# 前十大安全議題

孟磊 譯

## 自動化

一項1996年的里程碑研究報告指出，航空駕駛員經常誤解自動化飛航路徑管理系統的能力、限制與運作方式，包括何時要一與何時不要一使用到可用程度的自動化。其中提出針對飛航組員對於這些系統的運作模式、它們所計畫的飛航路徑與飛機的動能狀態的不察的關切。

延續前述報告，2006年取代已經42年之久的美國商用航空運輸飛機自動化飛航導引系統設計標準幫助設定更高等級的作業安全、效率、可靠性與全天候全球導航精確性重建信心一這些對於必須容納更多飛機，而且飛航路徑可能太複雜或太精確而無法容許手動飛航的次世代空域而言都是必要的。

2006年在ASW雜誌對最新的自動化標準的報導中提到，飛航導引系統不應導致不安全的空速降低或是當飛行員嘗試取代它們時造成潛在危險，美國的新規則規範“飛航導引系統的功能、控制、指示與警告的設計必須使飛航組員對於飛航導引系統的行為與操作的錯誤與混淆降到最低”。

然而在其後的幾年間，幾起航空失事調查再度證實自動化的缺點確實對大型商用噴射機造成影響，這些失事與例行的飛航數據分析都導向對於如何最大化地降低人為因素錯誤與其他諸如飛航組員高度依賴正常系統操作與不願改換手動飛行、手動飛行技巧生疏與不足的飛航路徑監控等風險的更深入研究。2015年最關鍵的重點可能是知識的強化與實務的應用將更加融入飛航作業中一更進一步地降低航空旅行的風險，不過還是取決於管理當局與航空業者能否完全將所學得的課程加以活用。

在駕駛艙自動化工作小組2013年終報告中部份提到飛航組員必須有對自動化更深入的知識與技巧、公司對於自動化的政策與在飛航中隨時準備好介入/取代系統以降低飛航路徑相關的風險。它要求製造商的新自動化設計應基於“飛航組員了解正常系統操作的能力與系統有效率而不出錯的功能…多系統整合的設計應該要能讓飛航組員在系統失效或降級模式時清楚地、確實與完整地了解該採取的措施。”


## 飛控撞地與進場落地失事

飛控撞地(CFIT)與進場落地(ALA)失事曾有多年間被定位為航空世界的頭號殺手。

當1990年初期，飛航安全基金會最初開始引導大家注意CFIT時，對於商用航空失事事件，CFIT類別比其他類別的失事事件還要多，在1991年到1995年間的全球涉及商用航空噴射客機的59件機體損失的失事中，17件(29%)是CFIT失事[1]，從1990年後期開始，CFIT失事與相關的傷亡逐年降低，但是2009年之後趨勢又開始反轉。

根據2004年到2013年發生的失事事件數據顯示，CFIT同時是死亡失事(16)與乘員傷亡(803)[2,3]的第二大原因，在2013年，全球商用噴射機發生的7件重大失事事件中，就有4件是CFIT失事，造成總共26名乘員死亡，此外全球另有八件商用噴射機失事中的兩件與22件商用渦輪螺旋槳失事中的八件也是屬於CFIT失事。

ALA在飛航安全基金會ALA降低(ALAR)任務小組1998年中期報告中被標註出來，其數據顯示從1980年到1998年涉及重量在5,700公斤(12,566磅)或以上的客機與貨機，每年平均有17件ALA死亡失事。

雖然ALAR安全商品與國際研討會議對於ALA失事件數的降低著有貢獻，但該類失事仍持續發生，在2013年發生的七件商用噴射機失事中，五件一其中三件也是CFIT一

是發生在進場與落地階段；總共造成76人死亡。另外有八件商用噴射機失事中的五件，與22件商用渦輪螺旋槳機失事中的15件也是屬於ALA。

**註釋：**

1.機體損失依照波音公司定義為在失事事件中，飛機“完全損毀，或是嚴重損毀至無法修復；機體損失也包含但不限於在事件中飛機失蹤，或是飛機殘骸被發現前搜尋終止，或是飛機完全無法接近。”

2.波音，1959-2013全球商用噴射機失事統計摘要，2014年九月。

3.Burin, James M,“2013年度檢討”Aero Safety World第九冊(2014年二月)：19-22。

## 組員資源管理

作為飛航組員安全績效的主要因素，組員資源管理(CRM)在所有組員的互動中確實是至關重要，CRM關係到有效的飛行監控、自動化系統勝任的運用、有效的威脅與錯誤管理、與所有牽涉到飛行的人之間的清楚並且適切地肯定的溝通，還有幾乎涵蓋其他所有必需由飛航組員協調的任務。

回顧整個航空史，在很多飛航失事與意外事件中，CRM的障礙都扮演了極其關鍵的角色，而且到現在也依然如此。

一件2009年一月27日發生在德州Lubbock，一架帝國航空的法製ATR42因結冰狀態而墜機的事件可作為CRM出錯而導致失事的例證，在事件中正駕駛受到重傷，副駕駛輕傷，而這架登記在飛遞航空名下，實際由帝國航空飛航作為額外貨機的飛機則遭受嚴重的損毀。

美國NTSB在2011年針對此次失事的最終調查報告中，將最初由於襟翼異常引發而導致飛航組員在進場過程中“未能監控並維持最低安全空速”，最後造成空氣力學上的失速列舉為事件的可能成因。

NTSB表示，組員不良的CRM是幾項成因其中之一，由於駕駛員們在確認襟翼的問題後，他們的CRM一從飛航初期的良好一因為正駕駛不適當的領導與副駕駛未能更堅定地表達她對於正駕駛繼續不穩定進場的決定的關切而惡化。

在多年來其他為數眾多包含人為因素而導致的失事事件中，更好的CRM可能可以免除因飛航組員的錯誤而造成的嚴重後果，在航空人為因素指南[1]一書中列舉出幾個若能恰當運用CRM，可能防止在嘗試緊急落地中關錯引擎、避免起飛中與滑行中的飛機發生碰撞，與被分心的組員未


