定義風險管理的要素

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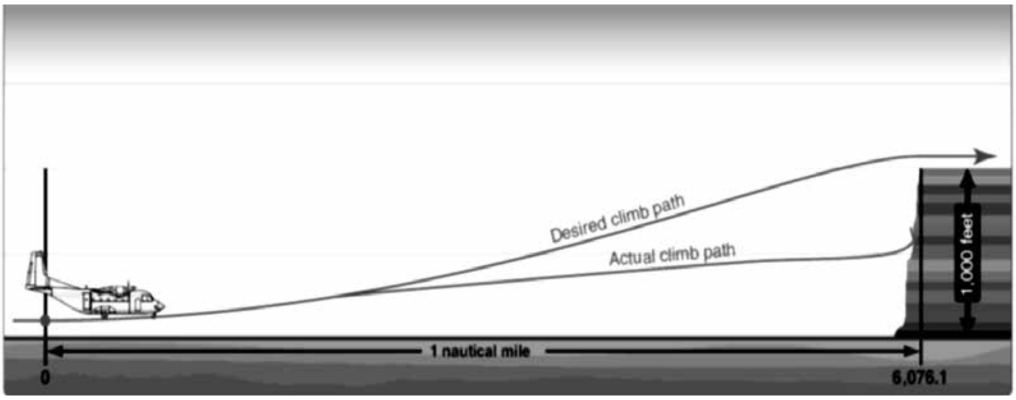

圖1-2 上圖是一個縮圖，顯示一架飛機從距離峽谷盡頭1浬，低於邊緣1000呎處的地面，以1000呎每秒速率爬升，越過6000呎所需時間是24秒，以飛機1000呎每秒的爬升率，經過大約半分鐘，飛機只能爬升500呎且無法越過邊緣。

簡介

風險管理－一個為應付危害的制式化方法－是一種評估放任風險不加以管控所獲的利益與潛在風險花費成本比較的邏輯流程，為了要更清楚解知何謂風險管理，對於“危害”與“風險”這兩個詞彙有必要詳加了解。

危害

定義危害

就定義上來說，危害是一個存在的狀況、事件、物件或情況，可能導向或導致例如失事等非預期或不希望看到的事件，它是危險的來源，常見的航空危害有四種：

1. 螺旋槳葉片上的微瑕
2. 不正確的飛機加油作業
3. 駕駛員的疲勞
4. 在飛機上使用未經核准的零件

確認危害

危害確認對於風險管理流程的起始是很重要的，有時候人們必須前瞻立即的狀況並預測該狀況的進程，而這種預知未來狀況的能力來自於經驗、訓練與觀察。

1. 螺旋槳葉片上的微瑕是一項危害，因為它可能導向疲勞裂痕，進而造成從那一點以外的螺旋槳斷裂，當斷裂的部分大到一定程度，所產生的振動足以損害引擎掛架使得引擎從飛機上脫離。
2. 不正確的飛機加油作業是一項危害，因為與飛機不正確的連結與/或接地會產生足以引燃油氣的靜電，不正確的飛機加油也意味著可能將渦輪用的油料加入汽油燃油系統中，上述的兩個狀況顯示一個簡單的流程，輕則可能造成財務損失，重則可能致命。
3. 駕駛員的疲勞是一項危害，因為駕駛員在犯下嚴重錯誤前可能不知道他或她對於飛行而言已經太過疲勞了，人類對於自身的精神狀態與疲勞程度是很差勁的監控者，根據某些研究報告，疲勞與藥物使用對人類能力的弱化程度是相同的。
4. 在飛機上使用未經核准的零件可能造成問題，因為航空零件在裝上飛機前都須經過下列一般性能測試：硬度、脆度、韌度、延展性、彈性、強度、密度、熔度、導電性與伸縮性。

如果駕駛員未確認危害而選擇繼續，那所牽涉的風險是沒有被控管的，然而沒有兩位駕駛員對危害的看法是完全相同的，這造成對危害的預知與標準化的挑戰，所以問題依舊，駕駛員如何確認危害？確認危害的能力取決於人格特質、教育程度與經驗。

