrix utilized by all reviewers.

Discrepancy Identification

Once individual reviews were conducted, the discrepancies between reviewers were identified for further review.

Internal Consensus Review

Further review was conducted by phone and email to reach the consensus ratings provided in our results. This process allowed for sharing considerations and interpretations of data.

Inadequate Data

Four of the twenty accident data sets had insufficient information to make the required determinations. Though inferences could be made from some of the data available, only verifiable information and justifiable viewpoints were used in our findings. Rationale for consensus findings was based on a conservative desire to reach defensible determinations. This resulted in the elimination of data sets due to incomplete information or data that could not be substantiated.

Interrelated Nature of Training Assumptions

During the process of analysis, the interrelated nature of the assumptions was noted. For example, if the determination was made that the airplane will not be accidentally operated outside of its normal parameters, then existing training skills provided to pilots during licensing training did not need to address that likelihood. Similarly, if it was assumed that the caution and warning alerting systems and cues would be understood by pilots, then it is reasonable to expect that they would have behaved in a reliable and predictable fashion.

V. Results

The results of the analysis conducted are compiled in Table 3.

A strong relationship was found between all four of the assumptions and conditions found in LOC-I accidents

Table 3 – Results of LOC-I Accident Analysis

“X” indicates the presence of a violation of the identified training assumptions with regard to the referenced accident dataset.

Accident Dataset #	Normal Envelope	Existing Skills	Adequate Cuing/SA	Reliable Response
1		X		X
2		X	X	X
3				X
4	X	X	X	X
5	Inadequate Data			
6	Inadequate Data			
7	X	X	X	X
8	X	X	X	X
9	X	X	X	X
10	X	X	X	X
11	X	X	X	X
12	X	X	X	X
13	X		X	X
14	Inadequate Data			
15	X	X	X	X
16	X	X	X	X
17	Inadequate Data			
18				X
19				X
20				X
Accidents with acceptable data				16
Invalid Assumption	10	11	11	16
Occurrence	62.5%	68.8%	68.8%	100.0%

VI. Analysis of Findings

The findings indicate that definitive changes to civil pilot training program requirements and the training experience received by pilots are warranted reflecting the true picture of what pilots competencies required in actual LOC-I encounters. Pilots receiving training based on the prevalent training assumptions identified will not be provided with the specific knowledge and practical skill development that may be required in an unexpected upset encounter. While common existing training assumptions indicate no

need for such training, that viewpoint is not supported by the accident record. Without changes based on aligning pilot performance capabilities with the actual threat represented by the accident record, a significant reduction in the current LOC-I accident rate is not likely to be achieved.

The importance of the correlations found is significant in helping to identify enhanced pilot training which can be used to reduce the present unacceptable rate of LOC-I accidents. If the origin of pilot deficiencies resulting in LOC-I can be successfully targeted to missing aspects of flight training based on training assumptions which do not apply to the aircraft upset domain, specific training designed to close resulting pilot performance gaps can be identified. The existence of a causal relationship between training assumptions that are invalid with regard to pilot skills required in the upset environment indicate the types of training may be appropriate in providing training focused on mitigating LOC-I. Such training is identified in the conclusions presented as a result of this study.

Historical Perspective

The fact that in the majority of the LOC-I accidents evaluated prevalent conceptions of the training needed and provided are not valid should not be entirely surprising. Until the mid-1990's, the civil pilot licensing standards which are being scrutinized here were not the de facto training standard for commercial pilot hiring¹¹. Until that time, airline pilot hiring worldwide was dominated by pilots who had received their training through military, rather than civilian pilot training channels and curricula. Due to increased overall pilot demand, and reductions in military pilot production worldwide, the majority of airline pilots hired today have received training through civilian pilot training.

So while the training assumptions identified in civilian pilot training programs have existed for many decades, the training result, in terms of the average all-attitude/all-envelope pilot competency in today's airline cockpit, is more recent. In overall terms, while enhancements to pilot training required to provide greater LOC-I mitigation would be new for civilian pilot training requirements, they would actually be a return to certain elements of training that have historically been received by the majority of commercial airline pilots.

VII. Conclusions

The study results indicate that current training assumptions may result in pilot deficiencies in the ability to safely and effectively respond to situations which have led to LOC-I accidents. The question that must be answered is what changes to pilot training programs and requirements would be appropriate to mitigate the LOC-I threat.

While many of the accidents evaluated could have been prevented through avoided at the *Awareness* or *Prevention* stages of mitigation, training in upset *Recovery* skills provides a secondary, redundant level of defense for LOC-I which is appropriate for the predominant threat to air safety. While it is obvious that specific skills devoted to appropriately recovering from an aircraft upset can prevent such a situation from escalating to a catastrophic LOC-I event, the primary benefit is far greater, if more subtle.

As is stated in the *Airplane Upset Recovery Training Aid*¹²: "It should be emphasized that recovery to a stabilized flight path should be initiated as soon as a developing upset condition is recognized." In other words, it is always preferable to intervene in an aircraft upset at as early a stage as possible. While prevention is far safer than recovery when it comes to defeating a LOC-I event, the chief benefit in training for recovery is not in the recovery skills gained, but in the improved capacity for mitigation through prevention. In training for recovery, the pilot in training must be repeatedly taken into situations requiring recovery (in a suitable training aircraft platform with an acceptable margin of safety) in order to develop necessary competencies. The repeated exposure to conditions beyond the threshold of normal flight operations provides an opportunity to identify the approaching boundaries of an aircraft upset. It is far easier to prevent something that has been experienced than something that has only been imagined.

Normal Envelope

In the majority of LOC-I accidents, normal operating parameters, standard aircraft limitations, or the normal maneuvering envelope within which pilots receive required training was exceeded. For pilots to be able to safely and effectively respond in such situations, they should be provided training in ranges of

aircraft attitude and flight conditions beyond those encountered in normal operations. The goal of such training is not to gain excess familiarity in such regimes, only to identify when and how to safely and expeditiously return an aircraft to its normal and safe operating domain.

Existing Skills

It is clear to see the tie to the *Normal Envelope* assumption. If aircraft encountering upsets do not remain in what can be considered a normal envelope, then a pilot trained with *Existing Skills* that presuppose that such a situation will not occur could find themselves in a situation for which current licensing skills had left them unprepared. The training assumption could be somewhat justified if the skills necessary in LOC-I only represented a linear progression of skills from licensing training. Such is not the case. Many of the skills required in situations leading to LOC-I are extremely counter-intuitive. Expecting pilots to react to situations requiring counter-intuitive reactions in a time-critical, life threatening environment was found to be unrealistic in over two-thirds of the accidents evaluated.

Two examples of required pilot competencies required in escalating upset encounters are provided. In highly choreographed, prescriptive approach-to-stall training scenarios, high performance aircraft at low altitudes may often be recovered from indications of stall, by application of power, with back pressure used to obtain a "minimum loss of altitude" which for decades was used as an objective standard for pilot performance in such situations. Unfortunately, at high altitudes or significant angles of attack, sustained forward control pressure may be required to reduce the angle of attack, which may result in significant altitude loss. This is just one of many examples where existing training provides either no helpful information or skill development, or worse yet, skills that could be inappropriate or even dangerous in reacting to certain impending loss of control situations.

