Scenario Realization Training
A Proposal for Secretary Rumsfeld's Challenge

By LtCol Terry W. Armstrong
HQ USAFE/SEF
Ramstein AB, GE

In a recent year, a fighter cut through several trees as it crashed into the dark terrain during a night approach to landing, killing the pilot and destroying the aircraft. In the year prior, two trainers collided while maneuvering in formation, killing a student pilot and destroying both aircraft. And, in the year preceding those mishaps, a transport landed short of the runway, driving the landing gear into the passenger compartment, killing three people and significantly damaging the aircraft. These are individual examples from a three-year period where operators were cited as the cause of a Class A flight mishap. During this same period, operators were causal in 46 of the 81 total Class A mishaps. These are high cost mishaps in need of a solution to prevent a continued loss of lives, resources and mission readiness.

On May 19, 2003, Defense Secretary Rumsfeld put forth the challenge to the Department of Defense to reduce current mishap rates by 50 percent within the next two years[1]. A challenge of this magnitude, however, requires an equally challenging alteration to the current system, since an analysis of the historical USAF mishap rates indicate this will be difficult to accomplish. While the mishap statistics in Figure 1 bear out a continued reduction of mishaps over the years, it is also clear in Figure 2 that the single best two-year improvement occurred between 1969 and 1971 with a 65 percent decrease in mishaps. However, the overall average rate of improvement between any two years is only about 10 percent. Historically speaking, the odds of achieving a 50 percent reduction in mishaps over two years are relatively low, and the last few years have been no exception. Mishaps where operators fly into the ground or each other are likely to continue, unless there is a concerted effort to change to the current system in a manner capable of addressing these types of operator-induced mishaps.

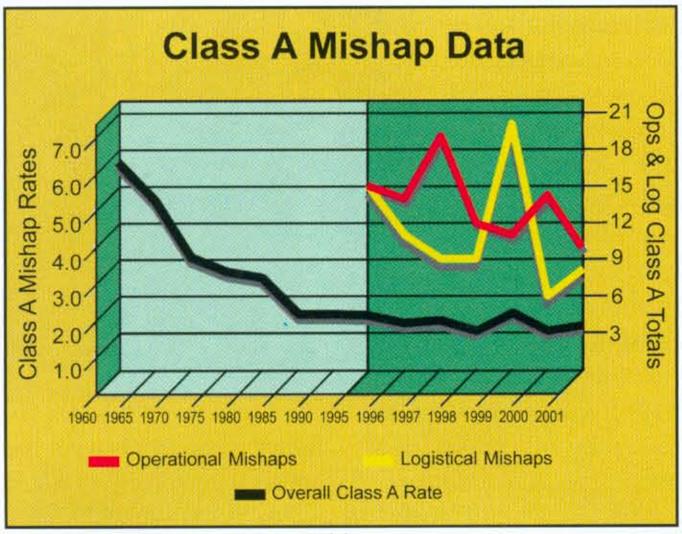

Figure 1: Historical Mishap Rates[2, 3]

There are no shortage of articles and other media calling for a decrease in mishaps, likewise there are very few helpful offerings on how this can be achieved—primarily due to a lack of new ideas. Fortunately, an analysis of some case mishaps and the current mishap system should show how the straightforward addition of "scenario realization training" can provide a new tool with direct, positive impact on the current 10 percent, two-year rate-of-return in mishap reductions. *Operators must be given hands-on, scenario training designed to incorporate lessons learned from mishaps caused by operators.*

The first step in understanding mishap reduction is to properly define "safety" in terms of "risk". Risk is an element every individual and corporate entity must face in the course of doing business. For a United States Air Force pilot, there is a certain level of risk every time an aircraft engine is started for a sortie. The pilot assumes risks that range from an engine fire at start-up to a breakdown in personal performance during execution of the mission. The USAF also bears these risks as a corporate entity. There is a constant trade-off between mission accomplishment and the risk of equipment or personnel failures that can result in the loss of an aircraft or trained personnel.

The true concept of "safety" is less about the indefinable notion of "being safe" than it is about managing risks. Since performing almost any activity of significance entails a certain level of risk, there is trade-off in the level of risk that must be accepted. Risk management is a conscious decision about how much risk can be accepted to achieve mission accomplishment. If too much risk is accepted, the cost of losing expensive equipment or valuable personnel becomes too great. Likewise, if completely "safe" (risk-free) operations are mandated, then mission accomplishment is compromised in favor of excessive caution. "Safety" decisions are really "risk" decisions, and risk decisions are a type of "economic" decision. Safe and efficient mission accomplishment is all about optimizing mission accomplishment through the economic use of resources while avoiding excessive loss of personnel or equipment.

In economic terms, as risk is reduced, the costs to make further reductions in risk begin to climb rapidly as improvements become marginal. Rather than expending resources in an attempt to exhort the current system into producing something it cannot, resources should be allocated to new options that offer a high potential payoff in risk reduction.

Consider the nature of most mishaps. A traditionally accepted division between types of mishaps is to distinguish between logistically-caused mishaps and operationally-caused mishaps. Although mishaps can be distinguished in alternative ways, this division separates the mechanical failures from the human failures. The Air Force Safety Center has defined the broad category of logistics related mishaps as mishaps "attributed to deficiencies involving the design, manufacture, overhaul, repair, maintenance or servicing of the aircraft." Operations causes are likewise defined as mishaps "attributed to deficiencies involving flying operations, to include air traffic control, operational guidance, flight crew training, and flying supervision."[4] The differentiation between logistical and operator mishaps in Figures 1 and 3 make it clear that operations typically outpace logistics as the cause of most Class A mishaps in most years. For many years, operators are the cause for as much as 60 percent of all Class A mishaps. These include the three examples cited earlier such as mid-air collisions, controlled flight into terrain (CFIT) or failing to adhere to proper procedures. While it is statistically significant that most mishaps are due to operators, the truly alarming statistic can be seen in Figure 3, which makes it clear that the operations mishaps also result in the most fatalities. Not only are there more operationally-caused mishaps, they are significantly more costly. It should be adequately clear that any efforts to reduce mishaps must aggressively target the operational causes, and risk reduction resources should be allocated accordingly.