人格特質

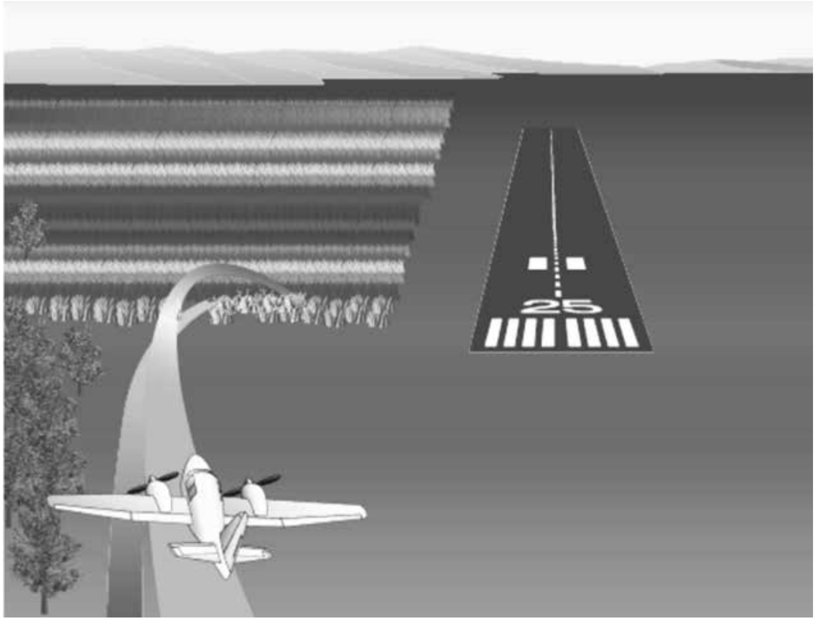

圖1-3 在試圖轉向跑道時，該飛行教官以失控的狀態提前墜地，毀損了飛機並使兩位飛行員都受傷。

人格特質在危害估計的方式上可造成重大影響，生性魯莽的人會把這個特質帶進駕駛艙裡，舉個例子，在2006年8月25日發行的商用與商務航空期刊中標題為“事故傾向的駕駛員”的文章中，Patrick R. Veillette博士指出研究顯示：有事故傾向的駕駛員所展現出的主要特質之一是他們對於規則的無視；同樣地，在另一份由Susan Baker博士與她在約翰霍普金斯公眾健康學院的統計學者團隊所做的研究中發現，駕駛員在飛航記錄中有事故紀錄與他們的車輛駕駛紀錄中的安全違規有非常高的關聯性，這份報告提出一個問題，就是開車習慣於無視交通規則的人，當他們進入飛航駕駛艙時，越可能成為同樣典型的駕駛員，這份報告進一步假設，對於職業駕駛員來說，偏離標準程序在財務與職涯上可能造成災難性的後果，但是對於天生的刺激追求者也可能成為強烈的誘因。

要改善刺激追求型駕駛員的安全紀錄可經由教育他們規則背後的理由與物理學上不可違背的定律來達成，FAA的規則與法令是設計來避免事故的發生，很多規則與法令是來自對事故的研究；相關的報告也用於訓練與事故防範的目的。

教育

不能教老狗新把戲的諺語純屬謬誤，在1970年代中期，航空公司開始在工作場所(駕駛艙)採用組員資源管理(CRM)，這個程序幫助機組員確認危害並提供工具讓他們排除危害或將影響降到最低。

法規

法規提供行為規範，並用以製出就算未加規範時也可能不會出現的結果，它們為危害設置一道門檻以減少危害，一個最簡單的例子就是聯邦法規第91章91.155節第14條(14 CFR)中所規範的基本目視飛航規則(VFR)的最低天氣標準，列出E類空域雲層間隙為高1000呎，低500呎，水平2000呎，飛航能見度3哩，這項法規提供一個運行的界限並幫助飛行員確認危害，比如說一個被認證為只能飛目視飛航規則的駕駛員面對遠低於E類空域天氣標準的天候時，除了因為低於法規的要求外，也可以確認天氣是有危害的。

經驗

經驗是經過時間而獲得的知識，乃是經由航空的關聯與經驗的累積而來，所以缺乏經驗可以被解讀為一種危害嗎?如果一項需要高度經驗技巧的活動由缺乏經驗的駕駛員去嘗試，那缺乏經驗就是一種危害，一個很好的例子就是一個有錢的飛行員買得起配備先進航電設備的飛機，可是卻缺乏可以安全地操控它的經驗；相對地，一個駕駛員的經驗也可能造成一個虛假的安全感，導致該駕駛員忽視或未能確認一個潛在的危害。

危害認知的工具

有幾個協助確認危害的工具：

諮詢通告(AC)

諮詢通告提供有助於符合14CFR的非法規資訊，它們放大法規的目的，例如AC 90-48，飛行員在防止碰撞的角色上提供了看見、反應與避讓來向航機所需的時間資訊。

了解匯流航機的危險

如果一個飛行員看見一架飛機在某個角度接近，而且與此飛行員本身的位置關係不變，那這兩架飛機最終必定相撞，如果一架飛機被發現在機鼻的45°角而且相對關係不變，一直到相撞的時候它仍將維持不變(45°)，因此，當一位飛行員看見一架飛機在匯流的航向，而且維持在同樣的位置，他必須改變航向、速度、高度其中之一或全部以避免空中相撞。

了解爬升率

在2006年，一架由屬於14CFR 135章，受雇於美國軍方的業者所飛航的CASA 212型機所發生的失事，如果對爬升率有基本認知的話就可能避免，這架飛機(飛航在阿富汗)試圖爬過一個箱型峽谷的脊頂，這架飛機以每分鐘