Adequate Cueing/SA

Although the *Adequate Cueing/SA* training assumption could be the subject of significant study on its own, extensive research is not necessary to understand why this assumption was violated in the preponderance of accidents analyzed. The connection between *Normal Envelope* and *Existing Skills* training assumptions has already been made. An additional correlation can be drawn with regard to the *Adequate Cueing/SA*. Although many advanced capabilities for warning, alerting, and providing information to pilots have been designed and in many cases currently exist in cockpits today, pilots are not required to be trained in their function, use, or meaning due to previously discussed training assumptions. If it is believed that the aircraft will remain in the *Normal Envelope*, and that *Existing Skills* will appropriately handle all situations that a pilot will face, then there is no motivation to provide pilots with the complete range of information and capabilities that current caution, advisory, and warning systems can provide.

Here are a few examples. A Pitch Limit Indicator, or PLI, is a display presentation which may be provided to pilots on an attitude indicator or primary flight display which represents the maximum pitch angle that may be achieved prior to stall. The PLI accounts for speed, weight, altitude, and other factors and displays them on an existing instrument. Though not a direct angle of attack indicator, it provides essentially the same information in a useful manner for the pilot. There is no requirement that the use of a PLI, in equipped aircraft, be trained.

An actual aircraft upset can be an extremely disorienting event. In addition to aircraft attitudes that may not have been experienced before because of both the *Normal Envelope* and *Existing Skills* assumptions, there are a whole host of other aural alerts, visual display changes, and even flight control law changes that can come into play. When they have not been experienced before, individually or in combination, it should be no surprise that they may sometimes add confusion rather than clarity to an already chaotic event.

The results of this situation can extend beyond experiential training to include academic information that is not routinely provided to pilots. The *Airplane Upset Recovery Training Aid*¹³ states that "a stall is characterized by any of, or a combination of, the following:

- a. Buffeting, which could be heavy at times.
- b. A lack of pitch authority.
- c. A lack of roll control.

d. Inability to arrest descent rate.

These characteristics are usually accompanied by a continuous stall warning.”

Because many full flight simulators cannot replicate many of these characteristics beyond the first indication of stall, many pilots in accident situations can be confused by the presence of such unfamiliar aircraft performance and behavior. Such behavior would be much more familiar, and situational awareness improved, if pilots were taught this information at some point in their career. No such training requirement exists, in large part due to the identified training assumptions.

Reliable Response

The interrelated nature of the previous training assumptions has been discussed. Their combined effects may work together in some ways to create the last training assumption violation in the face of LOC-I conditions, that pilots will provide a predictable and *Reliable Response*. The significance of the fact that in all accident cases evaluated, pilots did not perform as their training would predict or as we would expect, must send a clear message that current training is not providing what is needed by pilots confronting an escalating upset event that results in loss of control.

Certainly there are examples of substandard airmanship to be found in the accident examples studied. However, the significance of the fact that in 100% of the accidents profiled, questionable pilot responses or actions were involved should indicate that whatever training is required for pilots to perform in a safe, effective, predictable, and reliable manner in the face of a threatening upset event, it is not being delivered by today's pilot training.

The combined result of the *Normal Envelope*, *Existing Skills*, and *Adequate Cueing/SA* training assumptions is to deny pilots with a path to follow in an unexpected upset encounter. The unpredictable, unreliable behavior and performance exhibited is testimony that the superb training that is provided to pilots today in normal operational and flight regime domains is not being provided for the safety of pilots and passengers in the arena of non-normal, upset flight conditions leading to LOC-I. The evidence is clear.

Implication to Professional Pilot Competencies

It is important to clarify that the assertions of this paper identify the erosion or eradication of a pilot's knowledge, skills and attitudes (KSAs) when measured under certain conditions found in actual LOC-I accidents. Simply put, when a pilot is challenged by a situation beyond their experience, where their pilot handling skills are ineffective at resolving the condition, and/or motion, visual, audio and vestibular cuing combinations compound the escalating confusion, it should not be surprising that traditional pilot competencies may no longer be effective. If LOC-I is to be mitigated through training, it necessitates the reconstruction of standard pilot KSAs in conditions characteristic of LOC-I accident events. These conditions can only be generated safely, with sufficient fidelity, in an all-attitude/all-envelope capable airplane with a specialized instructor following a LOC-I-specific building-block program.

In the accidents evaluated as a part of this study, 1,756 people died over a ten year period. While there is some risk involved in aspects of the training required to mitigate the LOC-I threat (all flight and aircraft-based training carries some measure of risk), that risk would be borne by pilots in training. It can be argued that the identifiable, controllable risk inherent in enhanced UPRT both reduces overall risk and places it more appropriately in the flight training environment. The current risk posed by the invalid training assumptions exposed by this evaluation is born by all who fly with pilots who have yet to receive the knowledge and practical skill development attainable through enhanced UPRT.

VIII. Acknowledgement

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X. Appendix A: Accident Data Selection Criteria

The following data were evaluated to determine whether the identified prevalent pilot training assumptions were valid in the data set for each accident. The overall data consist of the 20 fatal worldwide commercial jet accidents from 2001-2010 as presented in the “Statistical Summary of Commercial Jet Airplane Accidents-Worldwide Operations, 1959-2010”, page 23, as published by the Aviation Safety Department of Boeing Commercial Airplanes, Seattle, WA, USA.

The International Civil Aviation Organization (ICAO) and the Commercial Aviation Safety Team (CAST), which includes Government officials and aviation industry leaders, have jointly chartered the CAST/ICAO Common Taxonomy Team (CICTT). CICTT includes experts from several air carriers, aircraft manufacturers, engine manufacturers, pilot associations, regulatory authorities, transportation safety boards, ICAO, and members from Canada, the European Union, France, Italy, the Netherlands, the United Kingdom, and the United States. CICTT is co-chaired by a representative from ICAO and CAST.

The CICTT team is charged with developing common taxonomies and definitions for aviation accident and incident reporting systems. Common taxonomies and definitions establish an industry standard language, to improve the quality of information and communication. With this standard language in place, the aviation community's capacity to focus on common safety issues is greatly enhanced. The CICTT Aviation Occurrence Taxonomy allows the assignment of multiple categories as necessary to describe the accident or incident. Since 2001, the Safety Indicator Steering Group (SISG) has met annually to code CICTT occurrence categories to the prior year's accidents.

In a separate activity, the CAST assigned each accident to a single principal category. Those accident assignments and a brief description of the categories are reported in Table 2. The CAST use of principal categories has been instrumental in focusing industry and government efforts and resources on accident prevention. Pareto charts using principal categories are used by CAST to identify changes to historic risk and to help to determine if the safety enhancements put in place are effective.

