檢查表的危機

雖經737機師判定為電氣系出問題，
但一時無法改正修復，其後其他異常情況竟紛至沓來。

龍文馨

英國空難失事調查局調查官說，在施放右前艙逃生滑梯時雖係扭曲打出，實際上滑梯本身並無機械故障

莫非定律 —任何事情都可能出錯—

在2014年9月3日那天晚上，一架捷圖Jet2公司波音737-300型機，自西班牙依比薩機場飛往英格蘭東中途機場，莫非定律再次展現。

該機載有152位旅客及5位機組員，經歷了一連串的事件，有電氣難題、通訊失效、客艙煙霧、起落架釋放不順、逃生滑梯無法使用等種種缺失，起源於該機電氣系統問題缺乏正式的檢查表，再加上一連串其它可能造成危害的失效延續併發，那很可能演變成一次悲劇性意外事件，所幸並未釀成災難。

英國空難失事調查局（U.K. Air Accident Investigation Branch, AAIB）最近發布了該意外事件的結案報告，它並未在該事件後對民航主管當局或廉價航空公司作出任何建議。但是捷圖（Jet2）廉價航空公司仍擬議發展新的程序。

此次一連串的意外事件，起源於降落過程中，蓄電瓶匯流條繼電器「喪失連續通電性」，機師注意到旅客廣播系統（PA）已失效，其後「似乎電路未串聯」之電氣失效萌生，造成裝備冷卻、風扇、收音機、氣象雷達、自動剎車系統及、”地形、參考速度、引擎燃油流量及N1〔引擎速度〕”等等儀表上之指示符號，一一自機師前方儀表顯示器中陸續消失。

在其他航空公司的航機上，亦曾發生過類似的繼電器問題，1997年一架737-500型機發生意外事件之結果，使得丹麥空難調查委員會（Board）對該項問題發佈了兩項建議，其中一項是要求波音公司發展一套通用之程序，即針對電瓶匯流條失效（battery bus bar）制訂出一體適用的檢查程序；然而波音公司說因為737機隊中先後出廠之新機已設計有多種不同之電氣構型，所以無法提供類似通案的程序。

上述意外事件飛機的飛航組員偵測出問題所在，並且由電瓶匯流條發現之情況，判定了核心問題，但是英國

空難失事調查局 AAIB指出：機上快速參考手冊並無「非正常檢查清單」可幫助機師組員。在飛機構型已既定情況下，機師確知該飛機電瓶本身可持續大約30分鐘供電給相關系統。

在上述那些失效情況中，所不明顯的是：只要兩具引擎的起動機能持續供電，要修復那次的電氣短路問題其實是相當簡單的。

事後Jet2公司已於該公司之檢查表中增列一份新的電瓶匯流條失效檢查表，指引機師選擇BAT（電瓶）鍵，將之轉按至備用電力開關，並且附有解釋，如果操作電瓶按鈕後，並未解決該項問題，則其後將是那些「有因果關係」之系統可能會失效。

該事件中，Jet2機師最後宣告進入緊急程序，因為他們不能確定機上電瓶是否供電，以及其他系統是否可能變成無法作動。同時，這些失效也開始困擾著空服員，也就是當空服員企圖向乘客廣播時，發現客艙廣播系統無功能，於是在前艙的空服員想試著用電瓶供電的擴音器，但是發現其音量已被設定成最低音量，而且音控鈕不見了。英國AAIB調查報告指出：「她隨即走入客艙，逐次向數排旅客說明狀況。」

在飛機降落中，副駕駛操作起落架手柄至“放下”及“鎖定”位置時，發現原應顯示的綠燈沒亮，無法確定其放下及鎖定與否。

機師於是中止進場，改飛至1000呎高度後，詢問塔台可否確認其起落架位置，但是塔台管制員只可以看到鼻輪起落架已放下，遂回應說，天色太暗，無法見到主輪是否放妥。

機師只好再爬高至3000呎空層，由副駕駛走出駕駛艙，經由「主客艙及駕駛艙間」之地板上的觀察孔，用目視確定主起落架已經放置於正常的釋放位置，AAIB調查報告如是說。

後續的降落過程，倒是完全沒有其他的事故，不過對於乘客及機組員而言，問題還沒中止。在該架737降落進場滑行至停機坪定位時，飛機前艙之空服員聞到也看到客艙開始冒煙，AAIB調查官說「機師們聞到強烈的酸味」，好像是反胃在喉嚨一樣。

在電氣系統失效之情況下，機師也設法與客艙組員直接通話。事後判定，駕駛艙以及客艙的煙霧來源，是繼電器燒掉了，以及冷卻系統之風扇失效時，環控系統導管中之淤塵及滑油餘漬被加熱所致。