1000呎的速率(fpm)爬升，距離峽谷的盡頭大約1哩，不幸的是，標高的改變也是1000呎，使得安全地爬升根本不可能，這架飛機撞到峽谷崖壁一半高度的地方，這要怎麼判斷？這架飛機的節速乘以1.68等於呎/每秒(fps)的速率，舉例來說，如果一架飛機以150節的速度飛航，換算成秒速大約250fps(150 × 1.68)，如果這架飛機距離峽谷的盡頭是1浬(NM)(6076.1呎)，1浬除以飛機的秒速，在這個事件中，6000呎除以250大約是24秒。[圖1-2]

了解漂降距離

在另一件事故中，一架Piper Apache在一次由受考核飛行學員執行的進場落地中，飛行教官將左引擎順槳，不幸地，之後該學員又將右引擎順槳，面對著前方一整排矮樹叢(包含灌木叢與不到10呎高的小樹木)，這位教官試圖轉向跑道，如同大部分的飛行員所知，執行轉向會造成速度降低或下降率增加，如果要避免前者就必須增加推力，從400呎失去動力可不是個好位置，飛機的垂直下降率很容易達到15到20呎每秒，當這位教官開始轉向跑道，下降率也由於轉向的執行而增加[圖1-3]，讓狀況更複雜的是該教官試圖取消順槳，這造成阻力增加，結果當螺旋槳開始轉動時也增加了下降率，飛機失速，導致失控的撞擊，如果這位教官保持直向，至少在撞擊的時候飛機還可能在控制當中。

控制中的落地有幾個好處：

- 飛行員可以持續操控飛機避開樹叢，而且以正確的姿態落地也有助於落地後的逃生。
- 大部分的飛機在正確姿態落地時比機鼻朝下或甚至上下顛倒時，駕駛艙下方的結構比上方能夠吸收更多撞擊的力量。
- 對於乘員而言，較輕的撞擊力道代表較輕的傷害與較高的機率在起火前逃生。

風險

定義風險

風險是未控制或排除的危害對未來的衝擊，它可視為危害所造成未來的不確定性，如果牽涉到技能，同樣的情況可能帶來不同的風險。

1. 如果微瑕沒有適當地鑑定，未來螺旋槳失效的潛在性是未知的。
2. 如果飛機沒有妥適地連結或接地，靜電會累積而且能夠也將會尋找對地面最小阻抗的路徑，一旦靜電釋放引燃油氣，可能瞬間引發爆炸。
3. 一個疲勞的飛行員無法展現出與任務要求相稱的能力等級。
4. 一個自製飛機的擁有者決定使用從附近五金材料中心買來比建議零件便宜，但看起來一樣且顯然完美匹配的鉚釘來接合與固定機翼，那在飛航中機翼脫落的潛在可能是未知的。

風險的型態	
總體風險	已確認的風險與未確認的風險的總和
已確認的風險	經由不同的分析技巧所判定的風險，系統安全的第一項工作就是在實際的限制內確認所有可能的風險。
未確認的風險	尚待確認的風險，有些未確認的風險是因為不幸事故發生後才得到確認的，有些風險則永遠無法確認。
不可接受的風險	在管理作為尚無法容許的風險，是屬於已確認風險中必須控制或排除的部分風險。
可接受的風險	可接受的風險是已確認風險中允許存留而無須進一步的工程或管理作為的部分，做此決定是管理行為上困難但卻是必要的責任，做此決定必須完全認知暴露於風險的是使用者。
殘留的風險	殘留的風險是所有系統安全的作為都已完全採行後仍然留存的風險，它並不必然等同於可接受的風險，殘留的風險是可接受風險與未確認風險的總和，這是轉移給使用者的總體風險。

圖1-4 風險的型態

風險評估矩陣				
可能性	嚴重性			
	災難性的	關鍵性的	輕微的	可忽略的
可能發生的	高度的	高度的	嚴重的	
偶爾發生的	高度的	嚴重的		
很少發生的	嚴重的		中度的	低度的
幾乎不可能的				

圖1-5 利用風險評估矩陣協助飛行員分辨低風險與高風險的飛航

在情境3中，疲勞的飛行員呈現的風險等級為何?在所有的情境與狀況中風險都相同嗎?也許不是。舉例來說，看看飛行員可能飛航的三個狀況：

1. 日間目視天氣狀況(VMC)飛航目視飛航規則(VFR)
2. 夜間VMC飛航VFR
3. 夜間儀器天氣狀況(IMC)飛航儀器飛航規則(IFR)

