人類行為

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圖2-1：四次事故中有三次是人員疏失所致

引言

四次事故中有三次是因人為表現不當所致(如圖2-1)。人類在航空體系中，是最具彈性、適應力最強、價值最高的，但也最易受到干擾其表現構成不良影響。

人類行為研究係用以試圖解釋人類行為功能是如何與為何產生。人類行為是個複雜的題材，它是人類本性與個人經驗及所處環境的共同產物。人類行為的定義廣泛，端視研究領域為何。在科學世界中，驅使人們循可預判的方式採取動作之種種因素，其產物即人類行為。

美國FAA運用人類行為研究，試圖降低航空界的人員疏失。追溯歷史，「飛行員失誤」(pilot error)係指飛行員的操作或處置決定，成為某件事故的肇因或主要因素。此定義涵括飛行員無法做出正確處置決定或採取適當作為。廣義而言，以「人員相關因素」(human factors related)一詞來說明這些事故才更為貼切。單一處置決定或事件不會導致失事，而是由一連串的事件所造成；其間所有處置決定形成連鎖事件，才導致這種結局。許多事件中涉及機組員間的互動。事實上，航空公司長久以來採行「組員資源管理」(crew resource management, CRM)與「線上導向飛行訓練」(line oriented flight training, LOFT)計畫，對飛安與利潤產生正向效應。相同的計畫程序亦能(在某種程度下)應用在通用航空領域之中。

人員發生疏失，顯現出體系中問題所在，但為何發生卻無從索驥。探究飛行員為何出錯，本質上涉及多種領域。在航空領域中檢視人員扮演的角色時，尤以飛行員而言，需要考量的一些人員因素包括：處置決定、顯示器與控制系統之設計、座艙儀表板佈局規劃、通訊、地圖與表單、檢查卡與系統程序。上述任何一項皆可能構成壓力因素，使人員表現失常，進而導致嚴重人為疏失。

由於飛行員處置決定不當(人為疏失)被認定是許多飛航事故的主要因素，人類行為研究即在設法找出單一個人接受風險的行為特質，以及事故發生時個人涉入之程度。無數科學家汲取過去數十年來的研究，就是為了探究如何增進飛行員的效能。

有肇事傾向的飛行員嗎？明尼蘇達州立大學的Elizabeth Mechem Fuller與Helen B. Baune於1951年撰寫的研究指出，確實發現有傷害傾向的孩童。這份研究取樣兩組區隔開的小學二年級生。研究顯示有55位學生會反覆出事，另外48位學生則未發生任何意外。這兩組學生皆來自同一所擁有600名學生的學校，其家庭組成亦相仿。

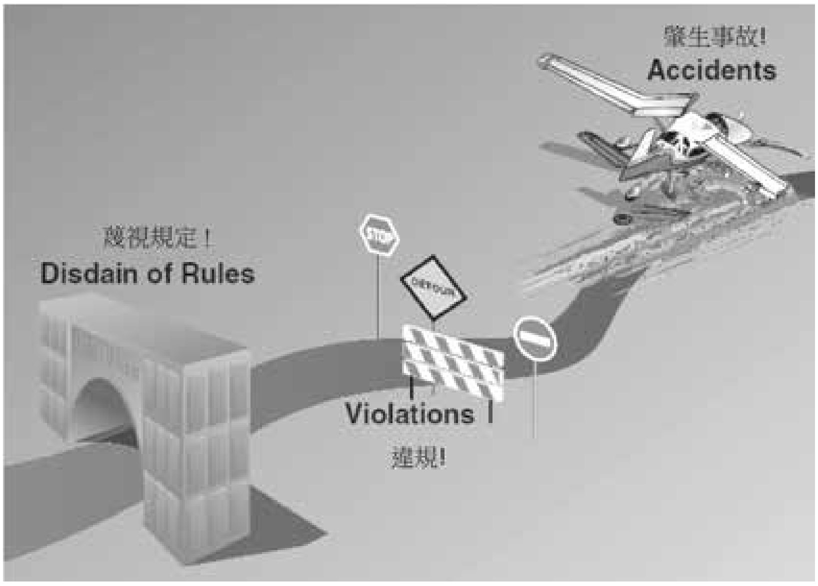

圖2-2：依據人類行為研究，交通違規與飛機事故有直接關聯。

未發生意外的這一組顯現出對安全有較佳的認識，而且很勤快，會與人合作，但是活動力較不旺盛。會反覆出事的這一組則是有較佳的體能技巧，並且會逞強、衝動，在承受壓力時顯現出叛逆的行為，失敗時沒有風度，並且喜歡成為目光焦點(如圖2-2)。對這項資料的一種詮釋是成年人的傷害性的行為特質源自於幼時的行為與環境，歸納結論指出任何飛行員群體，應僅能由具安全警覺、勤快與協力合作特質的飛行員組成。這顯然不僅是不正確的推斷，同樣也是不可能達成的，因為飛行員來自普羅大眾，而且也有各式各樣的個性。