Complete descriptions of the categories are available at <http://www.intlaviationstandards.org/>

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	1/31/2001	Lineas Aereas Suramericanas	Caravelle	LANDING	LANDED SHORT AFTER GO-AROUND	3		3	HK-3932X	EL YOPAL
1	<p>Narrative Description: During the final stage of a visual approach to Mitu, the aircraft undershot, touching down just before the airfield perimeter fence. It ran forward, through the fence and its left main undercarriage struck a low mound and broke away. Meanwhile, power had been increased for a go-around and the aircraft got airborne again. The aircraft climbed away safely and the pilot elected to divert back to El Yopal. However, apparently due to the damage sustained during the undershoot, hydraulic pressure had been lost and the crew were unable to retract the undercarriage. The aircraft continued towards El Yopal but power was lost during the final approach and a forced landing was attempted in fields some three miles short of the airfield. During the landing the aircraft struck trees, broke up and caught fire. The accident happened in daylight and in clear weather. The aircraft was operating a cargo flight Bogota - El Yopal - Mitu with a general cargo including 14 earthenware jars of gasoline.</p>									
	11/12/2001	American Airlines	A300	INITIAL CLIMB	CRASHED SHORTLY AFTER TAKEOFF	260	5	265	N14053	(near) BELLE HARBOR
2	<p>Narrative Description: The aircraft was destroyed by impact and post impact fire when it crashed in a residential area of Belle Harbor, Queens very shortly (103sec.) after take-off from Runway 31L at JFK International Airport, New York. The point of impact was in the general area of Belle Harbor/Rockaway Beach, about 6 or 7km. from the airfield. Some parts of the aircraft, including both of its engines and its vertical stabilizer, separated prior to impact with the ground and were found remote from the main crash site. The accident happened in daylight (0916L) and in fine, clear weather. Wind 320deg./11kt. The aircraft was operating a flight (AA587) to Santo Domingo, Dominican Republic.</p> <p>The aircraft had been cleared to follow the Kennedy Nine/Bridge Climb SID, which calls for a left turn within JFK 4.5DME. The flight took off about 105sec. behind a Japan Airlines Boeing 747 and encountered a 'mild' wake from that aircraft as it was turning left as cleared. During the wake encounter, the co-pilot, who was handling the aircraft, responded, initially, with control wheel inputs which were 'too aggressive' and his initial rudder pedal input was 'unnecessary to control the plane.' These pedal inputs created cyclic rudder motions which, ultimately, overstressed the vertical stabilizer attachments, starting with the right rear lug and it broke away. The vertical stabilizer was exposed to aerodynamic loads that were about twice the certified design limit and exceeded the certified ultimate load limit.</p> <p>The co-pilot was said to have had a 'tendency to overreact' to wake turbulence by taking unnecessary actions, including making 'excessive' control inputs. It was noted that the American Airlines Advanced Aircraft Manoeuvring Program ground school training encouraged pilots to use rudder to assist with roll control during recovery from upsets, including wake turbulence and the NTSB believes that the 'Manoeuvring Program 'excessive bank angle simulator exercise' could have caused the co-pilot to have an unrealistic and exaggerated view of the effects of wake turbulence, erroneously associating such encounters with the need for aggressive roll upset recovery techniques, and led to the development of control strategies that would produce 'a much different, and potentially surprising and confusing, response' if performed in flight.</p> <p>The A300-600 rudder control system couples a rudder travel limiter system, that increases in sensitivity with airspeed, with, according to the NTSB, the lightest pedal forces of any transport-category aircraft that they evaluated during their investigation. Because of this high sensitivity (light pedal forces and small pedal displacements), the A300-600 rudder control system is said to be susceptible to potentially hazardous rudder pedal inputs at higher airspeeds.</p> <p>The NTSB determined that the probable cause of the crash was the in-flight separation of the aircraft's vertical stabilizer resulting from it experiencing loads beyond its ultimate design limit, created by the co-pilot's 'unnecessary and excessive rudder pedal inputs.' Contributing to this were the characteristics of the A300-600 rudder system design and elements of the American Airlines Advanced Aircraft Manoeuvring Program.</p>									
	5/4/2002	EAS Airlines Nig	BAC 1-11	INITIAL CLIMB	CRASHED ON TAKEOFF USED MORE THAN AVAILABLE RUNWAY	73	30	103	5N-ESF	KANO
3	<p>Narrative Description: The aircraft was destroyed by impact and post impact fire when it crashed, shortly after take-off, in a built up area about 3km. from Kano Airport. Apart from those killed on board the aircraft, a further 30 people on the ground also died and 24 were seriously injured. 23 residential buildings, two mosques and a school are also said to have been destroyed in the crash and subsequent fire. The accident happened in daylight (1330L) and in fine weather; wind 170deg./7kt., Temp +36C and QNH 1003. The aircraft's take-off weight was 39,243kg. Kano airfield elevation is 1,565ft. The main runway at Kano (24/06) was closed for resurfacing work at the time of the accident and the One Eleven therefore used the shorter runway, Runway 23, which is 2,600m. long. It is reported that, on take-off, the aircraft used up the full length of the runway and then continued for 60m across the overrun area and then for a further 180m across soft sandy ground before it eventually became airborne. It apparently struck a number of approach lights at this time. It apparently then climbed to a height of between 300 and 400ft. before beginning to descend. One witness on the ground has reported seeing the aircraft 'turning and wobbling' prior to the crash. The aircraft was operating a flight to Lagos.</p>									
	3/6/2003	Air Algerie	737	TAKEOFF	AIRPLANE CRASHED AFTER TAKEOFF	102		102	7T-VEZ	TAMANRASSET
4	<p>Narrative Description: On take-off from Runway 02 at Tamanrasset, after getting airborne, while climbing through about 100ft., the co-pilot, who was handling the aircraft, called for the undercarriage to be retracted. However, at about this point, there was, apparently, a failure on the No.1 engine and the captain took over control. After the change of control, the co-pilot reportedly asked the captain if he wanted the undercarriage retracted but apparently received no reply. The undercarriage was not retracted and the aircraft's airspeed began to decay. It eventually stalled and crashed, tail first, just outside the airport boundary, about 600m. beyond the end of the runway and slightly to the left of the extended centreline. It caught fire and was destroyed.</p>									
	7/8/2003	Sudan Airways	737	INITIAL CLIMB	CRASHED AFTER TAKEOFF	116		116	ST-AFK	PORT SUDAN
5	<p>Narrative Description: 14min. after take-off from Port Sudan, the pilot advised ATC that he had a problem with an engine (believed to have been the left engine) and that he had shut it down and was returning. The pilot subsequently carried out the normal procedure for an ILS approach to Runway 35. However, on final approach, the aircraft was to the right of the centreline and the pilot elected to carry out a go around. Power was increased and the undercarriage retracted but, while turning to position for a second approach, the aircraft seems to have gone out of control. It subsequently crashed in scrub about 5km. from the airfield. The accident happened in darkness (about 0400L). Weather, wind, from the SW at 7kt and visibility 4,000m. The aircraft was operating a flight to Khartoum.</p>									
	12/18/2003	Lineas Aereas Suramericanas	DC-9	DESCENT	CRASHED INTO JUNGLE	3		3	HK-4246X	near MITU
6	<p>Narrative Description: During the initial descent into Mitu, shortly after the flight reported routinely out of FL290, about 80 miles from the airfield, radar contact was lost and the primary return was replaced by several smaller returns. The accident happened in daylight (1709L) and in VMC. The aircraft was operating a flight from El Yopal with a cargo of cement.</p>									