在這些天氣狀況中，不只飛行員的精神敏銳度，他或她所飛航的環境也會影響風險等級，一個比較資淺的飛行員相對於不同天候、夜航與區域熟悉度與有較高經驗值的

飛行員，對於潛在風險的評估是截然不同的，例如，一個經常夜航的資深飛行員可能顯示為低風險，但是諸如疲勞等其他因素則可能改變其風險評等。

在情境4中，使用附近五金材料中心買來的鉚釘的飛行員所呈現的風險等級為何?這些鉚釘看起來摸起來與原廠建議的都一樣，那為什麼要多花錢呢?這個自製者造成甚麼風險?從附近五金材料中心買來的鉚釘只是低強度金屬鉚釘，可是原廠規範的機翼鉚釘則是公差小而且是抗鏽蝕的，此自製者所採用的鉚釘在起飛的應力下可能斷裂。

管理風險

風險是不確定性的程度，風險管理的檢視可以產生很多定義，但它卻是管理不確定性的可行方法[圖1-4]，風險評估則是指定給任務、行動或事件的量化的數值[圖1-5]，當配備對於一項活動的預測評估表，飛行員便能管理並降低(減輕)他們的風險，以在建造自製飛機時使用不適當的零件來說，雖然人們可以輕易地看見危害是高且是非常嚴重的，它的確可以讓使用那些鉚釘的人認知到這個風險，不然，就像在很多其他的例證中，事後可以用圖1-5的表來檢視，管理風險需要紀律來把自己從活動中抽離出來做為一個沒有偏見的評估者，而非一個在飛航任務中有直接利害關係的熱切參與者；另一個簡單的步驟就是問三個問題－它安全嗎、它合法嗎、它合理嗎?雖然這並非正規的風險評估方法，它卻能使一個飛行員正視他或她即將要做的事情的簡單現實。

因此，風險管理就是用來控制、排除或降低危害在可接受的限度內的方法，風險管理對每一個人來說都是獨一無二的，因為沒有兩個人的技巧、知識、訓練與能力是完全相同的，對於一個飛行員的可接受風險等級，可能在另一個飛行員是不適用的，很不幸的是，在很多例證中飛行員覺得他或她可接受的風險等級大於他們的能力，以致於冒了危險的風險。

它是一種設計來系統化地確認危害、評估風險等級以決定最佳行動方案的決策流程，一旦風險被確認後，它們必須經過評估，風險評估決定風險的等級(可忽略的、低度的、中度的或高度的)以及風險的等級是否值得所計畫的作為，如果風險等級是“可接受的”，那所計畫的作為就可以採行，一旦計畫的作為開始後，就必須考慮是否繼續，當原本的航程無法按計畫完成時，飛行員必須要有可行的備案。

因此，危害與風險是風險管理的兩個關鍵性要素，危害可以是飛行員所遭遇到實際的或感覺的狀況、事件或情勢。

總結

危害與風險的觀念是風險管理的核心要素，風險的型態與飛行員的經驗決定個人可接受的風險等級。

圖1-6 以技能而言，每位飛行員可能有不同的限制，然而在這種狀況下沒有任何技能可以把這條線提升到更高等級。

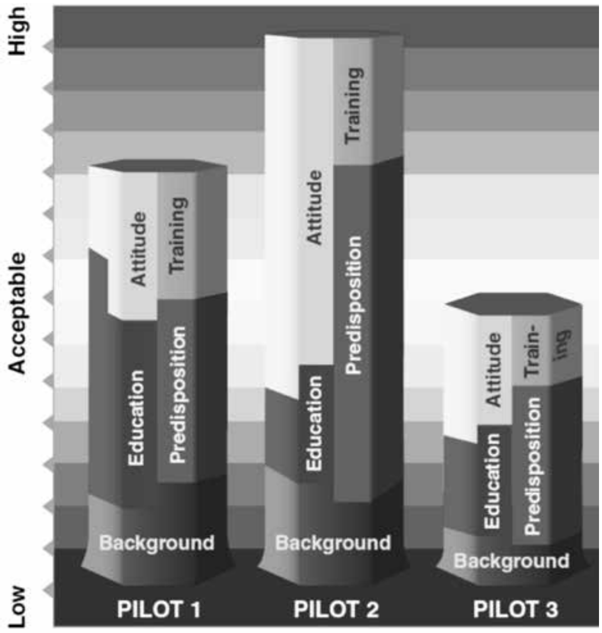

圖1-7 儘管可能接受相同的訓練，飛行員所接受的風險等級是因人而異的，當情況發展而複雜度超過一個飛行員的能力範圍(包括背景+教育+素質+態度+訓練)， 風險變成一種問題而必須加以個別化管理，風險管理的關鍵在於飛行員對於自身限制與風險觀念的認知。

