現代航空安全之五大進步

歐文 譯

儘管航空公司失事事件持續惱人地成為新聞頭條，並常在毫無線索下被自稱專家的大肆深入分析，然而航空安全仍持續大幅改善。這種喋喋不休讓大眾感到憂心，並對航空安全形成錯誤概念。

然而，近幾十年來，新的改善方案及發明已讓飛行座艙完全轉變，因此航空業已從「令人印象深刻的安全」進展至「令人無法置信的安全」。

注意事項及免責聲明：

- 這是業界圈內人之個人意見「對，也就是自稱的專家」
- 就以下許多內容，個人係運用懶人參考方法，先用谷歌搜尋，然後再用維基百科搜尋。
- 前五項重大改進係以隨機方式呈現，並無隱含效益。但第一項則是例外，因為就個人意見它是現代噴射時代中航空安全最重要之改善方案。

第五項：TCAS-空中防撞系統

航空安全的許多改善方案都是因為航空失事事件所致。事實上，當今現代飛航管制系統可追溯至大峽谷上空之慘烈空中相撞，當時一架聯合航空道格拉斯DC-7型客機撞到一架環球航空洛克希德L-1049超級星座號，兩架飛機上之128名人員全部喪生。

因此，1958年聯邦航空法案創設了聯邦航空局(FAA，後來改名為聯邦航空總署)，並透過一系列陸基雷達管制員而大幅擴展航管系統。目前，美國本土之48州每吋土地幾乎都享有雷達管制。

機上另一項重大科技進展就是TCAS。運用飛機Mode C雷達資料以答覆ATC雷達有關識別、速度及高度訊號詢答，機上TCAS系統會針對其他飛機所可能造成之威脅提出警告。若兩架飛機上均有TCAS系統，在緊急情況時，雙方系統會相互協調並作出垂直解決方案，亦即指揮一架飛機爬升，另一架下降。

第四項：EGPWS—增強型近地警告系統

美國航空前往加州之 965航班發生悲慘之可控飛行撞地情況，成為航空業界之另一警鐘。在夜間極度情晰飛航條件中，經驗豐富之機組員把一架狀況完好之民航機直接撞山，造成機上159位乘客及8位機組員全部喪生。

該民航機配備了革命性並可監看雷達高度表資料以預判可能地表撞擊點之全新近地警告系統(GPWS)。然而，警告來的太晚，飛行員無法飛越地表。

現今增強型GPWS提供現代民航機全球地形之資料庫，大幅提高安全裕度，甚至在飛行員之導航儀表上顯示潛在危險地形。

加上TCAS，這已大幅增加飛行員之情況掌握。

第三項：低層風切警告系統

另一項導致安全重大進展之悲劇則是1975年東方航空第66班機之失事事件。該班機係微暴氣流雷雨造成風切之受害者，由於風切之方向及速度改變快，造成這架波音727飛機在落地前失速，導致機上124名人員中之113人喪生。

飛機就像在液體中之物體，很像是河中之船隻。在任何情況下，飛機一定有最低速限，而風就像是河中會改變的水流。若風之速度及/或方向改變夠快，在理論上飛機在調整適應前會在幾個關鍵時刻中失去空速。在極端情況下，飛機會因改變太大而無法改正。

在東方航空失事事件後，NASA發展出一套新的LLWS-1系統，以偵測風速及方向變化快速且經常與微暴氣流有關之氣流。如果區域內偵測到對流活動(如暴雷雨)時，入境及離境飛機就會接收到低層風切警告之警示。

另外在飛行座艙中之另一項利器就是預測風切偵測系統，它是運用機上都卜勒氣象雷達偵測飛機前方降雨之剪應力。

第二項：跑道安全警告系統

1977年特內里費島兩架B-747相撞造成583人喪生，至今仍然是航空史上最慘烈之失事事件。此一失事事件係因跑道入侵所致，當時一架波音747開始進行起飛滾行，而另一架飛機則還在跑道上。