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	1/3/2004	Flash Airlines	737	CLIMB	AIRPLANE CRASHED AFTER TAKEOFF	148		148	SU-ZCF	SHARM EL-SHEIKH
7	<p>Narrative Description: The aircraft crashed into the Madiq Tiran (Strait of Tiran) about 2.5min after take-off from Sharm-el-Sheikh, Egypt.</p> <p>The aircraft took-off from Runway 22R at Sharm-el-Sheikh and then initially followed the normal departure procedure, which, due to the high ground running southwest/northeast of the airport, calls for a climb straight ahead on the runway heading before tuning left, back towards the SHM VOR located just to the northeast of the airfield. It would appear that the aircraft was following this procedure and commenced the left turn as expected after reaching 1,000ft.</p> <p>The procedural left turn, with a bank angle of 20deg., continued until the aircraft reached a magnetic heading of 140deg. at a height of 3,600ft, at which point the bank angle decreased to 5deg. The autopilot was then engaged but almost immediately the captain, who was handling the aircraft, is heard to make a sudden exclamation and the FDR recorded the right aileron deflecting to 7.2deg TEU for one second. The autopilot disengaged and the captain called for 'heading select', which was actioned by the co-pilot. Meanwhile the aircraft's left bank had been slowly decreasing until it reached, briefly, a wings level attitude. After this there was a series of aileron motions commanding a right bank and the captain is heard to say 'see what the aircraft did.' The right bank continued to increase and the co-pilot prompted 'turning right sir.' After a brief delay the captain replied 'what.' At this time the aircraft was in a 17deg right bank and the ailerons were acting to increase the bank. Four seconds later the co-pilot again prompted the captain 'aircraft is turning right.' The captain replied 'ah' and then, after a short delay, 'turning right... how turning right.' The right bank continued to increase, reaching just over 40deg 40sec after the autopilot disconnected. The captain then stated 'ok come out', the ailerons moved to just beyond neutral and the high roll rate stopped. However, the ailerons then again moved to increase the right bank. The bank angle exceeded 50deg. and the co-pilot warned 'overbank'. At this point the aircraft had climbed to 5,460ft. The captain then commanded 'autopilot' and the co-pilot replied 'autopilot in command' but there is no record of the autopilot being engaged. 2sec. later the captain again says 'autopilot'. The bank angle had now reached 70deg. and the co-pilot is heard to state 'overbank, overbank', to which the captain replied 'ok' but the FDR still recorded aileron motions to increase the right bank. The crew apparently continued to try to engage the autopilot for the next several seconds but, apparently without success.</p> <p>57sec after the ailerons first began to command a right bank, the FDR recorded a large aileron motion to the left and the right bank began to decrease from its maximum of 111deg. However, by this time the aircraft was descending through 3,470ft in a 43deg nose down attitude. Attempts to recover the aircraft continue but it impacted the sea before they could be successfully completed.</p> <p>The accident happened in darkness (0446L) but in fine, clear weather with light winds. The aircraft was operating a charter flight from Sharm-el-Sheikh to Paris via Cairo (technical stop). Most of the passengers were holiday makers with Voyages FRAM, a major French holiday company. There were also six off-duty crew members onboard travelling as passengers.</p>									
	8/16/2005	West Caribbean Airways	MD-82	CRUISE	CRASHED IN MOUNTAINS - DUAL ENGINE FAILURE	160		160	HK-4374X	MARACAIBO
8	<p>Narrative Description: The aircraft was destroyed when it crashed in open country some 74nm from Maracaibo. The aircraft was operating a flight from Panama City to Martinique and departed at 0600UTC. The flight appears, initially, to have proceeded routinely with the pilot contacting Maiquetia ATC on entering the FIR on Airway UA553 at 'Sidos' at 0651UTC. At that time the aircraft was at its en route altitude of FL330. However, six minutes later, at 0657UTC, the pilot asked permission to descend to FL310. The flight crew later asked for clearance to FL290, FL240 and, finally, to 14,000ft. Meanwhile, at 0659UTC, in response to ATC asking if there was a problem, the pilot advised that they had a 'dual engine flameout.' The aircraft continued to descend and was lost from radar at 0701UTC while passing through FL143. The crew did not declare an emergency. The accident happened in darkness.</p> <p>An initial inspection of the wreckage found that the aircraft had impacted the ground in a nose-up attitude and a slight roll to the right. Both engines showed evidence of high-speed compressor rotation at impact.</p> <p>An initial review of the aircraft's CVR and FDR showed that the flight had reached FL330 at 0641UTC and then accelerated to Mach 0.76. At 0649UTC, 90sec. after reaching Mach 0.76, the aircraft's speed began to 'steadily' decay and the horizontal stabiliser moved from about 2 units nose-up to 4 units nose-up. By 0657UTC the aircraft's speed had decayed to Mach 0.6 and, at this point, the autopilot disengaged. The aircraft began to lose height. At 0658UTC the sound of the stick shaker and the aural stall warning begins and continues until impact with the ground. The aircraft continued to descend and its speed continued to decay, eventually reducing to 150KIAS as the aircraft passed through about FL250. Between 0657 and 0658UTC the No.2 engine went to flight idle and, generally, remained at flight idle throughout the descent but power did increase briefly 'several times.' Data for the No.1 engine is not available.</p>									
	9/5/2005	Mandala Airlines	737	TAKEOFF	CRASHED AFTER TAKEOFF	100	49	149	PK-RIM	MEDAN
9	<p>Narrative Description: The aircraft was destroyed when it crashed on take-off from Medan coming down in a residential area about 500m beyond the end of the runway. It is understood that some of the surviving passengers described the aircraft as 'shaking' and then suddenly losing height immediately after take-off - 'I could not believe it. After take-off, the plane really shook and then suddenly it plummeted to a main road on top of the cars below.' Witnesses on the ground are reported as saying that the aircraft failed to climb immediately after take-off, adopted a nose-high attitude and struck the ILS localiser before crashing on the street just beyond the airfield boundary. The impact and the subsequent fire is said to have destroyed between 10 and 20 houses and five or six minibuses. 49 people on the ground were killed in the crash with a further 26 being seriously injured. The accident happened in daylight (1004L). Weather; wind 350deg./6kt., visibility 5000m in rain showers, cloud, scattered at 1600ft. and temperature +30C. The aircraft was operating a flight (RI091) to Jakarta, Soekarno-Hatta International Airport.</p> <p>The subsequent investigation found that the take-off had been attempted with the aircraft's flaps/slats fully retracted. It is suggested that the crew forgot to correctly configure the aircraft for take-off because they had carried out the check list 'inadequately.' It is understood that the take-off configuration warning horn can not be heard at any point during the take-off on the CVR.</p>									
	5/3/2006	Armavia	A320	FINAL APPROACH	A320 CRASHED INTO BLACK SEA NEAR SOCHI, RUSSIA	113		113	EK-32009	ADLER-SOCHI
10	<p>Narrative Description: The aircraft was destroyed when it crashed into the waters of the Black Sea during an ILS approach to Runway 06 Sochi. The point of impact was about 6km from the coast. The accident happened in darkness (0213L) and in poor weather; wind, variable at 1m per sec., visibility 4km. in light rain showers and mist and cloud, broken at 600ft and overcast (cumulonimbus) at 2,700ft. However, there were apparently periods of heavy rain and the press described the weather as 'stormy'. The aircraft was operating a flight from Yerevan, Armenia.</p> <p>It is reported that the weather had deteriorated while the flight was inbound to Sochi and the pilot subsequently elected to divert back to Yerevan. However, ATC then apparently advised him that there had been some improvement in the weather at Sochi and he decided to carry out an approach. The flight was cleared to land when about 10km from the runway with the weather at that time reported as visibility 4km and a 190m ceiling. However, about 30sec. later, when the aircraft was about 7km from the runway, ATC advised the crew that the ceiling had reduced to 100m and instructed them to stop their descent, make a right turn and climb to 600m.</p> <p>At the start of the go-around the crew did not comply with the standard procedure, which required the application of take-off thrust, retraction of the flaps by one step and retracting the undercarriage. The climb was made in Open Climb mode under autopilot control while still in landing configuration and with the autothrust in speed-hold mode. Shortly after the start of the climb the Low Energy Warning 'Speed, Speed, Speed' sounded. The crew responded correctly and moved the engine thrust levers to the take-off position. At this point the captain disengaged the autopilot and began a stabilized right turn with a roll of about 20deg, climbing at a rate of 2 to 3 m/s and accelerating.</p> <p>This turn continued through about 90deg but the captain then apparently moved his side stick to command a nose-down attitude and the aircraft began to descend with a pitch angle of up to 12deg nose-down and a roll angle of up to 40deg to the right. The aircraft's speed and rate of descent rapidly increased. The EGPWS activated and both pilots made simultaneous control inputs but with neither pressing the Take-Over button. The inputs were not coordinated and were made in opposite directions. Recovery was not made and the aircraft impacted the water at high speed.</p> <p>The Commission was unable to determine why the captain had moved the side stick so that the aircraft started to descend and held it in that position for a 'long time' but noted that 'probably such inadequate piloting was caused by a lack of monitoring of such flight parameters as pitch, altitude and roll at night in difficult weather conditions with a background of fatigue and psycho-emotional stress.'</p> <p>The accident happened in the early hours of the morning and the crew may have been fatigued due to the difficulty of getting adequate sleep during the day time. They also appear to have been considerably stressed, with the CVR capturing numerous expletives and non-professional comments, and fixated on landing at Sochi. However, the report does not explore why the crew and, in particular, the captain should have developed such a mental state.</p>									