能在飛機撞擊地面前注意到高度警示聲響的案例。

改進的CRM訓練，改善的溝通與決策技巧與遵守標準作業程序是加強CRM並避免未來失事與意外事件的因素中的幾個項目。

**註釋:**

1.相關資料可經由SKYbrary的OGHFA入口網頁www.skybrary.aero/index.php/Portal:OGHFA 查詢

## 飛航路徑監控

“適當的飛航路徑控制”與“有效的監控”對於多年來參與無數會議，聽取有關內容簡報的航空公司駕駛員與飛航作業/安全主管似乎已是老調常談，但是在11月一份新發表的論述顯現出來，用最普通的語言闡述，著眼於幾項最關鍵的要素來幫助全球的航空業更進一步降低失事的風險。

20項建議一包含以下將提到為何組員會低估自身錯誤管理飛機飛航路徑與動能狀態的弱點的人為因素研究一已經在這份名為改善飛航路徑監控的實用指南的最終報告中揭露。這份報告是由組成主動飛航監控工作小組的28位專家所撰寫並由飛航安全基金會發行，該工作小組成立於2012年的航空業人為因素圓桌會議之後，該會議主要是針對可能導因於監控不足的商用航空運輸失事。

他們主要地檢視傳統上對於航空公司駕駛員訓練的強調與飛機操控的評估，相對於他們所謂的“飛航路徑管理的首要”，該報告指出“監控乃適切地注視、觀察、保持追蹤，或交叉檢查，…監控是飛航組員必須用來幫助他們確認、防止或改正可能影響安全裕度的事件，…改良的飛航路徑監控的用意是減少可能導致飛航路徑偏離的錯誤數量。”

該工作小組總結說造成增加飛航路徑偏離或未確實監控航機動能狀態風險的狀況是可預測且為專家所熟知的，而且有很多改善措施實際是用於任何飛行員、航空業者與自動化飛航路徑管理系統。

舉例來說，該報告指出航空公司應該“導入對於飛航路徑偏離較易犯錯的區域(AOV)的觀念並討論後續對於任務/工作量管理的需求”，“練習介入以保持有效的監控或是當裝備降級時如何重建有效的監控，建議的介入以在高工作負擔的情境下保持狀況解知與飛航路徑監控/交叉驗證的能力，對於保護飛航路徑管理不被分心與中斷的組織政策與做法。”

此外，對於關鍵飛行員訓練的成果要求包括飛行員對於自動化系統如何運作的完整知識、在發生狀況時必需的AOV相關的取樣率(“飛行員注視/關注外在情況與駕駛艙儀表間的頻率”)，與在緊急、異常或高壓力狀況下如何執行有效的飛航路徑監控。

## 鋰電池運載

被歸類為危險品的鋰電池由於若是不正確的包裝、損壞或處置而導致短路或失效時會有潛在的煙霧、無法控制的火勢與爆出極端熾熱的液體，在商用航空運輸或商務航空的關注度日益升高，此外，隨著鋰電池驅動裝置的日漸普遍，為數愈多的鋰電池被帶入全球各地的客艙或是貨艙。

在IATA資深安全與飛航作業副總，同時也是一位機長的Kevin Hiatt所著，最近才剛發行的“航空業者鋰電池風險降低指南”的前言中提到：每年估計經由航空郵遞、貨運或是旅客行李載運的鋰電池將上看10億個[1]。換算下來，以一架100人座的單走道窄體噴射客機而言，就有為數約500個的鋰電池經由旅客攜帶的手機、筆記型或平板電腦、相機與其他電子用品被帶上飛機。[2]

注意到鋰電池已經是三架貨機損失的成因，IATA已經將鋰電池的運載定位為緊急的安全議題[3]，此外，根據IATA 2014年五月在馬德里所召開客艙作業安全會議的一份簡報中的資料，IATA客艙作業安全任務小組已將鋰電池相關的煙霧/火焰事件列為它2014年前三大與2015-2016的前二大安全議題。

一般鋰電池有三種類型：鋰-鐵電池、鋰-離子電池與鋰-離子-聚合物電池，鋰-鐵電池是單次使用(不可充電)，裝置於手錶或心律調節器中，鋰-離子電池是可充電而通常用來為如筆記型電腦等消費性電子用品供電，鋰-離子-聚合物電池也是可充電而常用於像平板與智慧型手機等消費性電子產品，它們與鋰-離子電池唯一的不同處只有形狀與外殼材質[4]，鋰-離子電池與鋰-離子-聚合物電池通常被統稱為鋰-離子電池。

鋰電池潛在的安全風險與它如何失效有關，短路或外在損壞可能造成鋰電池失效，如果單一鋰電池進入熱失控，可能導致同組合中其他的鋰電池也失效，如果有多組電池被包裝在一起，例如貨物的拖運，所擔心的就是單一電池失效所產生的火將波及其他的電池，鋰電池產生的火焔是極度高熱且很難撲滅的，而且當鋰電池失效時，升高的內部壓力也可能造成爆炸，另外造成風險的因素是托運的數量，托運者未能(不管無心地或故意地)遵守運載的要求，還有品質低劣與仿冒或偽造品等。

依照ICAO規定，從2015年一月一日起，鋰-鐵電池被當作貨物單獨托運者(相對於被包含在裝備中或與其所屬裝備一起包裝者)被限制為只能由貨機運載，美國FAA有提供旅客有關允許作為隨身行李或托運行李電池類型的指南。

<faa.gov/about/office-org/headquarters_offices/ash/ash_programs/hazmat/passenger_info/media/faa_airline_passengers_and_batteries.pdf>