跑道入侵仍然一項風險。為了降低這項威脅，美國航空安全系統最近所增加之一項利器就是跑道安全警告系統(簡稱RSWS)。

RSWS運用所有飛機之應答器資料以偵測在跑道上入境或離境飛機之移動。當偵測到移動時，跑道交叉路口處的紅燈會亮起來，警告正通過之飛機。反之，當一架飛機在跑道頭排隊準備起飛，而另一架被允通過場面時，離境飛機前之一排紅燈會亮起來，以為警示。

目前，已有一些機場裝設了RSWS系統，而且其運用正在快速增加中。

第一項：CRM—組員資源管理

就某些方面而言，科技已促使航空安全進步到飛行員本身已成為飛機最大負債，而這也促使一些笨蛋建議最安全的駕駛艙就是沒有飛行員的座艙。

個人完全不同意這種離譜的陳述。

儘管人類可能是飛機最大負債，但他們超越一切也是最重要的安全資產。

誠如我們很不幸地得知近期德國之翼失事事件中，人為因素可在航空安全上扮演主要角色。很顯然地，企圖自殺的飛行員極其罕見，但人為因素仍然影響著現今之民航飛行員。雖然FAA及大眾傾向於將美國飛行員當成自動機器人，在飛行時可不必考量人為議題，但民航飛行員持續面臨疲勞、壓力及如同FAA所言需要在飛行中使用廁所以處理生理需求等議題。

簡言之，難過的說，我們仍然是凡人。

誠如所言，也再次強調，人類飛行員是目前您飛機上最大的安全裝置。雖然無人機與自動駕駛往往成為頭條新聞(今天飛機實務上是自己在飛, 對嗎?)，但最後一行仍然是：

電腦可能處理，但不能思考。

你會相信你的車子可能用巡航控制載你到雜貨店嗎?應該不會。儘管當今之現代民航自動駕駛相當雜複先進，但它的最多就是三度空間的巡航操控而已。

飛機上最重要之安全議題就是:判斷一人類思考腦袋。

--電腦能夠決定在紐約哈德遜河上迫降嗎?

--如果沒有Richard de Crespigny及其了不起之組員在Qantas QF32班機上，電腦能夠在A380引擎爆炸後兩小時排除壞資料之故障並安全地將龐大超重飛機降落，拯救超過400名乘客及機組員?

萬一您還在懷疑，答案是明確的不行。

電腦甚至無法決定午餐要吃什麼。

因此，我相信會行使(而非模擬)真正判斷的「思考」電腦在未來一百年後才會出現。

民航機單一飛行員之概念同樣地荒謬。在35年的飛行生涯中，我已不斷地觀察，兩位飛行員之飛行甲板係最安全最務實之概念。兩個人絕對遠優於一個人。兩位飛行員一一位正機師及一位副機師可以相互發掘彼此之錯誤，討論像是天氣繞路或改道耗油，並在遇到狀況時相互協助。

我在個人的部落格及其他文章中廣泛地討論組員資源管理，也就是CRM，在此不再進入細節探討。然而，它仍然是過去數十年間航空安全重大進步的關鍵因素。

Richard de Crespigny機長與我在他即將播出並且引人入勝的三段錄影訪談中共同探討這個議題。

然而，CRM可以簡單的摘述如下:

以前「船長就是上帝」的航海傳統已在近來數十年

間轉變成「船長掌舵，領導一批經驗豐富且合格之專業人員」的概念。

換言之，機長在作出關鍵決定前會以敬重態度向其重要組員，特別是副機師(FO)獲得意見看法。反之，一位好機長會創造信任環境讓每位組員覺得受到重視，而且能夠毫無疑慮的說出任何關切事項。

拿個有趣的比喻來說，看看星際爭霸戰影集中幾位艦長角色之演變。

剛開始時，我們有老式「船長就上帝」的Kirk艦長。然而，在下一世代星際爭霸戰中，我們所碰到的Jean Luc Picard艦長，他不但重視他的組員，而且積極向他們諮詢意見。