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	1/31/2001	Lineas Aereas Suramericanas	Caravelle	LANDING	LANDED SHORT AFTER GO-AROUND	3		3	HK-3932X	EL YOPAL
1	<p>Narrative Description:</p> <p>During the final stage of a visual approach to Mitu, the aircraft undershot, touching down just before the airfield perimeter fence. It ran forward, through the fence and its left main undercarriage struck a low mound and broke away. Meanwhile, power had been increased for a go-around and the aircraft got airborne again. The aircraft climbed away safely and the pilot elected to divert back to El Yopal. However, apparently due to the damage sustained during the undershoot, hydraulic pressure had been lost and the crew were unable to retract the undercarriage. The aircraft continued towards El Yopal but power was lost during the final approach and a forced landing was attempted in fields some three miles short of the airfield. During the landing the aircraft struck trees, broke up and caught fire. The accident happened in daylight and in clear weather. The aircraft was operating a cargo flight Bogota - El Yopal - Mitu with a general cargo including 14 earthenware jars of gasoline.</p>									
	11/12/2001	American Airlines	A300	INITIAL CLIMB	CRASHED SHORTLY AFTER TAKEOFF	260	5	265	N14053	(near) BELLE HARBOR
2	<p>Narrative Description:</p> <p>The aircraft was destroyed by impact and post impact fire when it crashed in a residential area of Belle Harbor, Queens very shortly (103sec.) after take-off from Runway 31L at JFK International Airport, New York. The point of impact was in the general area of Belle Harbor/Rockaway Beach, about 6 or 7km. from the airfield. Some parts of the aircraft, including both of its engines and its vertical stabilizer, separated prior to impact with the ground and were found remote from the main crash site. The accident happened in daylight (0916L) and in fine, clear weather. Wind 320deg./11kt. The aircraft was operating a flight (AA587) to Santo Domingo, Dominican Republic.</p> <p>The aircraft had been cleared to follow the Kennedy Nine/Bridge Climb SID, which calls for a left turn within JFK 4.5DME. The flight took off about 105sec. behind a Japan Airlines Boeing 747 and encountered a 'mild' wake from that aircraft as it was turning left as cleared. During the wake encounter, the co-pilot, who was handling the aircraft, responded, initially, with control wheel inputs which were 'too aggressive' and his initial rudder pedal input was 'unnecessary to control the plane.' These pedal inputs created cyclic rudder motions which, ultimately, overstressed the vertical stabilizer attachments, starting with the right rear lug and it broke away. The vertical stabilizer was exposed to aerodynamic loads that were about twice the certified design limit and exceeded the certified ultimate load limit.</p> <p>The co-pilot was said to have had a 'tendency to overreact' to wake turbulence by taking unnecessary actions, including making 'excessive' control inputs. It was noted that the American Airlines Advanced Aircraft Manoeuvring Program ground school training encouraged pilots to use rudder to assist with roll control during recovery from upsets, including wake turbulence and the NTSB believes that the 'Manoeuvring Program 'excessive bank angle simulator exercise' could have caused the co-pilot to have an unrealistic and exaggerated view of the effects of wake turbulence, erroneously associating such encounters with the need for aggressive roll upset recovery techniques, and led to the development of control strategies that would produce 'a much different, and potentially surprising and confusing, response' if performed in flight.</p> <p>The A300-600 rudder control system couples a rudder travel limiter system, that increases in sensitivity with airspeed, with, according to the NTSB, the lightest pedal forces of any transport-category aircraft that they evaluated during their investigation. Because of this high sensitivity (light pedal forces and small pedal displacements), the A300-600 rudder control system is said to be susceptible to potentially hazardous rudder pedal inputs at higher airspeeds.</p> <p>The NTSB determined that the probable cause of the crash was the in-flight separation of the aircraft's vertical stabilizer resulting from it experiencing loads beyond its ultimate design limit, created by the co-pilot's 'unnecessary and excessive rudder pedal inputs.' Contributing to this were the characteristics of the A300-600 rudder system design and elements of the American Airlines Advanced Aircraft Manoeuvring Program.</p>									
	5/4/2002	EAS Airlines Nig	BAC 1-11	INITIAL CLIMB	CRASHED ON TAKEOFF USED MORE THAN AVAILABLE RUNWAY	73	30	103	5N-ESF	KANO
3	<p>Narrative Description:</p> <p>The aircraft was destroyed by impact and post impact fire when it crashed, shortly after take-off, in a built up area about 3km. from Kano Airport. Apart from those killed on board the aircraft, a further 30 people on the ground also died and 24 were seriously injured. 23 residential buildings, two mosques and a school are also said to have been destroyed in the crash and subsequent fire. The accident happened in daylight (1330L) and in fine weather; wind 170deg./7kt., Temp +36C and QNH 1003. The aircraft's take-off weight was 39,243kg. Kano airfield elevation is 1,565ft. The main runway at Kano (24/06) was closed for resurfacing work at the time of the accident and the One Eleven therefore used the shorter runway, Runway 23, which is 2,600m. long. It is reported that, on take-off, the aircraft used up the full length of the runway and then continued for 60m across the overrun area and then for a further 180m across soft sandy ground before it eventually became airborne. It apparently struck a number of approach lights at this time. It apparently then climbed to a height of between 300 and 400ft. before beginning to descend. One witness on the ground has reported seeing the aircraft 'turning and wobbling' prior to the crash. The aircraft was operating a flight to Lagos.</p>									
	3/6/2003	Air Algeria	737	TAKEOFF	AIRPLANE CRASHED AFTER TAKEOFF	102		102	7T-VEZ	TAMANRASSET
4	<p>Narrative Description:</p> <p>On take-off from Runway 02 at Tamanrasset, after getting airborne, while climbing through about 100ft., the co-pilot, who was handling the aircraft, called for the undercarriage to be retracted. However, at about this point, there was, apparently, a failure on the No.1 engine and the captain took over control. After the change of control, the co-pilot reportedly asked the captain if he wanted the undercarriage retracted but apparently received no reply. The undercarriage was not retracted and the aircraft's airspeed began to decay. It eventually stalled and crashed, tail first, just outside the airport boundary, about 600m. beyond the end of the runway and slightly to the left of the extended centreline. It caught fire and was destroyed.</p>									