**註釋：**

1.IATA. 航空業者鋰電池風險降低指南，有效期2015年一月1日-十二月31日，蒙特婁2014。

2.Tang, Allen“客艙安全的改善與新挑戰”2014年五月在馬德里一場IATA客艙作業安全會議中提出的簡報，Tang是新加坡航空學院主任訓練專員。

3.IATA. IATA2013年安全報告，於2014年四月。

4.FAA William J Hughes科技中心航空研究部門，鋰-離子電池與鋰-鐵電池火焔的撲滅，2014年一月。

## 飛航中失控

在過去十年中，飛航中失控(LOC-I)失事所造成的死亡人數比其它航空失事類別都多。

根據2004到2013年間所統計牽涉西方製造商用噴射機的失事數據顯示，16件LOC-I失事事件共造成飛機上1,526人與地面上50人死亡，幾乎是第二大失事類別飛控撞地所造成死亡人數的兩倍[1]。

根據漢威航太飛航安全科技主任工程師暨近地警告系統研發首席Don Bateman的說法，LOC-I失事的主要成因包括空間迷向與可能對東西方製造飛機儀表不同的姿態顯示格式產生混淆，Bateman在2011年說這兩類成因佔LOC-I失事所造成死亡人數的將近一半[2]。

Bateman說其它的成因則有因尾流造成的擾亂、在訓練的練習中過度操縱尾舵、自動駕駛模式的混淆與未能減小攻角以重新取得飛機的控制等。

為了減少LOC-I失事，國際民航組織(ICAO)標準組現在要求飛行員在獲得飛機類別的機種檢定前必須先經過“擾亂防止與恢復訓練”(UPRT)，而業界也在其飛航模擬

訓練裝備上致力於強化高高度失速防止的訓練。

ICAO的文件Doc 10011-飛機攪亂防止與恢復訓練手冊指出，失速與飛機攪亂有著極密切的關連，也說明其標準與設計作為UPRT行動核心的建議作法。

**註釋：**

1.波音，1959-2013全球商用噴射機失事統計摘要，2014年九月。

2.Don Bateman“防止LOC的簡便工具”航空安全世界第六冊(2011年6月): 28-32

## 飛行員疲勞

飛行員疲勞-在過去多年間由航空失事調查員列舉為為數眾多失事的原因之一，本身也是美國VTSB所提出超過200項安全建議與其它世界各國調查單位的數十項建議的主題之一。

儘管諸多建議已被很多國家的民航主管當局所採用，而且較迫切的關於管制飛航與執勤時間限制的法令也已修訂，疲勞仍然持續成為頗多的失事成因之一。

一個比較近期的例子就是2013年八月14日，一架UPS所屬的空中巴士A300-600型機，在結束一段跨夜飛行任務時，於美國阿拉巴馬州伯明罕市進場時墜毀，兩位飛行員一也是這架飛機上唯二的乘員一都死亡而且飛機全毀，NTSB將飛行員疲勞一兩位飛行員都在飛行中抱怨的事情一列為四個造成飛機失事的成因之一[1]。

儘管新的美國FAA對於執勤與休息的規定並不適用於這架失事航班一它們是在這架飛機失事後才生效而且也排除飛航貨機的組員一但這架貨機仍然符合那些規定。

然而睡眠的犧牲與被中斷的生理時鐘一就是在24小時之間的睡眠與甦醒的節奏一影響了這組失事的組員，就如它們從過去以來持續影響著其他組員一樣。

飛航安全基金會一直以來都是對於負責任的疲勞指南的堅定提倡者；在它最近有關改善疲勞的作為就是發展一與國家商務航空協會共同一商務航空的勤務/休息指南，介紹一個設計作為商務航空疲勞管理方案基石的一項有科學依據的計畫。該項指南可在此鏈結獲得<flightsafety.org/files/DutyRest2014_final1.pdf>。

**註釋：**

1.NTSB. 失事報告 NTSB/AAR-14/02，在一次夜間非精確儀器進場落地時墜毀；UPS 航班1354, 空中巴士A300-600, 飛機編號N155UP；2013年八月14日阿拉巴馬州伯明罕市，可見於www.ntsb.gov NTSB表示可能的成因是組員持續非穩定進場並且未能監控航機的高度，“導致不經意的下降…撞到地障。”

**Basic Aviation Risk Standard (BARS) Program Top 10 Audit Findings, 2014**

1. SMS documentation and implementation
2. Quality assurance
3. Maintenance duty time/fatigue management
4. Maintenance training content and frequency
5. Emergency response plans
6. Control of spare parts
7. Operational risk assessment
8. Hot refuelling
9. Procedures training for dangerous goods
10. CRM/ADM training for flight crew

## 跑道安全

跑道安全相關事件是商用航空運輸最常見的失事類型，根據IATA統計，在2009年到2013年間發生的失事事件有58%是發生在跑道環境中，而此類別最常見的型態則是跑道逸出，佔了該期間所有失事的23%[1]，IATA在它最新發表的年度安全報告中指出“儘管航空整體失事率呈下降趨勢，跑道逸出事件卻是維持不變，所以改善跑道安全是業界降低作業風險策略的關鍵重點。”

根據IATA資料顯示，2013年定期與非定期商用飛航失事中有43%發生在落地階段，這類被歸類為跑道安全相關事件的類別，與飛航中失控(LOC-I)、飛控撞地(CFIT)形成高風險事件類別[2]，跑道安全相關事件[3] 雖然佔據2013年高風險類別失事中的63%，不過死亡人數卻只佔6%。

飛行員持續不穩定進場到落地是跑道逸出最主要的成因，世界飛安基金會已進行多年的重飛、決策與執行計畫已接近尾聲，最終報告預期將在2015年初期完成。

**註釋：**

1.IATA, IATA2013年安全報告，2014年四月。

2.ICAO, ICAO安全報告2014年版。

3.跑道安全相關事件包括下列ICAO事件次類別：非正常跑道接觸、鳥擊、地面碰撞、地面作業、跑道逸出、跑道侵入、在地面失控、碰撞障礙物、落地過短/落地過長，與機場。