在Fuller與Baune研究問世的55年後，Patrick R. Veilette博士在2006年於《商務暨商業航空》(Business and Commercial Aviation)期刊中發表的《肇生事故傾向的飛行員》(Accident-Prone Pilots)一文中，探討肇生事故傾向的飛行員存在之可能性。維氏引用「平凡人機長」(Captain Everyman)的經歷，來顯現為何飛機事故不是一次，而是一連串不當的選擇所致。在「平凡人機長」的案例中，他在一次未放起落架的降落事故後，發生另一次事故，他駕駛Beech 58P型「男爵」(Baron)式機時滑行時偏離機坪。接下來，「平凡人」起飛前受航務人員無線電呼叫打岔，而忽略進行燃油交互供油檢查。這位「平凡人」單飛著，讓右燃油選擇瓣放在交互供油位置上。當飛機擺平巡航時，他發現飛機有向右側滾傾向，隨即用副翼配平修正。他並未發覺兩具發動機此時皆由左翼油箱供油，使得左翼變輕(如圖2-3)。航行2小時後，「平凡人」正沿著險峻的峽谷飛行時，右發動機熄火。當他進行故障排除，試著找出右發動機失效的原因時，左發動機也停擺。「平凡人」將飛機降在河川的沙洲上，但飛機最後沉入水下10呎之深。

幾年之後，「平凡人」駕駛de Havilland「雙獺」(Twin Otter)式機降落時，飛機急向左傾，偏離跑道，墜入離跑道375呎的一片沼澤中。機身與發動機嚴重受損。事故調查人員檢查飛機殘骸時發現鼻輪轉向控制柄放在全轉向位置上。在起飛後與降落前檢查卡上，均規定該控制柄必須置中。「平凡人」卻將這項忽略了。

到底「平凡人」是有肇事傾向還是他純粹運氣差?忽略檢查卡上的細節，顯然在過去事故中經常出現。儘管大多數飛行員會犯相同錯誤，然而飛機系統上額外的操作裕度(extra margin)、良好的警告系統、稱職的副駕駛或純粹運氣好，可能讓這些錯誤在空難發生前被發覺。為了探究造成飛行員肇事傾向的原因，聯邦航空署督導進行一項廣泛研究，找出有、無肇事的飛行員兩者間之相似與相異處。這項研究專案對4千名飛行員進行問卷調查，其中「無」飛安紀錄者佔半數，另一半曾涉及事故。

研究發現具有肇事傾向的飛行員有5種特質(如圖2-4)：

一、蔑視規定；

二、飛行紀錄上的事故次數與駕車紀錄上違規次數有高度關聯性；

三、經常被歸類為「尋求刺激與冒險」的個性；

四、在蒐集資料與採取行動的速度及選擇時衝動躁進，而非處事有方、循規蹈矩；

五、無顧或鮮少運用其他資訊來源，其中包括副駕駛、空服人員、地勤人員、飛行教官與航管人員。

相反的，成功的飛行員擁有專注、負荷管理、監督與同步多工的能力。某些在航空界使用之最新心理篩選測驗中，考驗應試人員多工能力，評量其精確性與個別應試人員同時專注於多項任務的能力。

研究也顯示飛行員個性與效能表現間有顯著關連，特別是在機組員協調與資源管理的領域上。機組員間區分出3種個性群組：好傢伙(right stuff)、壞傢伙(wrong stuff)，以及不長進的傢伙(no stuff)。如同字面意義所示，好傢伙具有正面的條件，此群組具有積極進取態度與正面的人際關係行為。而壞傢伙群組則具有高度負面的特質，例如獨