Kirk也許是有史以來最壞的艦長，而Picard則是一位較佳之艦長。

要獲得更多有關這項引人入勝之主題內容，請勿錯過民航機師而且同時是作者的Jean Denis Marcellin傑出書籍：飛行員因素(The Pilot Factor)

氣象雷達一約從第二次世界大戰開始，氣象雷達已演進成為相當先進之裝置，讓飛行員得以航行繞過暴風雨天氣，絕對是現在飛行座艙中非常重要之配備。

詢答器/模式C詢答器一緣自第二次世界大戰敵我識別器，詢答器係另一針對雷達設施之詢問訊號傳送飛機資料(識別、速度、高度)之好用工具。模式C引進了程式中之垂直部分，也就是高度報告。

EFIS一電子飛行儀表系統一目前幾乎每架飛機座艙內都有EFIS系統，它將稱為「蒸氣壓力表」的六項舊式標準飛行儀表整合成在CRT或LED螢幕上，協助現在飛行員更易於進行儀器飛行。此外，EFIS系統也包括在自動飛行中，減輕飛行員一般之飛行負擔，增加對大局之注意時間，達成強化飛行安全之目的。

本文作者Eric Auxier係美國一家主要航空公司A320之機長，他飛行生涯已達35年，飛行時數超過2萬1千小時。過去20年來，他所飛的是A320級空中巴士(A321-A319)，所累積之該機種飛行時數超過1萬4千小時。另外，他也是波音737及DHC-8之合格機師。他的飛行生涯讓他得以從阿拉斯加叢林到加勒比群島，以及兩地之間的所有地方。他不但是廣受歡迎的“Adventures of Cap'n Aux”航空部落客而且也是四本書之作者。2013年，他著作的「最後叢林飛行員」讓他獲得亞馬遜前100名突破小說獎。

譯自 Airways News 網站

Top 5 Modern Improvements in Aviation Safety

Eric Auxier

While the airline accident du jour continues to (annoyingly) grab the headlines and be overanalyzed ad nauseum by the media's self-proclaimed yet often clueless "experts," airline safety continues to improve by leaps and bounds. All this blathering tends to worry the public, giving them a false perspective on aviation safety.

In recent decades, however, improvements and inventions have transformed the cockpit—and thus the airline industry — from impressibly safe to incredibly safe.

Notes and Disclaimers:

- This is my opinion, as an "industry insider" (Yes, a "self-proclaimed expert!")
- For many of the factoids presented below, I use the "lazy man's reference": Google search, followed by Wikipedia.
- The Top 5 are in somewhat random order, rather than implied effectiveness. The exception is Number 1 which, in my opinion, has been the greatest improvement to aviation safety in the modern jet era.

Number 5: TCAS—Traffic Collision Avoidance System

Many improvements in aviation safety have come off the backs of airline tragedies. In fact, today's modern Air Traffic Control system traces its roots to the tragic midair collision over the Grand Canyon, when a United Airlines Douglas DC-7 struck a Trans World Airlines Lockheed L-1049 Super Constellation. All 128 on board both flights perished.

As a result, the Federal Aviation Act of 1958 created the Federal Aviation Agency (FAA, later renamed the Federal Aviation Administration,) which in turn greatly expanded the Air Route Traffic Control System, a series of ground-based radar controllers. Today, virtually every square inch of the contiguous 48 states enjoy radar

control.

On-board, another wonderful advancement in technology has been TCAS. Using radar data from "Mode C" airplanes—which reply to ATC radar interrogation signals with data such as identification, speed and altitude—the on-board TCAS system warns of potential threats of other aircraft. If both planes have TCAS on board, in an emergency situation, the two boxes will coordinate with each other to come up with a vertical "solution," commanding one plane to climb and the other to descend.