## 安全資訊分享與保護

對於航空安全數據的例行收集與分析，以至於結果資訊的分享被廣泛地認為有助於提升業界已經是一流的安全紀錄，因為了解潛在飛機失事的成因可以幫助防止未來可能的失事，就如美國FAA在九月時一份陳送給ICAO的區域航空安全小組一泛美洲(RASG一PA)的報告中所說，“能

夠有效率地收集並分享安全資訊給整個國際社會有助於提升全球的航空安全，一個安全管理系統包含分享民航管理當局與航空業界個別組織所握有的資訊與促進一個政府一業者間夥伴關係的工具是必要的。”[1]

有多個資訊分享計畫與獎勵措施正在形成，其中某些例如美國的航空安全資訊分析與分享(ASIAS)計畫，普遍被認為是成功的案例，ASIAS對於前兆與威脅的分析就已被美國商用航空安全團隊(CAST)採用在美國航空系統中確認浮現中的風險，此外，來自CAST與IATA飛航數據交換計畫的經過統整且去除身分辨識資料的趨勢資訊，則被以受控制且安全的方式分享給RASG一PA使其參與者能用以應對他們國家或作業中的問題。

不過對於合法且有效益的全球數據分享還存在諸多嚴重的障礙，包括收集與分析數據的組織間缺乏協調、工作的重疊以致參與者必須提供數據給多個計畫、鼓勵開放性安全議題報告的計畫設計不足，還有可能是最嚴重的，就是對安全數據與資訊不被運用於航空安全以外的範圍的保護不足。

安全資訊分享與安全資訊保護(SIP)同時被列入排定於二月2-5日在蒙特婁舉行的ICAO 2015年第二次高階安全會議(HLSC 2015)的討論議程，在HLSC準備中的工作報告其中之一就是由飛航安全基金會總顧問肯尼斯昆恩擔任副主席的SIP任務編組(SIP TF)所建議的安全資訊保護。

SIP TF的提案包括對芝加哥公約中6號附約(航空器飛航作業)、13號附約(航空器失事與意外事件調查)與19號附約(安全管理)的修訂，對於6號附約的建議是針對經由飛航數據分析系統與疲勞風險管理系統所收集資訊加強法律上的保護，而對13號附約的修訂建議則是涵蓋失事調查主管機關與司法機關間的合作。

安全資訊的收集、分析、分享與保護是基金會的最高優先項目之一，並且是基金會得到FAA與CAST支援所著手進行的一項全球安全資訊計畫的主題。

**註釋：**

1.美國FAA，“美國針對ICAO 2015 HLSC(高階安全會議)的優先項目”，RASG一PA/7一WP/10，第七屆區域航空安全小組一泛美洲年度計畫會議，2014年九月，古拉索，威廉市。

**訓練**

一個航空專業人員訓練的特性一潛移默化的傳統一近年來已無法滿足社會上普遍追求迅速可行方法的期待了，一個例子就是最近對於導入航空駕駛員攪亂防止、認知與恢復訓練建立程序的改變，另一個則是加強組員飛行員執照訓練的出現，與後來因為一起美國的空難，導致被加上至少要有1,500小時擔任航空公司副駕駛的資格限制。

其他類似的變化也改變了空服員、簽派員、空中交通管制員、維修技師與其他必須持有執照/證書的航空專業人員等領域的訓練，所有人員已無一倖免，改變已經迫使人們必須接受對於人為因素(例如疲勞)、訓練缺口的確認(例如便攜式電子產品)、對於長久以來視為當然的目前做法的重新檢視(例如飛航路徑監控)與取代不合時宜的作法(例如失速訓練)等新的領悟。

所幸的是在各個領域中都可以立即找到願意對改變傳統訓練加以考慮的人，有一篇ASW的文章提到“當現今最佳的證據證明風險正在升高或是現狀已經不合時宜，專家毫不遲疑地呼籲業界的同僚是該放棄原先的信仰、慣性的作法或文化上的常規了”。一份前面有提到的2013年的報告(“飛航路徑監控”p.14)也是一個業界如何不再遲疑的評估訓練缺口的典型，其中說道:「目前的訓練方式、訓練裝備、訓練所投入的時間還有內容可能不足以提供妥善管理飛航路徑管理系統所需的知識、技巧與判斷力…飛航教師的訓練、經驗與線上作業的熟悉度也許不足以有效地訓練飛航組員適當的飛航路徑管理。」

ASW的文章涵蓋了眾多跨領域的主題，包括：排除重複式的/可預測的訓練劇本，與以時間為導向的聚焦，套一句主動飛行員監控工作小組的話說，在一個表現/能力導向的環境中，用“能模仿出線上作業動態(意外之事)的切合實際的劇本”來取代這些；包含用時間壓力或其他科技來評量實際的能力；創造必須有深入的知識才能通過的訓練劇本；還有持續灌輸智能模型來幫助人們避免或一步步克服疑惑。

教師與考核者，不論是在飛機客艙中或是塔台中，同樣都認知到人們可能幾乎不會注意到一項特定的技藝除非他們確知必須在測驗中證明已經精通該項技藝，提升航空訓練以促進從一個專業領域跳到其他領域潛能的例證包括：與其他人一同參與需要立即以實際劇本練習，聚焦在理論訓練的各種活動；隨著進度逐步的以精通度測試學生的進展，而不是在訓練結束後才給予無所不包的測驗；重新設定組員/客艙資源管理課程以適用於新進員工的文化；養成公正文化為中心的課堂，使在其中的航空專業人員能自在地在其他同事面前講述自己的錯誤，承認自己不瞭解一個系統與/或要求補救的技巧訓練。

*譯自Aero Safety World Dec 2014 － Jan 2015*

# TOP 10 Safety Issues

## Automation


A landmark 1996 study concluded that airline pilots often misunderstood the capabilities, limitations and operation of automated flight path man agement systems, including when — and when not — to use the available levels of automation. Concerns also were raised about flight crews becoming unaware of these systems' mode of operation, their projected flight path and the airplane energy state.