裁或專斷。不長進的傢伙之群組則在追求目標與人際關係的行為上表現很差。

此3種群組顯見於Robert L. Helmreich與John A. Welhelm於1991年發表的《組員資源管理訓練成果》(Outcomes of Crew Resources Management Training)的研究報告中。在其研究期間，其中一分組的參與者對訓練抱持負面反應，似乎是最需要施訓的人卻最無法接受訓練。作者認為個性因素在他們的反應上扮演某種程度的角色，因為有負面反應的人就是缺乏人際關係技巧的人，他們也不屬於「好傢伙」類型。研究推測，這群人對強調溝通與人際關係技巧的作法感到威脅。

個性特質的影響可從飛行員飛一班次的方式看出。例如，在儀器飛行時，某位飛行員可能對粗估(approximation)或「猜測」(guesstimate)數據的作法感到不適，傾向用自己的邏輯與解決問題的技巧來維持操控。另一位飛行員則擁有不錯的視覺空間技巧，在儀器飛行時，會掃視儀表數據，並運用許多「經驗法則」。前一位飛行員的個性反映，他需要凡事按步就班與井然有序。第二類型的飛行員則能順勢靈活，並認為人工心算才會帶來麻煩。

沒有人會刻意肇生事故，許多事故是不當判斷所致。例如，某位飛行員當日出勤多次航班，由於旅客延遲登機或其他因素，致使其行程持續延宕。在當日最後班次前，天氣開始變差，但這位飛行員認為仍可擠出一趟短程班次；只要10分鐘就能抵達下一站。但是當行李上機、開始上路，飛行員駕機飛掠一片凍原時就已經看不到地平線了。飛行員決定繼續航行，因為他告訴目的地村莊航務員他在途中，而且航行時能見度不佳。這位飛行員最後未達目的地，搜救人員發現飛機就墜在凍原上。

在此案例中，一連串事件使得飛行員作出不當的處置決定。首先，該飛行員對自己施加壓力來完成該次航程，然後飛進一個不容許改變航向的天氣情況。在過去許多類似案例中，出事的航班皆以「可控飛行撞地」(controlled flight into terrain, CFIT)收場。

FAA 2005年研究指出，與通用航空事故相關的人員疏失顯然具有多種面向。該研究分析特別披露，絕大部分事故係與技術疏失相關，接續是處置決定疏失、違反規定，以及認知錯誤(如圖2-5)。研究的下一步，是針對前述4項找出各種介入的手段。將人員疏失一網打盡，是不切實際的目標；因為出錯也是一種人類的正常行為。另一方面，許多航空事故是可以預防的，瞭解這一點，就要研擬對策，減低人員疏失後果造成之危害。此項為了抵銷可預判的人員疏失、融合飛行員訓練的人類行為研究，即是為了達成此一目標。

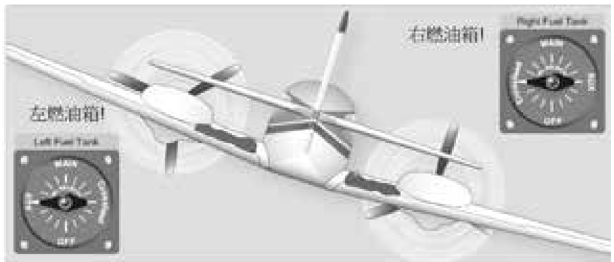

圖2-3：飛行員意外讓兩具發動機皆由左燃油箱供油，且未找出右翼側傾的原因。他因缺乏飛安紀律，肇生事故。

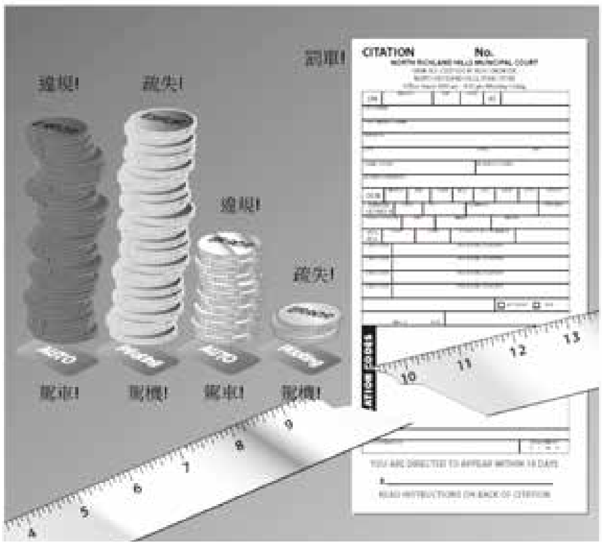

圖2-4 具有危險心態的飛行員，肇事率也高。

圖2-5：有肇事傾向的飛行員無法運用手邊的資源，或不願傾聽。

本章摘要

人類行為研究，有助於歸納出造成飛行員處置決定不當的行為特質。

譯自 FAA Risk Management Handbook

Human Behavior

Figure 2-1. Three out of four accidents result from human error.