譯自 FAA Risk Management Handbook

Defining Elements of Risk Management

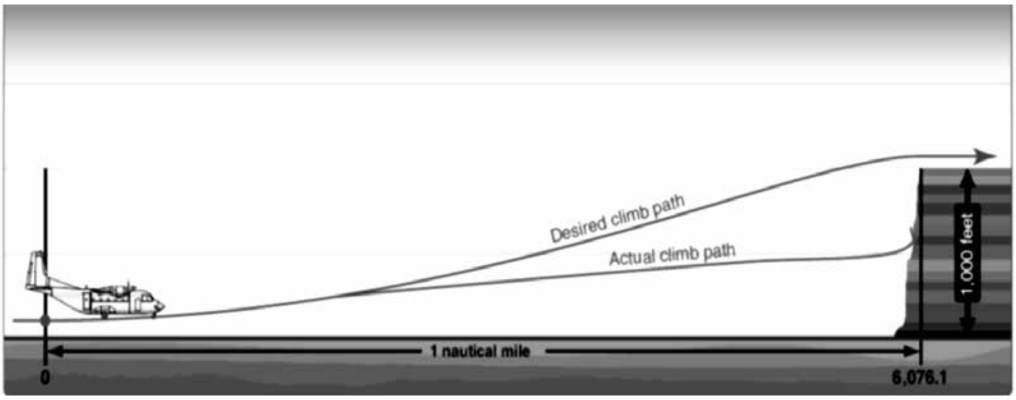

Figure 1-2. The figure above is a scale drawing of an aircraft climbing at 1,000 fpm, located 1 NM from the end of the canyon and starting from the canyon floor 1,000 feet below the rim. The time to cover 6,000 feet is 24 seconds. With the aircraft climbing at 1,000 fps, in approximately ½ minute, the aircraft will climb only 500 feet and will not clear the rim.

Introduction

Risk management, a formalized way of dealing with hazards, is the logical process of weighing the potential costs of risks against the possible benefits of allowing those risks to stand uncontrolled. In order to better understand risk management, the terms "hazard" and "risk" need to be understood.

Hazard

Defining Hazard

By definition, a hazard is a present condition, event, object, or circumstance that could lead to or contribute to an unplanned or undesired event such as an accident. It is a source of danger. Four common aviation hazards are:

1. A nick in the propeller blade
2. Improper refueling of an aircraft
3. Pilot fatigue
4. Use of unapproved hardware on aircraft

Recognizing the Hazard

Recognizing hazards is critical to beginning the risk management process. Sometimes, one should look past the immediate condition and project the progression of the condition. This ability to project the condition into the future comes from experience, training, and observation.

1. A nick in the propeller blade is a hazard because it can lead to a fatigue crack, resulting in the loss of the propeller outboard of that point. With enough loss, the vibration could be great enough to break the engine mounts and allow the engine to separate from the aircraft.
2. Improper refueling of an aircraft is a hazard because improperly bonding and/or grounding the aircraft creates static electricity that can spark a fire in the refueling vapors. Improper refueling could also mean fueling a gasoline fuel system with turbine fuel. Both of these examples show how a simple process can become expensive at best and deadly at worst.
3. Pilot fatigue is a hazard because the pilot may not realize he or she is too tired to fly until serious errors are made. Humans are very poor monitors of their own mental condition and level of fatigue.

Fatigue can be as debilitating as drug usage, according to some studies.

4. Use of unapproved hardware on aircraft poses problems because aviation hardware is tested prior to its use on an aircraft for such general properties as hardness, brittleness, malleability, ductility, elasticity, toughness, density, fusibility, conductivity, and contraction and expansion.

If pilots do not recognize a hazard and choose to continue, the risk involved is not managed. However, no two pilots see hazards in exactly the same way, making prediction and standardization of hazards a challenge. So the question remains, how do pilots recognize hazards? The ability to recognize a hazard is predicated upon personality, education, and experience.

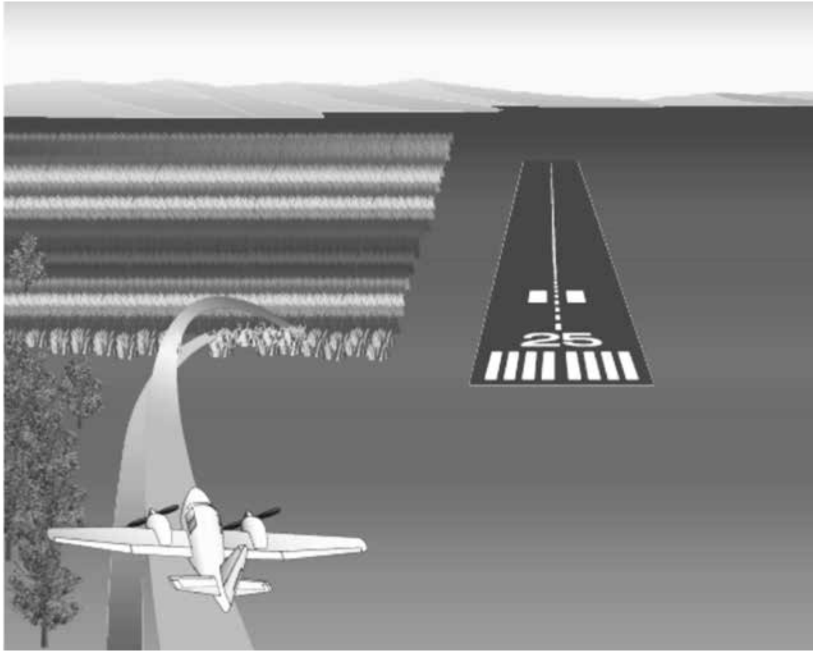

Figure 1-3. In attempting to turn toward the runway, the instructor pilot landed short in an uncontrolled manner, destroying the aircraft and injuring both pilots.