Number 4: EGPWS—Enhanced Ground Proximity Warning System

Another wake up call for the industry came in the form of American Airlines Flight 965 into Cali, which suffered a catastrophic "CFIT"—Controlled Flight Into Terrain. In nighttime, "severe clear" conditions, the experienced crew flew a perfectly good airliner straight into a mountainside, killing all 159 passengers and eight crew members.

The airplane was equipped with the revolutionary new "GPWS," Ground Proximity Warning System, which

looks at radar altimeter data to predict a possible impact with terrain. However, the warning came too late, and the pilots were unable to out-climb the terrain.

Today's "Enhanced" GPWS gives the modern airliner a worldwide terrain database which greatly improves the safety margin, and even displays the potential hazardous terrain on the pilots' ND, or Nav Displays.

Along with TCAS, this has greatly aided the pilots' situational awareness.

Number 3: LLWAS—Low Level Windshear Alert System

Another tragedy that led to great improvements in safety was the 1975 crash of Eastern Airlines Flight 66. Flight 66 was a victim of "Windshear" caused by a thunderstorm microburst—that is, a rapid change in the direction and speed of the airmass in which it was flying, causing the Boeing 727 to stall shortly before landing, killing 113 of 124 on board.

A plane is simply a body moving through a fluid, much like a boat in a river. In any given configuration, there will be a minimum airspeed at which the plane can fly. The wind, like the river's current, can change. If the wind changes in speed and/or direction fast enough, the plane may theoretically lose that airspeed for a few critical moments before adjusting. In extreme cases, it may be too much from which an airplane can recover.

In the aftermath of Eastern, NASA developed a new system called LLWS-1 to detect these rapid changes in windspeed and direction, most often associated with microbursts. Over the years, this system has been improved and refined, including the incorporation of Doppler radar. If convective activity (i.e. thunderstorms) are detected in the area, LLWS advisories are given to arriving and departing aircraft.

Another recent addition to the cockpit has been predictive windshear detection systems, which uses onboard Doppler weather radar to detect shears in precipitation ahead of the aircraft.

Number 2: RSWS—Runway Safety Warning System

The most deadly accident in aviation history remains 1977′s Tenerife collision between two B-747′s, in which 583 people lost their lives. The accident was the result of a "runway transgression" when, in foggy weather, one B-747 began the takeoff roll while another was still on the runway.

Runway transgressions remain a hazard. To alleviate this threat, one of the most recent and delightful additions to the U.S. aviation safety system has been the Runway Safety Warning System.

RSWS uses transponder data from all aircraft to detect movement of an arriving or departing aircraft on a runway. When one is detected, red lights illuminate at runway intersections to alert transiting aircraft. Conversely, when an airplane is lined up at the end of the runway, ready to takeoff, and another is cleared to cross downfield, a row of red bars light up in front of the departing aircraft as a warning.

Currently, RSWS has been installed at several airports, and is rapidly expanding in use.

Number 1: CRM—Crew Resource Management

In some ways, technology has advanced aviation safety to the point where the human pilots themselves have become the airplane's greatest liability. This has prompted some nincompoops to suggest the safest cockpit may be the one with no pilots.

I vehemently disagree with this absurd statement.

While humans may be the airplane's greatest liability, they also remain—head and shoulders above anything else — its greatest safety asset.

As we have tragically learned in the recent Germanwings crash, the human element can play a major role in aviation safety. Obviously, a homicidal pilot is exceedingly rare, but human factors still effect today's airline pilot. While the FAA and the public tend to treat us pilots as automatons that can fly without human issues, airline pilots are constantly facing such factors as fatigue, stress, and, yes, the need to "tend to one's physiological needs," as the FAA dryly puts it, by using the lavatory inflight.

In short, sad to say, we are still mortal humans.

This being said—and I say again—the human pilot is by far the greatest safety "device" onboard your airplane. While drones and autopilots tend to grab the headlines ("Today's planes practically fly themselves, right?"), the bottom line remains:

Computers can Process, but they can't think.