Introduction

Three out of four accidents result from improper human performance. *[Figure 2-1]* The human element is the most flexible, adaptable, and valuable part of the aviation system, but it is also the most vulnerable to influences that can adversely affect its performance.

The study of human behavior is an attempt to explain how and why humans function the way they do. A complex topic, human behavior is a product both of innate human nature and of individual experience and environment. Definitions of human behavior abound, depending on the field of study. In the scientific world, human behavior is seen as the product of factors that cause people to act in predictable ways.

The Federal Aviation Administration (FAA) utilizes studies of human behavior in an attempt to reduce human error in aviation. Historically, the term "pilot error" has been used to describe an accident in which an action or decision made by the pilot was the cause or a contributing factor that led to the accident. This definition also includes the pilot's failure to make a correct decision or take proper action. From a broader perspective, the phrase "human factors related" more aptly describes these accidents. A single decision or event does not lead to an accident, but a series of events; the resultant decisions together form a chain of events leading to an outcome. Many of these events involve the interaction of flight crews. In fact, airlines have long adopted programs for crew resource management (CRM) and line oriented flight training (LOFT) which has had a positive impact upon both safety and profit. These same processes can be applied (to an extent) to general aviation.

Human error may indicate where in the system a breakdown occurs, but it provides no guidance as to why it occurs. The effort of uncovering why pilots make mistakes is multidisciplinary in nature. In aviation—and with pilots in particular—some of the human factors to consider when examining the human role are decision-making, design of displays and controls, flight deck layout, communications, software, maps and charts, operating manuals, checklists and system procedures. Any one of the above could be or become a stressor that triggers a breakdown in the human performance that results in a critical human error.

Since poor decision-making by pilots (human error) has been identified as a major factor in many aviation accidents, human behavior research tries to determine an individual's predisposition to taking risks and the level of an individual's involvement in accidents. Drawing upon decades of research, countless scientists have tried to figure out how to improve pilot performance.

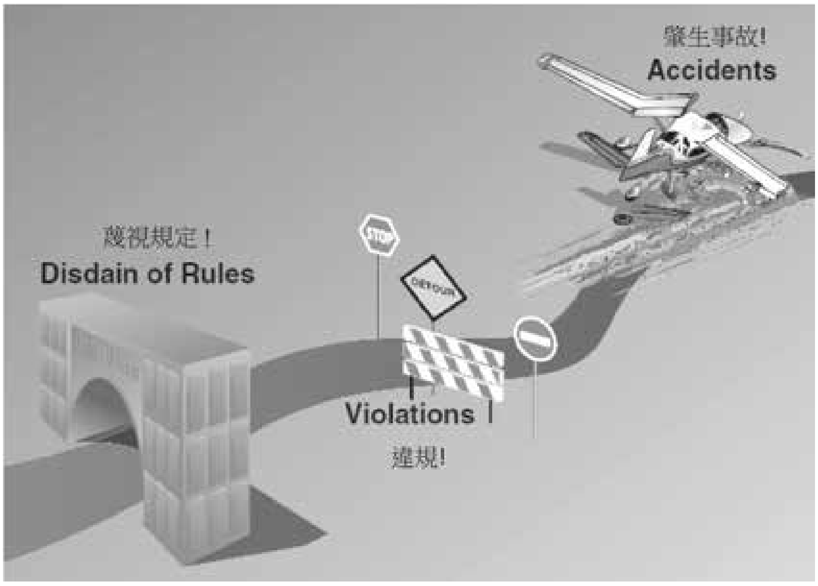

Figure 2-2. According to human behavior studies, there is a direct correlation between disdain for rules and aircraft accidents.

Is there an accident-prone pilot? A study in 1951 published by Elizabeth Mechem Fuller and Helen B. Baune of the University of Minnesota determined there were injury-prone children. The study was comprised of two separate groups of second grade students. Fifty-five students were considered accident repeaters and 48 students had no accidents. Both groups were from the same school of 600 and their family demographics were similar.