Personality

Personality can play a large part in the manner in which hazards are gauged. People who might be reckless in nature take this on board the flight deck. For instance, in an article in the August 25, 2006, issue of Commercial and Business Aviation entitled Accident Prone Pilots, Patrick R. Veillette, Ph.D., notes that research shows one of the primary characteristics exhibited by accident-prone pilots was their disdain toward rules. Similarly, other research by Susan Baker, Ph.D., and her team of statisticians at the Johns Hopkins School of Public Health, found a very high correlation between pilots with accidents on their flying records and safety violations on their driving records. The article brings forth the question of how likely is it that someone who drives with a disregard of the driving rules and regulations will then climb into an aircraft and become a role model pilot. The article goes on to hypothesize that, for professional pilots, the financial and career consequences of deviating from standard procedures can be disastrous but can serve as strong motivators for natural-born thrill seekers.

Improving the safety records of the thrill seeking type pilots may be achieved by better educating them about the reasons behind the regulations and the laws of physics, which cannot be broken. The FAA rules and regulations were developed to prevent accidents from occurring. Many rules and regulations have come from studying accidents; the respective reports are also used for training and accident prevention purposes.

Education

The adage that one cannot teach an old dog new tricks is simply false. In the mid-1970s, airlines started to employ Crew Resource Management (CRM) in the workplace (flight deck). The program helped crews recognize hazards and provided tools for them to eliminate the hazard or minimize its impact.

Regulations

Regulations provide restrictions to actions and are written to produce outcomes that might not otherwise occur if the regulation were not written. They are written to reduce hazards by establishing a threshold for the hazard. An example might be something as simple as basic visual flight rules (VFR) weather minimums as presented in Title 14 of the Code of Federal Regulation (14 CFR) part 91, section 91.155, which lists cloud clearance in Class E airspace as 1,000 feet above, 500 feet below, and 2,000 feet horizontally with flight visibility as three statute miles. This regulation provides both an operational boundary and one that a pilot can use in helping to recognize a hazard. For instance, a VFR-only rated pilot faced with weather that is far below that of Class E airspace would recognize that weather as hazardous, if for no other reason than because it falls below regulatory requirements.

Experience

Experience is the knowledge acquired over time and increases with time as it relates to association with aviation and an accumulation of experiences. Therefore, can inexperience be construed as a hazard? Inexperience is a hazard if an activity demands experience of a high skill set and the inexperienced pilot attempts that activity. An example of this would be a wealthy pilot who can afford to buy an advanced avionics aircraft, but lacks the experience needed to operate it safely. On the other hand a pilot's experience can provide a false sense of security, leading the pilot to ignore or fail to recognize a potential hazard.

Experience sometimes influences the way a pilot looks at an aviation hazard and how he or she explores its level of risk.

Types of Risk	
Total Risk	The sum of identified and unidentified risks.
Identified Risk	Risk that has been determined through various analysis techniques. The first task of system safety is to identify, within practical limitations, all possible risks.
Unidentified Risk	Risk not yet identified. Some unidentified risks are subsequently identified when a mishap occurs. Some risk is never known.
Unacceptable Risk	Risk that cannot be tolerated by the managing activity. It is a subset of identified risk that must be eliminated or controlled.
Acceptable Risk	Acceptable risk is the part of identified risk that is allowed to persist without further engineering or management action. Making this decision is a difficult yet necessary responsibility of the managing activity. This decision is made with full knowledge that it is the user who is exposed to this risk.
Residual Risk	Residual risk is the risk remaining after system safety efforts have been fully employed. It is not necessarily the same as acceptable risk. Residual risk is the sum of acceptable risk and unidentified risk. This is the total risk passed on to the user.

Figure 1-4. Types of risk.

Risk Assessment Matrix

Likelihood	Severity: Catastrophic	Critical	Marginal	Negligible
Probable	High	High	Serious	
Occasional	High	Serious		
Remote	Serious	Medium	Medium	Low
Improbable				

Figure 1-5. Using a risk assessment matrix helps the pilot differentiate between low-risk and high-risk flights.

Tools for Hazard Awareness

There are some basic tools for helping recognize hazards.