In that context, the 2006 replacement of 42-year-old U.S. design standards for automated flight guidance systems in commercial air transport airplanes helped restore confidence in the intended trajectory of ever-higher levels of operational safety, efficiency, reliability and all-weather global navigation precision — all necessary to fit more aircraft into next-generation airspace in which flight paths could be too complex or precise to allow flying manually.

*ASW* reported in 2006 that the latest automation standard in part stated that flight guidance systems shall not cause an unsafe reduction in airspeed or create a potential hazard when pilots attempt to override them. The new U.S. regulation specified, "The flight guidance system functions, controls, indications and alerts must be designed to minimize flight crew errors and confusion concerning the behavior and operation of the flight guidance system."

In the following years, however, investigations of several airline accidents again identified automation vulnerabilities affecting large commercial jets. These crashes and routine flight data analysis prompted deeper study of how best to mitigate human factors errors and other risks, such as flight crews' high reliance on normal system operation and reluctance to transition to manual flight, degradation of manual flying skills and ineffective flight path monitoring. The key takeaway, as of 2015, may be that knowledge enhancements and their practical application increasingly are infiltrating flight operations — further reducing risk in airline travel but dependent on regulators and operators to fully adopt the lessons learned.

The Flight Deck Automation Working Group's 2013 final report partly described flight crews' need for in-depth automation knowledge and skills, a company policy on automation, and constant readiness to intervene/override systems to mitigate flight path–related risks during flights It asked manufacturers to base new automation designs "on the flight crew's ability to understand normal system operations and their ability to function effectively without error. ... The integration of multiple systems should be designed such that the flight crew has clear, definitive and well understood actions in the event of failures or degraded modes."

## CFIT and ALA

Controlled flight into terrain (CFIT) and approach and landing (ALA) accidents have for years been targeted as among the primary killers in the aviation world.

When Flight Safety Foundation first helped draw attention to CFIT in the early 1990s, more commercial aviation accidents were attributed to CFIT than to any other accident category. From 1991 through 1995, of 59 hull loss accidents involving the worldwide commercial jet fleet, 17 (29 percent) were CFIT accidents.[1] The numbers of CFIT accidents and related fatalities moved downward for several years beginning later in the 1990s, but the trend reversed after 2009.

Data for accidents occurring from 2004 through 2013 show CFIT in second place as the cause of both fatal accidents (16) and on-board fatalities (803),[2,3] and in 2013, of seven major accidents involving worldwide commercial jets, four were CFIT crashes that killed a total of 26 people aboard. Two of eight business jet crashes and eight of 22 crashes of commercial turboprops worldwide also were attributed to CFIT.

ALAs were targeted with the publication in 1998 of the final report by Flight Safety Foundation's ALA Reduction (ALAR) Task Force, which cited data showing an average of 17 fatal ALAs every year from 1980 through 1998 in passenger and cargo operations involving aircraft weighing 5,700 kg (12,566 lb) or more.

ALAR safety products and international workshops have contributed to lower numbers of ALAs, but the accidents persist. Of 2013's seven major accidents involving commercial jets, five accidents — three of which were also CFIT accidents — occurred during approach or landing; a total of 76 people were killed. Five of eight business jet crashes and 15 of 22 commercial turboprop accidents also were ALAs.

**Notes**

1. *A hull loss* is defined by Boeing as an accident in which the airplane is "totally destroyed, or damaged and not repaired; hull loss also includes but is not limited to events in which the airplane is missing, or the search for the wreckage has been terminated without it being located, or the airplane is completely inaccessible."
2. Boeing. *Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations*, 1959–2013. September 2014.
3. Burin, James M. "2013: Year in Review." *AeroSafety* World Volume 9 (February 2014): 19–22.

## Crew Resource Management

As a primary factor in safe flight crew performance, crew resource management (CRM) is crucial in virtually all pilot interactions. CRM touches on effective pilot monitoring, competent use of automated systems, effective threat and error management, clear and properly assertive communication among all those involved in the flight, and nearly every other task involving flight crew coordination.

Throughout aviation history, a breakdown in CRM has played a key role in many aviation accidents and incidents, and it continues to do so today.

One accident that serves as an example of CRM gone wrong was the Jan. 27, 2009, crash of an Empire Airlines Avions de Transport Régional Alenia ATR 42 during an instrument landing system approach to Lubbock, Texas, U.S., in icing conditions. The captain was seriously injured, the first officer suffered minor injuries, and the airplane — registered to FedEx and operated by Empire as a supplemental cargo flight — was substantially damaged in the crash (*ASW*, 05/11, p. 46).

In its 2011 final report on the accident, the U.S. National Transportation Safety Board (NTSB) cited as the probable cause the crew's "failure to monitor and maintain a minimum safe airspeed" during the approach, which was complicated by a flap anomaly and which ended in an aerodynamic stall.

The crew's poor CRM was among several contributing factors, the NTSB said, noting that after the pilots recognized the flap problem, their CRM — which had been good early in the flight — deteriorated, with the captain offering inadequate leadership and the first officer failing to assertively press her concerns about the captain's decision to continue their unstabilized approach.

In numerous other accidents over the years that have had human factors causes, strong CRM might have saved the flight crews from the devastating consequences of their errors. The *Operator's Guide to* Human Factors in Aviation[1] cites examples in which the proper exercise of CRM might have prevented the shutdown of the wrong engine during an attempted emergency landing, the collision between one airplane that was taking off and another that was taxiing, and the failure of a distracted crew to notice an altitude warning sound shortly before their airplane struck the ground.

Improved CRM training, improved communication and decision-making skills, and compliance with standard operating procedures are among the factors that can enhance CRM and help avoid future accidents and incidents.