The accident-free group showed a superior knowledge of safety and were considered industrious and cooperative with others but were not considered physically inclined. The accident-repeater group had better gymnastic skills, were considered aggressive and impulsive, demonstrated rebellious behavior when under stress, were poor losers, and liked to be the center of attention. *[Figure 2-2]* One interpretation of this data—an adult predisposition to injury stems from childhood behavior and environment—leads to the conclusion that any pilot group should be comprised only of pilots who are safety conscious, industrious, and cooperative. Clearly, this is not only an inaccurate inference, but is impossible to achieve since pilots are drawn from the general population and exhibit all types of personality traits.

Fifty-five years after Fuller-Baune study, Dr. Patrick R. Veillette debated the possibility of an accident prone pilot in his 2006 article "Accident-Prone Pilots," published in Business and Commercial Aviation. Veillette uses the history of "Captain Everyman" to demonstrate how aircraft accidents are caused more by a chain of poor choices than one single poor choice. In the case of Captain Everyman, after a gear-up landing accident, he became involved in another accident while taxiing a Beech 58P Baron out of the ramp. Interrupted by a radio call from the dispatcher, Everyman neglected to complete the fuel cross-feed check before taking off. Everyman, who was flying solo, left the right fuel selector in the cross-feed position. Once aloft and cruising, he noticed a right roll tendency and corrected with aileron trim. He did not realize that both engines were feeding off the left wing's tank, making the wing lighter. *[Figure 2-3]*

After two hours of flight, the right engine quit when Everyman was flying along a deep canyon gorge. While he was trying to troubleshoot the cause of the right engine's failure, the left engine quit. Everyman landed the aircraft on a river sand bar, but it sank into ten feet of water.

Several years later, Everyman was landing a de Havilland Twin Otter when the aircraft veered sharply to the left, departed the runway, and ran into a marsh 375 feet from the runway. The airframe and engines sustained considerable damage. Upon inspecting the wreck, accident investigators found the nosewheel steering tiller in the fully deflected position. Both the after-takeoff and before-landing checklists required the tiller to be placed in the neutral position. Everyman had overlooked this item.

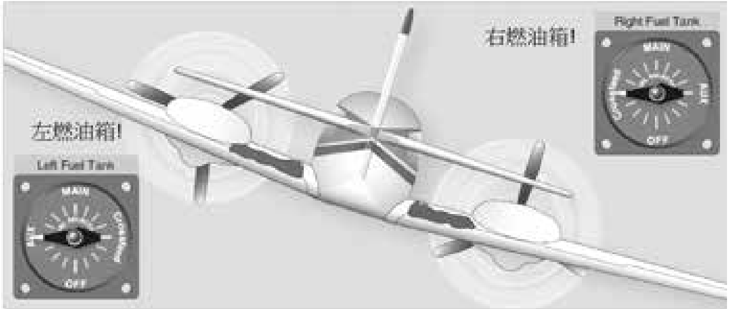

Figure 2-3. The pilot inadvertently fed both engines from the left fuel tank and failed to determine the problem for the right wing low. His lack of discipline resulted in an accident.

Now, is Everyman accident prone or just unlucky? Skipping details on a checklist appears to be a common theme in the preceding accidents. While most pilots have made similar mistakes, these errors were probably caught prior to a mishap due to extra margin, good warning systems, a sharp copilot, or just good luck. In an attempt to discover what makes a pilot accident prone, the Federal Aviation Administration (FAA) oversaw an extensive research study on the similarities and dissimilarities of pilots who were accident free and those who were not. The project surveyed over 4,000 pilots, half of whom had "clean" records while the other half had been involved in an accident.

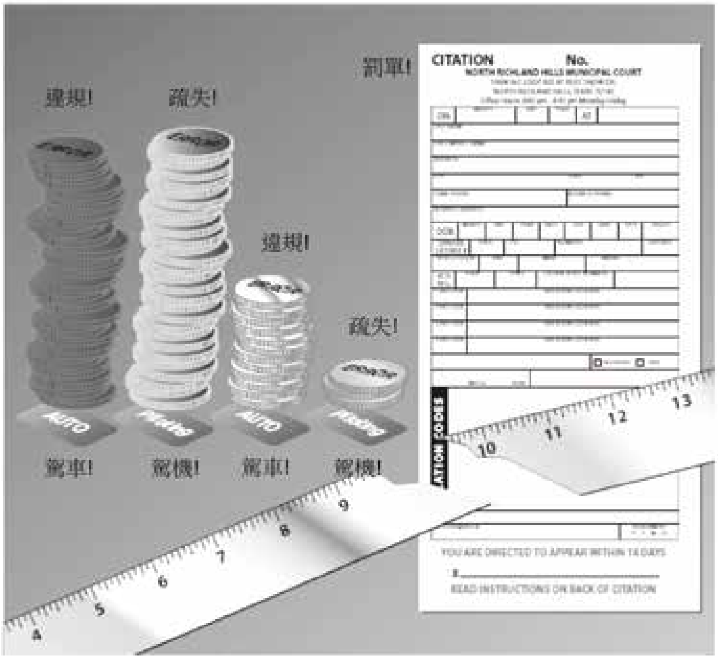

Figure 2-4. Pilots with hazardous attitudes have a high incident rate of accidents.