Advisory Circulars (AC)

Advisory circulars (ACs) provide nonregulatory information for helping comply with 14 CFR. They amplify the intent of the regulation. For instance, AC 90-48, Pilot's Role in Collision Avoidance, provides information about the amount of time it takes to see, react, and avoid an oncoming aircraft.

Understanding the Dangers of Converging Aircraft

If a pilot sees an aircraft approaching at an angle and the aircraft's relationship to the pilot does not change, the aircraft will eventually impact. If an aircraft is spotted at 45° off the nose and that relationship remains constant, it will remain constant right up to the time of impact (45°). Therefore, if a pilot sees an aircraft on a converging course and the aircraft remains in the same position, change course, speed, altitude or all of these to avoid a midair collision.

Understanding Rate of Climb

In 2006, a 14 CFR part 135 operator for the United States military flying Casa 212s had an accident that would have been avoided with a basic understanding of rate of climb. The aircraft (flying in Afghanistan) was attempting to climb over the top ridge of a box canyon. The aircraft was climbing at 1,000 feet per minute (fpm) and about 1 mile from the canyon end. Unfortunately, the elevation change was also about 1,000 feet, making a safe ascent impossible. The aircraft hit the canyon wall about ½ way up the wall. How is this determined? The aircraft speed in knots multiplied by 1.68 equals the aircraft speed in feet per second (fps). For instance, in this case if the aircraft were traveling at about 150 knots, the speed per second is about 250 fps (150 x 1.68). If the aircraft is a nautical mile (NM) (6,076.1 feet) from the canyon end, divide the one NM by the aircraft speed. In this case, 6,000 feet divided by 250 is about 24 seconds. [Figure 1-2]

Figure 1-6. Each pilot may have a different threshold where skill is considered, however; in this case no amount of skill raises this line to a higher level.

Understanding the Glide Distance

In another accident, the instructor of a Piper Apache feathered the left engine while the rated student pilot was executing an approach for landing in VFR conditions. Unfortunately, the student then feathered the right engine. Faced with a small tree line (containing scrub and small trees less than 10 feet in height) to his front, the instructor attempted to turn toward the runway. As most pilots know, executing a turn results in either decreased speed or increased descent rate, or requires more power to prevent the former. Starting from about 400 feet without power is not a viable position, and the sink rate on the aircraft is easily between 15 and 20 fps vertically. Once the instructor initiated the turn toward the runway, the sink rate was increased by the execution of the turn. [Figure 1-3] Adding to the complexity of the situation, the instructor attempted to unfeather the engines, which increased the drag, in turn increasing the rate of descent as the propellers started to turn. The aircraft stalled, leading to an uncontrolled impact. Had the instructor continued straight ahead, the aircraft would have at least been under control at the time of the impact.

There are several advantages to landing under control:

- The pilot can continue flying to miss the trees and land right side up to enhance escape from the aircraft after landing.
- If the aircraft lands right side up instead of nose down, or even upside down, there is more structure to absorb the impact stresses below the

cockpit than there is above the cockpit in most aircraft.

- Less impact stress on the occupants means fewer injuries and a better chance of escape before fires begin.

Risk

Defining Risk

Risk is the future impact of a hazard that is not controlled or eliminated. It can be viewed as future uncertainty created by the hazard. If it involves skill sets, the same situation may yield different risk.

1. If the nick is not properly evaluated, the potential for propeller failure is unknown.
2. If the aircraft is not properly bonded and grounded, there is a build-up of static electricity that can and will seek the path of least resistance to ground. If the static discharge ignites the fuel vapor, an explosion may be imminent.
3. A fatigued pilot is not able to perform at a level commensurate with the mission requirements.
4. The owner of a homebuilt aircraft decides to use bolts from a local hardware store that cost less than the recommended hardware, but look the same and appear to be a perfect match, to attach and secure the aircraft wings. The potential for the wings to detach during flight is unknown.