**Note**

1. Materials are available through SKYbrary's OGHFA Portal at <www.skybrary.aero/index.php/Portal:OGHFA>.

## Flight Path Monitoring

"Proper flight path control" and "effective monitoring" have a familiar ring to airline pilots and flight operations/safety managers who, over the years, have attended conference presentations addressing some of their elements. In November, however, a newly articulated approach emerged, focusing on a few most-critical elements explained in plain language to help the worldwide aviation industry further reduce the risk of accidents (*ASW*, 11/14, p. 30, and <flightsafety.org/files/flightpath/EPMG.pdf>).

Twenty recommendations — including the underlying human factors science of why flight crews underestimate their vulnerability to mismanagement of aircraft flight path and energy state — have been released in this final report, titled *A Practical Guide for Improving Flight Path Monitoring*. The report was prepared by 28 subject specialists comprising the Active Pilot Monitoring Working Group and was published by Flight Safety Foundation. The working group, organized after the Human Factors Aviation Industry Roundtable meeting in 2012, addressed concerns expressed during that meeting about commercial air transport accidents in which ineffective monitoring was a factor.

Essentially, they looked at the traditional emphasis of airline pilot training and evaluation on control of the aircraft versus what they call the "primacy of the flight path management." The report says in part, "Monitoring is adequately watching, observing, keeping track of, or cross-checking. ... Monitoring is something that flight crews must use to help them identify, prevent and mitigate events that may impact safety margins. ... Improved flight path monitoring is intended to reduce the number of errors that result in flight path deviations."

The working group concluded that situations conducive to increased risk of flight path deviation and ineffective monitoring of energy state are predictable and well understood by experts, as are many effective mitigations suitable/ adaptable to virtually any pilot, airline and automated flight path management system.

For example, air carriers should "introduce the concept of areas of vulnerability (AOV) to flight path deviations and discuss the resultant need for improved task/workload management," the report says. "Practice interventions to maintain effective monitoring or to resume effective monitoring if degraded. Suggest interventions that protect situational awareness and flight path monitoring/cross-verification capability during high-workload situations. Institute policies and practices that protect flight path management from distractions and interruptions."

Moreover, among key pilot training outcomes needed are thorough pilot knowledge of how automated systems work, the required AOV-dependent sampling rate ("the frequency with which a pilot directs his/her gaze and attention to the external situation and flight deck indicators") for the situation, and how to perform effective flight path monitoring during emergency, non-normal and stressful situations.

## Lithium Battery Carriage

Lithium batteries, which are classified as dangerous goods, are a growing concern in commercial air transport and business aviation because of the potential risk of smoke, uncontrollable fire and explosive venting of extremely hot liquid if the cells short or fail because they are not packaged correctly, are damaged or mishandled, or are not manufactured to standards. In addition, lithium battery–powered devices are increasingly prevalent, and this drives up the number of batteries finding their way into passenger cabins and cargo holds around the world.

In the foreword to the recently published *Lithium Batteries Risk Mitigation Guidance for Operators*, Kevin Hiatt, a captain and senior vice president, safety and flight operations, at the International Air Transport Association (IATA), said that it is estimated that upward of 1 billion lithium batteries are transported each year by air in mail, as cargo or in passenger baggage.[1] Put another way, if one takes into account the num- ber of mobile phones, laptop and tablet computers, cameras and other electronic devices passengers carry onto an aircraft, a single-aisle, narrowbody jet carrying 100 passengers could have as many as 500 lithium batteries on board.[2]

IATA, noting that lithium batteries have been a contributing factor in the loss of three cargo aircraft, has characterized the transport of the batteries as an emerging safety issue.[3] In addition, the IATA Cabin Operations Safety Task Force identified lithium battery–related smoke/fire events as one of its top three safety issues for 2014, and one of the top two issues for 2015–2016, according to a presentation made at the IATA Cabin Operations Safety Conference in Madrid in May.

There are three common types of lithium batteries or cells: lithium-metal, lithium-ion and lithium-ion-polymer. Lithium- metal batteries are single-use (non-rechargeable) and are found in items like watches and pacemakers. Lithium-ion batteries are rechargeable and are used to power consumer electronics, such as laptop computers. Lithium-ion-polymer batteries also are rechargeable and also are found in consumer electronics such as tablet computers and smartphones. They differ from lithium-ion batteries only in their geometry and outer case material.[4] Lithium-ion and lithium-ion-polymer batteries often are simply referred to as *lithium-ion*.

The potential safety risk is related to how lithium batteries fail. A short circuit or external damage can lead to an individual cell failing. If the cell goes into thermal runaway, it can cause the other cells in a battery to fail. If multiple batteries are packaged together, such as in a cargo shipment, the concern is that failure-produced fire in one battery could spread to the others. A lithium battery fire is extremely hot and difficult to extinguish, and when batteries fail, an internal pressure buildup could result in an explosion. Also contributing to the risk are the number of batteries being shipped, the failure of shippers (either inadvertently or intentionally) to follow shipping requirements, and low-quality and counterfeit or fake batteries.

Effective Jan. 1, 2015, lithium-metal batteries that are transported by themselves (as opposed to batteries packed with or within equipment) as cargo will be restricted to cargo aircraft only, according to the International Civil Aviation Organization. The U.S. Federal Aviation Administration offers guidance to passengers on the types of batteries that are allowed in carryon and checked baggage at <faa.gov/about/office_org/ headquarters_offices/ash/ash_programs/hazmat/passenger_ info/media/faa_airline_passengers_and_batteries.pdf>.

**Notes**


1. IATA. *Lithium Batteries Risk Mitigation Guidance for Operators, Effective 1 January–31 December 2015*. Montreal, 2014.
2. Tang, Allan. “Improvements in Cabin Safety and New Challenges.” Paper presented at the IATA Cabin Operations Safety Conference, Madrid, May 2014. Tang is the principal training specialist, Singapore Aviation Academy.
3. IATA. *IATA Safety Report 2013*. April 2014.