其後，很快的，機長呼叫緊急情況「May day」，於是客艙組員啟動機艙逃生門及緊急逃生梯（slide），呼叫乘客緊急逃生；然而，在打出前門的逃生滑梯時，它竟呈扭曲狀伸展旋轉而出，導致無法使用。在機艙左後門的空服員，起初尚不知機長已下達緊急撤離的逃生指示，她原先以為將會由登機梯（portable stair）讓旅客正常下機，直至她注意到旅客從左機艙後方滑梯逃出，她才啟動前艙逃生滑梯。

事後，調查官確定，機身前方逃生滑梯釋放後呈現扭曲狀，並非該裝備失效，而是肇因於打出逃生滑梯時，機門尚未完全開啟到位，造成滑梯呈螺旋型之滾轉打出。

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Checklist Crisis

Anomalies grow after 737 pilots ID, but cannot fix, electrical problem

John Croft

AAIB investigator say there were no mechanical problems with the Right front evacuation slide that twisted when deploying.

Murphy's Law - anything that can go wrong, will appeared to rule on the night of September. 3, 2014, when a Jet Boeing 737-300 was descending into the East

Midlands Airport in England after a flight from Ibiza, Spain. The aircraft, with 152 passengers and five crewmembers, experienced a chain of events, electrical problems, communication failures, smoke in the cabin, unease about the landing gear and a disabled evacuation slide - that were initiated by the lack of a formal checklist for the electrical problem and perpetuated by a series of otherwise innocuous failures that, together, created an incident that could have turned tragic, but did not.

The U.K. Air Accident Investigations Branch (AAIB), which recently released final report on the incident, did not make any recommendation to regulators, Boeing or the low-fare carrier following the event, but Jet2 opted to deploy new procedures.

The precipitating incident involved a "loss of continuity" across a battery bus relay during the descent. The pilots noticed that the public address system (PA) had failed, and then "seemingly unconnected" electrical failures emerged, which caused equipment cooling fan, radio, weather radar, auto brake system and "terrain, reference speeds, engine fuel flow and Nl [engine speed]" icon indicators to disappear in succession from the pilots' displays.

Similar relay issues had occurred on other airlines' aircraft. As the result of a 1997 incident with a 737-500,

the Danish Air Accident Investigation Board issued two recommendations to address the problem, one of which called for Boeing to develop generic procedure for the loss of the battery bus bar. However, Boeing said it was unable to provide such a procedure because of the many different electrical configurations across the 737 fleet.

The crew of the incident aircraft diagnosed the problem and correctly identified the core issue as emanating from a battery bus bar, but "commented that there were no non-normal checklists in the Quick Reaction Handbook to help them." says the AAIB. With the aircraft as configured, the pilots knew the aircraft battery on its own would continue providing power to systems for approximately 30 min.

What was not apparent under those circumstances was how simple the problem would have been to fix, given that both engine generators continued to provide power. A new battery bus-failure checklist-added to Jet2's checklists after this event-instructs pilots to select the "Bat" (battery) setting for the Standby Power switch, and explains which "consequential" systems will be lost if the Bat setting does not fix the problem.

The Jet2 pilots ultimately declared an emergency because they were unsure if the batteries were discharging and whether other systems might become inoperative.

Meanwhile, failures began to dog the flight attendants who when attempting to brief the passengers found that the PA system was inoperable. An attendant at the front of the cabin then tried using a battery powered megaphone, but discovered that the volume had been set to the lowest level and the volume knob was missing. "She walked through the cabin briefing the passengers a few rows at a time," says the AAIB.

As the aircraft descended to land, the first officer moved the landing gear lever to the "down" position, but no confirmation lights verified the "down and locked" status. The pilots then discontinued the approach, asking the tower to verify the landing gear status as they flew over at 1000 ft. Controllers could see that the nose gear was down, but said it was too dark for them to see the main gear. The pilots climbed back to 3,000 ft., where the first officer used "observation ports in the floor of the main cabin and the flight deck “to visually confirm the landing gear had extended properly, says the AAIB.

The subsequent landing was uneventful, but problems were not over for the crew or Passengers. As the 737 approached its parking stand, flight attendants in the forward area of the aircraft smelled and saw smoke in the cabin, and the pilots smelled a "strong acrid smell which they 'felt in the throat", the AAIB says. The pilots could not directly communicate with the flight attendants given the electrical failure.

The smoke in the cockpit and cabin was later attributed to the burning of the relay and to residue from oil and dust in the environmental system duct work that had heated up when fans failed in the cooling system.

Soon after, the captain declared a "mayday" and evacuation began via over-wing exits and emergency slides. At the right front door, however, a slide twisted upon deployment and could not he used. At the left rear door, the flight attendant was at first unaware of the evacuation order and assumed there would he a normal exit onto portable stairs until she noticed passengers sliding off the bock of the left wing; She then deployed the slide.

Investigators later determined that the twisting of the slide at the front exit was not related to equipment failure but potentially to the door not being fully open when the slide deployed, causing a corkscrew motion.

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