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	1/1/2007	Adam Air	737	CRUISE	737-400 CRASHED INTO SEA SULAWESI, INDONESIA	102		102	PK-KKW	(near) Sulawesi Island
11	<p>Narrative Description:</p> <p>The aircraft disappeared while en route between Surabaya and Manado. Radar contact with the flight was lost at 1307L, just over an hour after departure. At that time it was on a heading of 070 at a point about 100 miles NNW of Makassar. Prior to the loss of contact the aircraft had been at FL350. There was no distress call. The weather at the time was described as 'storms' with heavy rain and strong winds.</p> <p>The CVR revealed that, during the flight, both pilots had been concerned about navigation problems and subsequently became engrossed with trouble shooting Inertial Reference System (IRS) anomalies for a period of at least the last 13 minutes, with minimal regard to other flight requirements during this time. An analysis of the DFDR data showed that, immediately prior to the accident, the aircraft was in cruise at FL350 with the autopilot engaged. The autopilot was holding 5 degrees left aileron wheel in order to maintain wings level. Following the crew's selection of the number-2 (right) IRS Mode Selector Unit to ATT (Attitude) mode, the autopilot disengaged. The control wheel (aileron) then centered and the aircraft began a slow roll to the right. The aural alert, BANK ANGLE, sounded as the aircraft passed 35 degrees right bank.</p> <p>The DFDR data showed that roll rate was momentarily arrested several times, but there was only one significant attempt to arrest the roll. Positive and sustained roll attitude recovery was not achieved. Even after the aircraft had reached a bank angle of 100 degrees, with the pitch attitude approaching 60 degrees aircraft nose down, the pilot did not roll the aircraft's wings level before attempting pitch recovery in accordance with standard operating procedures. The aircraft reached 3.5g, as the speed reached Mach 0.926 during sustained nose-up elevator control input while still in a right bank. The recorded airspeed exceeded V_{dive} (400 kcas), and reached a maximum of approximately 490 kcas just prior to the end of the recording.</p> <p>The captain did not manage task sharing and crew resource management practices were not followed. There was no evidence that the pilots were appropriately controlling the aircraft, even after the BANK ANGLE alert sounded as the aircraft's roll exceeded 35 degrees right bank.</p> <p>The NTSC determined that the accident resulted from a combination of factors, including the failure of the pilots to adequately monitor the flight instruments, particularly during the final two minutes of the flight. Preoccupation with a malfunction of the Inertial Reference System (IRS) diverted both pilots' attention from the flight instruments and allowed the increasing descent and bank angle to go unnoticed. The pilots did not detect and appropriately arrest the descent soon enough to prevent loss of control.</p> <p>At the time of the accident, Adam Air did not provide their pilots with IRS malfunction corrective action training in the simulator, nor did they provide aircraft upset recovery training in accordance with the Airplane Upset Recovery Training Aid developed by Boeing and Airbus. In accordance with Civil Aviation Safety Regulations, Indonesian operators are required to provide training in emergency or abnormal situations or procedures. However, at the time of the accident, the Indonesian regulations did not specifically require upset recovery to be included in their flight operations training.</p> <p>Technical log (pilot reports) and maintenance records showed that between October and December 2006, there were 154 recurring defects, directly and indirectly related to the aircraft's Inertial Reference System (IRS), mostly the left (number-1) system. There was no evidence that the airline's management was aware of the seriousness of the unresolved and recurring defects. There was no evidence that Adam Air included component reliability in their Reliability Control Program (RCP) to ensure the effectiveness of the airworthiness of the aircraft components for the fleet at the time of the accident.</p>									
	5/5/2007	Kenya Airways	737	CLIMB	737-800 CRASHED DENSELY WOODED MANGROVE SWAMP	114		114	5Y-KYA	(near) Douala
12	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed immediately after take-off from Runway 12 at Douala. The point of impact was in a marshy, wooded area close to the extended centre line of the runway and some 3sm SSE of the airport. The aircraft hit the ground in a steep dive. The accident happened in darkness (0008L) and in 'poor weather' with reports of heavy rain associated with local thunderstorm activity. The visibility was described as 'adequate' but the departure took the aircraft over an extensive area of mangrove swamp with no visible ground lights. The aircraft was operating a flight (KQ507) from Abidjan, Ivory Coast to Nairobi via Douala.</p> <p>On departure, after getting airborne, the aircraft had a tendency to roll to the right due to the combined effects of a slight asymmetry in its construction and a small amount of right rudder trim. This was immediately corrected by the captain, the pilot flying, and he continued to control this slight roll as the aircraft climbed to 1,000ft. However, for reasons that are not fully explained, after passing 1,000ft, the captain ceased to make control inputs and apparently made no attempt to control the aircraft for the next 55 seconds. The report suggests that, during this time, the crew's attention was 'likely focused on using the weather radar to avoid the thunderstorms.'</p> <p>As the aircraft climbed through 1,600ft the captain made the call 'OK command' in reference to the engagement of the autopilot. This should have been cross checked by the co-pilot but, according to the CVR, he remained silent. The CMD (Command) button on the mode control panel was pressed but the autopilot failed to engage, possibly because forward pressure was applied to the control column at the same time. Neither pilot apparently noticed that the autopilot had failed to engage.</p> <p>The aircraft continued to climb and slowly roll to the right. As it climbed through 2,400ft, ATC advised a new altimeter setting. The pilots executed the change but still neither of them noticed the aircraft's bank attitude despite it being displayed on the electronic attitude director indicator.</p> <p>The flight continued with apparently neither pilot being aware of the increasing bank. As the aircraft climbed through 2,700ft the bank angle exceeded 30 degrees and the EGPWS gave the warning 'bank angle.' This seems to have startled the pilot as he is heard to 'exclaim' and immediately began to make 'erratic' control wheel inputs, first 22deg to the right then 20 degrees left followed by 45 degrees right and 11 degrees left. The aircraft's bank angle reached 50 degrees right.</p> <p>The captain again attempted to engage the autopilot but, because of the aircraft's attitude it engaged in control wheel steering mode and the only effect was to reduce the bank angle to 30 degrees. The captain seems not to have understood what was happening and continued to make 'confused and intense' control inputs including 'several bursts' of right rudder. At a bank angle of 80 degrees the co-pilot called 'right' but then immediately corrected himself and called 'captain left, left, left... correction left' but the situation was not recovered and the aircraft crashed.</p> <p>The captain had a relatively poor training record and he had made only 'slow progress' up to command on the Boeing 737. Since achieving command his instructors and examiners had written a number of reports about him mentioning several recurrent shortcomings including in CRM, knowledge of systems, adherence to SOPs, cockpit scanning and situational awareness, planning and decision making. According to Kenya Airways management his overall performance was judged to be below 'standard' and was categorised as 'acceptable'. Following a Line Proficiency Check of the captain in August 2006, in which he exhibited deficiencies in several areas, a manager noted that 'a review of the entire training programme will be carried out to see if complacency or incompetence is the issue.'</p> <p>The report described the captain as having a 'strong character' and a 'heightened ego' and to being 'domineering (towards) subordinates'. This was said to manifest itself as 'excessive confidence' with a 'touch of arrogance.' The co-pilot was described as 'by nature reserved' and 'not assertive.' During the accident flight 'he appears (to have been) subdued by the strong personality of the captain and to have 'completely placed his confidence (in him)'. As a result he seems to have been almost completely passive and did not bring to the captains attention the 'clearly visible and important lapses of piloting.'</p> <p>The probable cause of the accident was determined to be a loss of control as a result of spatial disorientation after a long slow roll during which no instrument scanning was done and in the absence of</p>									