4.FAA William J. Hughes Technical Center, Aviation Research Division. *Extinguishment of Lithium-Ion and Lithium-Metal Battery Fires.* January 2014.

## Loss of Control–In Flight

For most of the last decade, loss of control–in flight (LOC-I) crashes have been responsible for more fatalities than any other aviation accident category.

Data for accidents involving Western-built commercial jet airplanes from 2004 through 2013 show that 16 LOC-I crashes killed 1,526 people in the airplanes, plus 50 people on the ground, nearly twice as many fatalities as the number associated with the second-place category, controlled flight into terrain.[1]

Leading causes of LOC-I, according to Don Bateman, chief engineer for flight safety technologies at Honeywell Aerospace and a leader in development of ground-proximity warning systems, are spatial disorientation and suspected confusion involving the differing formats of attitude indicators in use on Western-built and Eastern-built airplanes. Together those two categories accounted for nearly half of LOC-I fatalities, Bateman said in 2011.[2]

Other frequent causes were upsets related to wake turbulence, training practices that have led to overcontrol of the rudder, autopilot mode confusion, and failure to decrease angle-of-attack to regain control of the airplane, Bateman said.

To mitigate LOC-I accidents, an International Civil Aviation Organization (ICAO) standard now requires pilots to undergo upset prevention and recovery training (UPRT) before they receive an airplane category type rating, and the industry has focused its efforts on training that emphasizes high-altitude stallprevention training in flight simulation training devices.

ICAO's Doc 10011, *Manual on Aeroplane Upset Prevention and Recovery Training*, notes that stalls and airplane upsets are closely related, and describes the standards and recommended practices designed to form the heart of UPRT efforts.

**Notes**


1.*Boeing. Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1959–2013*. September 2014.

2.Bateman, Don. "Simple Tools to Prevent LOC." *AeroSafety World* Volume 6 (June 2011): 28–32.

## Pilot Fatigue

Pilot fatigue, cited by aviation accident investigators as a factor in numerous crashes over the years, has been the subject of more than 200 safety recommendations issued by the U.S. National Transportation Safety Board (NTSB) alone, along with scores more by the world's other investigative bodies.

Despite the adoption of many of those recommendations by civil aviation authorities, as well as the adoption of more stringent regulations governing flight and duty time limits and rest requirements, fatigue continues to factor in numerous accidents.

Among the more recent was the crash of a UPS Airbus A300-600 on approach to Birmingham, Alabama, U.S., at the end of an overnight flight on Aug. 14, 2013. Both pilots — the only people in the airplane — were killed, and the airplane was destroyed. The NTSB cited pilot fatigue — something both crewmembers had complained about during the flight — as one of four factors contributing to the crash.[1]

Even though new U.S. Federal Aviation Administration (FAA) duty and rest requirements did not apply to the accident flight — they took effect after the crash and exempted crews on cargo flights — the flight was conducted within those limits.

Nevertheless, sleep loss and disruption of circadian rhythms — the patterns of sleepiness and wakefulness in each 24-hour period — affected the accident crew, as they have affected other crews before and since.

Flight Safety Foundation has been a consistent advocate of responsible fatigue guidelines; among its most recent efforts at mitigating fatigue was the development — along with the National Business Aviation Association — of *Duty/Rest Guidelines for Business Aviation*, which describes a science-based program designed to serve as a cornerstone of fatigue management programs in business aviation. The guidelines are available at <flightsafety.org/ files/DutyRest2014_final1.pdf>.

**Notes**

1. NTSB. Accident Report NTSB/AAR-14/02, *Crash During a Nighttime Nonprecision Instrument Approach to Landing; UPS Flight 1354, Airbus A300-600, N155UP; Birmingham, Alabama, August 14, 2013*. Available at <www.ntsb.gov>. The NTSB said the probable cause was the crew's continuation of their unstabilized approach and their failure to monitor the airplane's altitude, which "led to an inadvertent descent … into terrain."

## Runway Safety

Runway safety–related events are the most common type of commercial air transport accident. According to the International Air Transport Association (IATA), 58 percent of all accidents occurred in the runway environment from 2009 through 2013, and the category's most frequent type is runway excursion, representing about 23 percent of all accidents over the period.[1] "While there is a downward trend in aviation accidents overall, runway excursions remain relatively unchanged. Improving runway safety is a key focus of the industry strategy to reduce operational risk," IATA said in its latest annual safety report.

In 2013, 43 percent of all accidents in scheduled and nonscheduled commercial operations occurred during the landing phase of flight, according to the International Civil Aviation Organization (ICAO), which groups runway safety–related events with loss of control–in flight (LOC-I) and controlled flight into terrain (CFIT) as high-risk occurrence categories.[2] Runway safety–related events[3] accounted for 63 percent of all high-risk category accidents in 2013, but only 6 percent of the fatalities.

Pilots continuing an unstable approach to landing is a primary cause of runway excursions. Flight Safety Foundation's multi-year Go-Around Decision-Making and Execution Project is drawing to a close, and a final report is expected in early 2015 (see "Too Few Misses," p. 20).

**Notes**

1. IATA. *IATA Safety Report 2013*. April 2014.
2. ICAO. *ICAO Safety Report 2014 Edition*.
3. Runway safety–related events include the following ICAO occurrence subcategories: abnormal runway contact, bird strike, ground collision, ground handling, runway excursion, runway incursion, loss of control on ground, collision with obstacle(s), undershoot/ overshoot, and aerodrome.