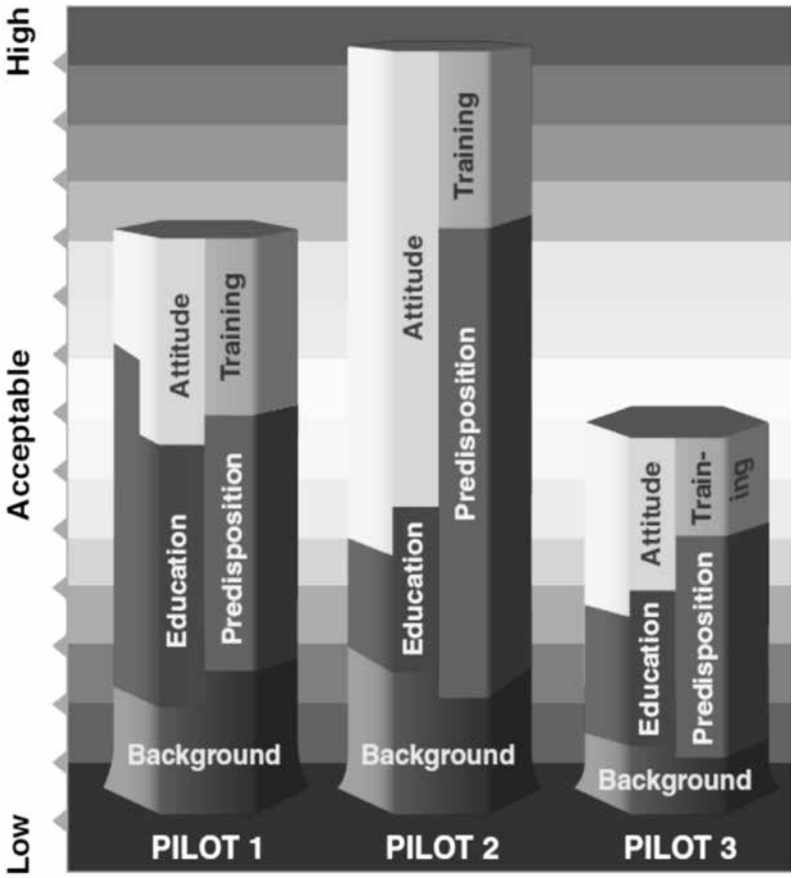

Figure 1-7. Pilots accept their own individual level of risk even though they may have received similar training. Risk, which must be managed individually, becomes a problem when a situation builds and its complexity exceeds the pilot's capability (background + education + predisposition + attitude + training). The key to managing risk is the pilot's understanding of his or her threshold and perceptions of the risk.

In scenario 3, what level of risk does the fatigued pilot present? Is the risk equal in all scenarios and conditions? Probably not. For example, look at three different conditions in which the pilot could be flying:

1. Day visual meteorological conditions (VMC) flying visual flight rules (VFR)
2. Night VMC flying VFR
3. Night instrument meteorological conditions (IMC) flying instrument flight rules (IFR)

In these weather conditions, not only the mental acuity of the pilot but also the environment he or she operates within affects the risk level. For the relatively new pilot versus a highly experienced pilot, flying in weather, night experience, and familiarity with the area are assessed differently to determine potential risk. For example, the experienced pilot who typically flies at night may appear to be a low risk, but other factors such as fatigue could alter the risk assessment.

In scenario 4, what level of risk does the pilot who used the bolts from the local hardware center pose? The bolts look and feel the same as the recommended hardware, so why spend the extra money? What risk has this homebuilder created? The bolts purchased at the hardware center were simple low-strength material bolts while the wing bolts specified by the manufacturer were close-tolerance bolts that were corrosion resistant. The bolts the homebuilder employed to attach the wings would probably fail under the stress of takeoff.

Managing Risks

Risk is the degree of uncertainty. An examination of risk management yields many definitions, but it is a practical approach to managing uncertainty. [Figure 1-4] Risk assessment is a quantitative value assigned to a task, action, or event. [Figure 1-5] When armed with the predicted assessment of an activity, pilots are able to manage and reduce (mitigate) their risk. Take the use of improper hardware on a homebuilt aircraft for construction. Although one can easily see both the hazard is high and the severity is extreme, it does take the person who is using those bolts to recognize the risk. Otherwise, as is in many cases, the chart in Figure 1-5 is used after the fact. Managing risk takes discipline in separating oneself from the activity at hand in order to view the situation as an unbiased evaluator versus an eager participant with a stake in the flight's execution. Another simple step is to ask three questions—is it safe, is it legal, and does it make sense? Although not a formal methodology of risk assessment, it prompts a pilot to look at the simple realities of what he or she is about to do.

Therefore, risk management is the method used to control, eliminate, or reduce the hazard within parameters of acceptability. Risk management is unique to each and every individual, since there are no two people exactly alike in skills, knowledge, training, and abilities. An acceptable level of risk to one pilot may not necessarily be the same to another pilot. Unfortunately, in many cases the pilot perceives that his or her level of risk acceptability is actually greater than their capability thereby taking on risk that is dangerous.

It is a decision-making process designed to systematically identify hazards, assess the degree of risk, and determine the best course of action. Once risks are identified, they must be assessed. The risk assessment determines the degree of risk (negligible, low, medium, or high) and whether the degree of risk is worth the outcome of the planned activity. If the degree of risk is "acceptable," the planned activity may then be undertaken. Once the planned activity is started, consideration must then be given whether to continue. Pilots must have viable alternatives available in the event the original flight cannot be accomplished as planned.

Thus, hazard and risk are the two defining elements of risk management. A hazard can be a real or perceived condition, event, or circumstance that a pilot encounters.

Summary

The concepts of hazard and risk are the core elements of risk management. Types of risk and the experience of the pilot determine that individual's acceptable level of risk.

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