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	8/20/2008	Spanair	MD-82	TAKEOFF	MD82 CRASHED ON TAKEOFF DUE IMPROPER CONFIGURATION	154		154	EC-HFP	MADRID
13	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed on take off from Runway 36L at Madrid Barajas International Airport. After getting airborne, the aircraft failed to climb above about 40ft. It rolled slightly to the left, then 20deg to the right, back to the left and then its right wing 'dropped' abruptly. The aircraft settled back heavily, tail first, onto the grass to the right of the runway and then ran forward 'for more than a mile' across uneven ground before eventually coming to rest in a shallow ravine where it was destroyed by fire. After getting airborne the aircraft's stick shaker activated and the stall warning sounded. The accident happened in daylight (1424L) and in VMC - CAVOK; wind reportedly variable 140 to 170deg at 4 to 7kt. and temp +28C. Madrid airport elevation is 610m. The aircraft was operating a flight (JKK5022) to Las Palmas de Gran Canaria.</p> <p>The aircraft had originally departed its stand about an hour earlier but had returned due to a 'problem' - an overheating Ram Air Temperature (RAT) probe. A mechanic attended the aircraft, checked the RAT probe heating section in the MEL and opened the circuit breaker (Z-29) for the heating element.</p> <p>An initial review of the FDR and CVR showed that, during the second departure, the aircraft's flaps apparently remained retracted but the take-off configuration warning horn did not sound.</p> <p>The position of the flaps is the last item of the After Start checklist; however, this seems to have been missed out by the crew as, at that point, the captain interrupted the calling of the checklist to ask the co-pilot to request taxi clearance from ATC. The position of the flaps/slats should be checked as part of the Take-off Imminent checks but it would appear that the crew may have carried this out without actually reading the values displayed by the flap/slat indicators.</p> <p>On the MD-80 the R2-5 relay energizes both the RAT probe heater and also provides input to the take-off configuration warning system. One area under investigation is that the problem experienced with the RAT probe heater may have been a symptom of an underlying problem with the R2-5 relay, which might therefore explain the apparent failure of the take-off configuration warning system.</p>									
	9/14/2008	Aeroflot-Nord	737	INITIAL APPROACH	737-500 CRASHED DURING APPROACH TO LAND	88		88	VP-BKO	Near Perm, Russia
14	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed apparently during its second ILS approach to Runway 21 at Perm, Russia coming down on a railway line approximately 10km short of the runway and 1.6nm to the left of the extended centreline. Last contact with the flight was said to be when it was at 1,100m. The accident happened in darkness (0515L) and in poor weather with an overcast ceiling at 240m and light rain; visibility 10km. The aircraft was operating a flight (5SU821) from Moscow Sheremetyevo to Perm.</p>									
	11/27/2008	XL Airways Germany	A320	INITIAL APPROACH	CRASHED INTO SEA NEAR PERPIGNAN FRANCE	7		7	D-AXLA	off the coast of Canet-Plage
15	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed into the sea off Canet-en-Roussillon, France while on an end of lease acceptance flight. The aircraft was carrying two XL Airways crew, four Air New Zealand personnel (a pilot and three engineers) and one person from the New Zealand CAA. The accident happened in daylight (1646L). Weather reported as wind 300deg./5kt., unlimited visibility and cloud, few at 3,300ft and broken at 5,300ft.</p> <p>The accident happened as the aircraft was positioning to join the ILS for Runway 33 at Perpignan. Witnesses report seeing it in level flight heading towards the coast. The noise of the aircraft's engines then increased, 'like an aircraft taking off', and it was then seen to pitch steeply nose-up and enter a climb. The aircraft disappeared briefly behind the cloud but then reappeared in a very steep nose-down attitude. This steep dive continued until impact with the sea.</p> <p>The acceptance flight was originally planned to last 2hr 35min but the aircraft was some two hours late departing. After take-off it flew towards the northwest and eventually climbed to FL390 before reversing its course and returning to Perpignan. The intention then was to fly an ILS approach before carrying out a go-around and continuing to Frankfurt where the aircraft was to be handed back to Air New Zealand.</p> <p>About 55min after take-off, while the aircraft was being radar vectored to join the ILS, the Air New Zealand pilot is heard to say 'low speed flight is now probably next' and then describe the procedures to be carried out which were necessary to activate the aircraft's alpha floor protection. Shortly after this the captain commented 'I think we will have to do the slow flight later...or we do it on the way to Frankfurt or I even skip it.' The descent continued and, about two minutes after the captain suggesting skipping the 'low speed flight' part of the programme, he said 'down below the clouds, so you want what?' The Air New Zealand pilot replied 'we need to go slow...'. Meanwhile the aircraft's flaps and slats had been moved to position '2' and the undercarriage extended. The engine thrust levers were then moved to the idle position.</p> <p>The aircraft levelled off at 3,000ft in full landing configuration. During the next 35sec the aircraft's speed decreased from 136 to 99kt. The horizontal stabilizer then moved to -11.2deg (full nose-up) and the aircraft's pitch attitude increased to 18.6deg. The stall warning then sounded and the thrust levers were moved to the TO/GA position. The aircraft began to climb and, initially, to accelerate. The crew retracted the undercarriage. The aircraft eventually climbed to about 3,800ft and reached a maximum pitch angle of 57deg. but meanwhile the speed had decayed to below 40kt. It rolled to the right and pitched nose-down. Control was not regained and the aircraft descended into the sea.</p> <p>The BEA notes that the 'low speed' check is supposed to be performed at about FL140.</p>									
	2/25/2009	Turkish Airlines (THY)	737	LANDING	APPROACH TO LANDING ACCIDENT	9		9	TC-JGE	(near) Amsterdam
16	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed during the final stage of an ILS approach to Runway 18R at Schiphol Airport, Amsterdam, coming down on open ground approximately on the extended centreline of the runway but about 1km short of the runway threshold. The accident happened in daylight (1031L). Weather reported as; wind 200deg/10kt., visibility 4,500m in mist and cloud, scattered at 700ft, broken at 800ft and overcast at 1,000ft. The aircraft was operating a flight (THY1951) from Istanbul, Turkey.</p> <p>The approach was carried out with the autopilot engaged and appeared normal until reaching a height of 1,950ft. However, at this point, the left radio altimeter suddenly indicated a reduction in altitude from 1,950ft to just 8ft. and this altitude was supplied to the autopilot. As an apparent result of this, the auto throttle commanded a reduction in engine power and the aircraft's speed then began to decrease. Meanwhile, because of the low height indication, the voice warning 'landing gear must go down' activated but the crew apparently did not register this as indicating a 'problem.'</p> <p>The aircraft's speed continued to decay until approaching the stall and the stick shaker then activated. The crew immediately applied full power but were too late to recover the situation and the aircraft struck the ground in a nose high attitude. It came to a stop after a ground slide of about 150m. The aircraft's speed at impact was about 175kmph. The Board notes that, for an aircraft of this weight, the normal speed would be 260kmph.</p> <p>The Board notes that an initial review of the aircraft's data recorder showed that, in eight flights, the problem with the altimeter had occurred twice before in similar circumstances.</p>									