## Safety Information Sharing and Protection

The routine collection and analysis of aviation safety data and the sharing of the resulting information are widely held to be key to improving the industry's already stellar safety record because of the potential for understanding the causes of aircraft accidents and preventing future accidents. As the U.S. Federal Aviation Administration (FAA) said in a working paper presented in September to the International Civil Aviation Organization's (ICAO's) Regional Aviation Safety Group — Pan America (RASG–PA), "The ability to effectively collect and disseminate safety information throughout the international community will help increase aviation safety worldwide. It is essential that a safety management system include tools for sharing information held by the civil aviation authority and the individual organizations within the aviation industry, promoting a government–industry partnership."[1]

Numerous information-sharing programs and initiatives are under way, and some, like the Aviation Safety Information Analysis and Sharing (ASIAS) program in the United States, often are held up as success stories. The analysis of precursors and threats by ASIAS has been used by the U.S. Commercial Aviation Safety Team (CAST) to identify emerging risks in the U.S. aviation system. In addition, aggregated, de-identified trend information from CAST and from the International Air Transport Association's Flight Data Exchange program is being shared with RASG–PA in a controlled and secure manner to enable RASG–PA stakeholders to address issues within their states or operations.

But there are a number of significant obstacles to legitimate and effective global data sharing, including a lack of coordination between organizations that collect and analyze data; duplication of effort that sees participants having to provide data to multiple programs; insufficient development of programs that encourage open reporting of safety issues; and, perhaps most importantly, limited protection of safety data and information against uses other than aviation safety.

Safety information sharing and safety information protection (SIP) are both on the agenda for discussion at ICAO's Second High Level Safety Conference 2015 (HLSC 2015), scheduled for Feb. 2–5 in Montreal. Among the items addressed in a working paper prepared for the HLSC are the recommendations on safety information protection made by the SIP Task Force (SIP TF), the vice chair of which was Kenneth Quinn, Flight Safety Foundation's general counsel.

The SIP TF proposals include amendments to Annexes 6 (Operation of Aircraft), 13 (Aircraft Accident and Incident Investigation) and 19 (Safety Management) of the Chicago Convention. The recommendations for Annex 6 apply the enhanced legal protections to information collected through flight data analysis and fatigue risk management systems, and the amendments to Annex 13 cover cooperation between accident investigation authorities and judicial authorities.

Safety information collection, analysis, sharing and protection is one of the Foundation's top priorities and is the subject of a global safety information project on which the Foundation has embarked with support from FAA and CAST.

**Notes**

1. Federal Aviation Administration. "U.S. Priorities for the ICAO 2015 HLSC (High Level Safety Conference)," RASG–PA/7–WP/10, Seventh Regional Aviation Safety Group — Pan America Annual Plenary Meeting, Willemstad, Curaçao, September 2014.

## Training

One characteristic of training commercial air transport professionals — the legacy of gradual, evolutionary changes — in recent years has not met society's expectation of rapidly implemented solutions. An example of a recent change to the established order in training is the introduction of upset prevention, recognition and recovery training for airline pilots. Others are the advent of training for the multi-crew pilot license and, in the aftermath of one U.S. accident, adding the qualification of at least 1,500 hours to fly as an airline first officer.

Comparable paradigm shifts have transformed training in the domains of flight attendants, dispatchers, air traffic controllers, maintenance technicians and other certified/licensed aviation professions. Across the board, changes have required acceptance of new insights into human factors (e.g., fatigue), identification of training gaps (e.g., portable electronic devices), reexamination of long-held assumptions about current practices (e.g., flight path monitoring) and replacing obsolete practices (e.g., stall training).

Willingness to consider changes in legacy training fortunately can be readily found across domains. One ASW article noted, "The experts did not hesitate to call for industry stakeholders to relinquish any belief, practice or cultural norm when today's best evidence proves an increased risk or obsolescence." A 2013 report cited earlier ("Flight Path Monitoring," p. 14), also is typical of how the industry assesses training gaps without hesitation, saying: "Current training methods, training devices, the time allotted for training, and content may not provide the flight crews with the knowledge, skills and judgment to successfully manage flight path management systems. … Flight instructor training, experience, and line-operation familiarity may not be sufficient to effectively train flight crews for successful flight path management."

*ASW* articles have covered many themes that bridge domains, including: eliminating repetitive/predictable training scenarios and any time-based focus and, in the words of the Active Pilot Monitoring Working Group, replacing these with "realistic scenarios that mimic the dynamics (surprises) of line operations" in a performance/competence-based environment; inducing stress through time pressure or other techniques to assess actual competence; creating scenarios that require indepth knowledge for success; and instilling mental models that help individuals avoid or logically work through confusion.

Instructors and evaluators, whether working in an airplane cabin or a control tower, similarly recognize that individuals may hardly pay attention to a specific skill covered unless they know they must prove mastery of the skill during an evaluation. Examples of aviation training improvements with potential to jump from one professional domain to others include: interspersing activities focused on theoretical training with others that require immediate practice in realistic scenarios; using mastery tests that progressively measure each student's progress rather than conducting an all encompassing test at the end of a training course; reshaping crew/cabin resource management courses to fit the culture of new-entrant employees; and fostering just culture–centered classrooms in which aviation professionals feel free to speak up about their own errors in front of their colleagues, admit when they do not adequately understand a system and/or request remedial skill training.

**Basic Aviation Risk Standard (BARS) Program Top 10 Audit Findings, 2014**

1. SMS documentation and implementation
2. Quality assurance
3. Maintenance duty time/fatigue management
4. Maintenance training content and frequency
5. Emergency response plans
6. Control of spare parts
7. Operational risk assessment
8. Hot refuelling
9. Procedures training for dangerous goods
10. CRM/ADM training for flight crew

SMS=safety management system; CRM/ADM=crew resource management/aeronautical decision making
Source: Presentation by Greg Marshall, BARS managing director and Flight Safety Foundation acting vice president global programs, at the International Air Safety Summit, Nov. 13, 2014, Abu Dhabi, United Arab Emirates

The Basic Aviation Risk Standard (BARS) Program was developed by Flight Safety Foundation and the resource sector in response to an industry-identified need for a common global aviation safety audit protocol that could be applied to onshore resource sector aviation support activities. BARS is a risk-based model framed against the threats posed to aviation operations, particularly those found in remote and challenging environments.

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