Would you trust your car's cruise control to drive you to the grocery store? Thought not. As sophisticated

as it is, today's modern airliner autopilot is nothing more than a fancy, 3D cruise control.

And therein lies the most important safety issue in an airplane: Judgement—i.e, the thinking human mind.

—Can a computer decide to ditch in the Hudson?

—Can a computer troubleshoot bad data for 2 hours in an A380 after the engine explodes and safely land the vastly overweight plane, saving over 400 passengers and crew, a la Captain Richard de Crespigny and his amazing crew aboard Qantas Flight QF32?

In case you're wondering, the answer is a definitive NO.

A computer can't even decide what to have for lunch.

As a result, I believe, the "thinking" computer—the one that exercises (NOT "simulates") true judgement—is still a hundred years in our future.

The single pilot airliner concept is equally absurd. In my 35 years of flying, I have repeatedly observed that the 2-pilot flight deck is the safest, most practical concept conceived. Two heads are exponentially better than one. Two pilots—a Captain and First Officer (NOT a "Pilot" and "Copilot," TUVM!)—can trap each other's errors, discuss fuzzy issues such as deviation around weather or diversion to take on more fuel, and assist each other when the lav juice hits the fan.

I have talked extensively on my blog and in other articles about CRM, or Crew Resource Management, so I won't go into much detail here. Nevertheless, it remains a critical component to the vast improvement in aviation safety over the past few decades.

Captain Richard de Crespigny and I explore this topic in depth in his fascinating, 3-part video interview, coming soon.

In short, however, CRM can be summed up in this:

The old maritime tradition that "The Captain is God" has given way in recent decades to the concept that, "The Captain is in charge, leading a team of experienced, qualified professionals."

In other words, the Captain respectfully solicits the input from his valuable crew—especially his First Officer—before making critical decisions. In turn, a good captain creates a trusting environment wherein each crew member feels valued, and safe to speak up about any concerns.

For a fun analogy, look at the "evolution" of the captains in the Star Trek TV series.

Originally, we had Captain Kirk, of the old "Captain is God" school. In Star Trek The Next Generation, however, we met Captain Jean Luc Picard, who not only valued his fellow crew, but actively sought their advice.

Kirk may be the baddest-ass captain of all time . . . but Captain Picard was a better captain.

For more on this fascinating subject, don't miss airline pilot and author Jean Denis Marcellin's excellent book, The Pilot Factor.

Honorable Mentions

Weather Radar—Around since WWII, weather radar has evolved into a highly sophisticated device which allows pilots to navigate around the stormy weather. Absolutely invaluable in today's cockpit.

Transponder/Mode C Transponder— Tracing its roots back to the original "IFF" (Identify Friend or Foe) system of WWII, the transponder is another wonderful tool that transmits aircraft data (identification, speed, altitude) to the interrogating signal, i.e., radar facilities. Mode C introduced the vertical portion of the equation, that is, altitude reporting.

EFIS—Electronic Flight Instrumentation Systems—In nearly every aircraft cockpit today, the EFIS system consolidates the six standard flight instruments of yesteryear, often called "steam gauges," into one CRT or LED (i.e., "TV") screen, helping today's pilot to more easily fly on instruments. Moreover, the EFIS is incorporated into the autopilot, which in turns increases safety by relieving the pilot of the burden of mundane flying tasks and frees up his or her attention to take in "the Big Picture."

Eric Auxier is an A320 Captain for a major U.S. airline, he has over 21,000 hours of flying in a career spanning 35 years. He has flown the A320-class Airbus (A321-A319) for the past 20 years, and has over 14,000 hours in type. He is also type rated in the Boeing 737 and DHC-8. His flying career has taken him from the Alaska bush to the Caribbean Islands and everywhere in between. A popular aviation blogger at "Adventures of Cap'n Aux" (capnaux.com) and author of four books, in 2013 he captured the coveted Amazon Top 100 Breakthrough Novels Award for "The Last Bush Pilots."

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