Accident Dataset	Event Date	Airline Name	Aircraft Model	Flight Phase	Title	Crew + Pax	Ground + Other AC	Total Fatal	Registry	Location
	10/21/2009	Sudan Airways	707	INITIAL CLIMB	CRASHED DURING INITIAL CLIMB W/ONE ENGINE FAILED	6		6	ST-AKW	near SHARJAH
17	<p>Narrative Description:</p> <p>The aircraft was destroyed by impact and post impact fire when it crashed on open ground immediately after take-off from Sharjah. It is reported that, shortly after getting airborne from Runway 30 at Sharjah, the aircraft was seen to enter a 'tight' right bank, lose height and crash close to the Sharjah Golf and Shooting Club about a mile from the end of the runway and half a mile to the right of the extended centre line. The accident happened in daylight (1530L); weather, wind 320deg./11kt., visibility greater than 10km., cloud, few at 4,000ft. and temperature +32C. The aircraft was operating a flight to Khartoum on behalf of Sudan Airways.</p> <p>The preliminary investigation found that the No.4 engine cowling had separated and fallen away during the initial climb and that the aircraft had begun to roll to the right shortly afterwards. It is understood that one area under investigation is a possible thrust reverser deployment on the No.4 engine.</p>									
	1/25/2010	Ethiopian Airlines	737	CLIMB	CRASHED INTO MEDITERRANEAN SEA	90		90	ET-ANB	Mediterranean Sea, Beirut
18	<p>Narrative Description:</p> <p>The aircraft was destroyed when it crashed into the sea shortly after take-off from Beirut, coming down approximately 3.5km off Naameh, Lebanon, some 5nm southwest of the airport. The accident happened in darkness (0241L) and in poor weather with heavy rain associated with local thunderstorm activity. The aircraft was operating a flight (ETH409) to Addis Ababa.</p> <p>The aircraft had taken off from Runway 21 and was cleared for an immediate right turn towards 'Chekka' onto a heading of 315deg. However, as the flight came round onto a northerly heading, ATC instructed the crew to turn left onto a heading of 270deg apparently in order to provide separation from inbound traffic. The aircraft turned to the left but continued round onto a southerly heading before making a further sharp left turn. The aircraft rapidly lost height in the turn and disappeared from radar.</p>									
	4/13/2010	Aerounion	A300	FINAL APPROACH	CRASHED NEAR RUNWAY DURING LANDING	5	1	6	XA-TUE	(near) Monterrey
19	<p>Narrative Description:</p> <p>The aircraft was destroyed when it apparently undershot on final approach to Runway 11 at Monterrey; apparently coming down on a road, where it struck at least one car killing the driver, just outside the airport boundary. The accident happened in darkness (2315L). Weather, wind 110deg./12kt., visibility 3sm in rain showers and cloud, broken at 600ft and overcast at 2,500ft. The aircraft was operating a cargo flight from Mexico City.</p>									
	5/12/2010	Afriqiyah	A330	FINAL APPROACH	CRASHED SHORT OF RUNWAY	103		103	5A-ONG	TRIPOLI
20	<p>Narrative Description:</p> <p>The aircraft was destroyed when it apparently undershot during the final stage of a non-precision approach to Runway 09 at Tripoli; impacting the ground about 900m short of the runway threshold and 200m to the right of the extended centreline of the runway. The accident happened at dawn (0610L). Weather, visibility 5 to 6km in mist and 'no significant' cloud. The aircraft was operating a flight from Johannesburg, South Africa. It is believed that the last contact with the flight was when the pilot advised ATC that they were going around.</p>									