Five traits were discovered in pilots prone to having accidents *[Figure 2-4]*:

1. Disdain toward rules
2. High correlation between accidents in their flying records and safety violations in their driving records
3. Frequently falling into the personality category of "thrill and adventure seeking"
4. Impulsive rather than methodical and disciplined in information gathering and in the speed and selection of actions taken
5. Disregard for or underutilization of outside sources of information, including copilots, flight attendants, flight service personnel, flight instructors, and air traffic controllers

In contrast, the successful pilot possesses the ability to concentrate, manage workloads, monitor, and perform several simultaneous tasks. Some of the latest psychological screenings used in aviation test applicants for their ability to multitask, measuring both accuracy and the individual's ability to focus attention on several subjects simultaneously.

Research has also demonstrated significant links between pilot personality and performance, particularly in the area of crew coordination and resource management. Three distinct subgroups of flight crew member personalities have been isolated: right stuff, wrong stuff, and no stuff. As the names imply, the right stuff group has the right stuff. This group demonstrates positive levels of achievement motivation and interpersonal behavior. The wrong stuff group has high levels of negative traits, such as being autocratic or dictatorial. The no stuff group scored low on goal seeking and interpersonal behaviors.

These groups became evident in a 1991 study, "Outcomes of Crew Resource Management Training" by Robert L. Helmreich and John A. Wilhelm. During this study a subset of participants reacted negatively to the training–the individuals who seemed to need the training the most were the least receptive. The authors felt that personality factors played a role in this reaction because the ones who reacted negatively were individuals who lacked interpersonal skills and had not been identified as members of the "right stuff" subset. It was surmised that they felt threatened by the emphasis on the importance of communications and human relations skills.

The influence of personality traits can be seen in the way a pilot handles a flight. For example, one pilot may be uncomfortable with approximations and "guesstimates," preferring to use his or her logical, problem-solving skills to maintain control over instrument flight operations. Another pilot, who has strong visual-spatial skills and prefers to scan, may apply various "rules of thumb" during a instrument flight period. The first pilot's personality is reflected in his or her need to be planned and structured. The second type of pilot is more fluid and spontaneous and regards mental calculations as bothersome.

No one ever intends to have an accident and many accidents result from poor judgment. For example, a pilot flying several trips throughout the day grows steadily behind schedule due to late arriving passengers or other delays. Before the last flight of the day, the weather starts to deteriorate, but the pilot thinks one more short flight can be squeezed in. It is only 10 minutes to the next stop. But by the time the cargo is loaded and the flight begun, the pilot cannot see the horizon while flying out over the tundra. The pilot decides to forge on since he told the village agent he was coming and flies into poor visibility. The pilot never reaches the destination and searchers find the aircraft crashed on the tundra.

In this scenario, a chain of events results in the pilot making a poor decision. First, the pilot exerts pressure on himself to complete the flight, and then proceeds into weather conditions that do not allow a change in course. In many such cases, the flight ends in controlled flight into terrain (CFIT).

Figure 2-5. Accident-prone pilots fail to use readily available resources, or they simply do not listen.

In a 2005 FAA study, it became apparent that human error associated with GA accidents is multifaceted. Specifically, the analyses revealed that the largest percentage of accidents is associated with skill-based errors, followed by decision errors, violations of the rules and regulations, and perceptual errors. *[Figure 2-5]* The next step will be identifying a variety of interventions targeted at all four error groups. Eliminating human errors is an unrealistic goal since errors are a normal part of human behavior. On the other hand, realizing that many aviation accidents are preventable means designing ways to reduce the consequences of human error. The study of human behavior coupled with pilot training that offsets predictable human error helps achieve that goal.

Summary

Studies of human behavior help isolate characteristics and behaviors that can lead to poor decision-making by a pilot.

From FAA Risk Management Handbook