Traditional USAF mishap prevention efforts have been developed and refined in large part through its system of safety investigations, honest reporting and follow-up actions from the resultant recommendations. Years of lessons learned through mishap investigations have added to the collection of rules, operating procedures, wildlife management, airfield midair collision avoidance programs, and other initiatives. Operating hardware has been improved as deficiencies have been identified, and pilots are educated about mishaps through quarterly safety meetings, safety read files, magazines and briefings. This system has been effective and has served the USAF well to reduce mishaps over the years. However, despite this effectiveness, it has not managed to prevent operators from causing over half of all major mishaps.

The limitation with this system has been a failure to conceptually integrate the lessons learned from operationally-caused mishaps into *proper hands-on training* for operators in a fundamental, broad-based approach. Programs and procedures are in place, pilots are professionals with well-developed tactical skills, but mishaps continue while the rate of improvement remains a statistically predictable 10 percent average reduction for any two years. An analysis of typical operationally-caused mishaps demonstrates that despite all of the elements of the current system in place, *it's the lack of awareness or recognition of events occurring in an impending mishap* that must be addressed for prevention. Training is the key to this prevention, not just marginal improvements on the current system to produce only more media, a renewed

Year	Class A Rate	Rate of Change	2-year Rate of Change	Year	Class A Rate	Rate of Change	2-year Rate of Change
1960	5.88			1981	2.44	-4.9%	**-20.9%**
1961	6.34	7.3%		1982	2.33	-4.7%	**-9.9%**
1962	5.75	-10.3%	**-2.3%**	1983	1.73	-34.7%	**-41.0%**
1963	4.39	-31.0%	**-44.4%**	1984	1.77	2.3%	**-31.6%**
1964	4.38	-0.2%	**-31.3%**	1985	1.49	-18.8%	**-16.1%**
1965	4.57	4.2%	**3.9%**	1986	1.79	16.8%	**1.1%**
1966	4.91	6.9%	**10.8%**	1987	1.51	-18.5%	**1.3%**
1967	4.54	-8.1%	**-0.7%**	1988	1.64	7.9%	**-9.1%**
1968	3.90	-16.4%	**-25.9%**	1989	1.59	-3.1%	**5.0%**
1969	4.05	3.7%	**-12.1%**	1990	1.49	-6.7%	**-10.1%**
1970	3.05	-32.8%	**-27.9%**	1991	1.11	-34.2%	**-43.2%**
1971	2.45	-24.5%	**-65.3%**	1992	1.69	34.3%	**11.8%**
1972	3.04	19.4%	**-0.3%**	1993	1.35	-25.2%	**17.8%**
1973	2.37	-28.3%	**-3.4%**	1994	1.46	7.5%	**-15.8%**
1974	2.89	18.0%	**-5.2%**	1995	1.44	-1.4%	**6.2%**
1975	2.77	-4.3%	**14.4%**	1996	1.24	-16.1%	**-17.7%**
1976	2.81	1.4%	**-2.8%**	1997	1.37	9.5%	**-5.1%**
1977	2.84	1.1%	**2.5%**	1998	1.14	-20.2%	**-8.8%**
1978	3.16	10.1%	**11.1%**	1999	1.55	26.5%	**11.6%**
1979	2.95	-7.1%	**3.7%**	2000	1.08	-43.5%	**-5.6%**
1980	2.56	-15.2%	**-23.4%**				

Figure 2: Two-Year Rates of Change

emphasis on rules or refinement of current programs.

Consider a mishap where two combat aircraft collided within the same formation. Investigators determined during the pilots' maneuvering an ambiguous radio call, misperception and channelized attention combined to create a collision course. The pilots were flying in accordance with the governing directives in an attempt to properly accomplish their mission, and no violations were noted. However, the combination of events transpired for the pilots *to fly themselves* into a catastrophic situation without sufficient awareness to prevent the mishap. This is captured in the post-mishap interview of one pilot when he stated, "All I know is that something violent just happened." Likewise, the other pilot stated, "[I] look outside…and I see us about to hit." Fortunately, both pilots survived this mishap, but two combat aircraft were lost.

Three recommendations from the safety investigation board on this mishap were produced. The investigators recommended: adding range proximity warning capability to the aircraft, to consider risk when scheduling the mission, and to include the mishap scenario in the Cockpit/Crew Resource Management (CRM) syllabus. The first recommendation was closed after agencies nonconcurred, given both the technical requirements and the capability of the human eye to perform the task when properly used. The second recommendation, to consider currency risks while scheduling, was closed after risk management responsibility was delegated to the individual units. Lastly, the CRM recommendation was closed after the scenario was incorporated into the CRM syllabus as recommended.

These recommendations from the current USAF safety system were useful, and the follow-up actions have undoubtedly provided a measure of mishap prevention. However, in this and many other case mishaps, there is little new to offer towards directly preventing the next midair collision. The discussion surrounding the first recommendation to "properly use the eye" was excellent, however there were no associated ideas provided to accomplish this and the recommendation was simply closed. The second recommendation, although rightfully incorporating risk decisions, was still a strictly administrative action. The final CRM recommendation correctly addressed training, but CRM is a "media-only" education syllabus that does not provide hands-on training for the pilots. Proper hands-on training, however, could actually teach the pilots how to avoid a collision such as this when the situation becomes conducive to a mishap.

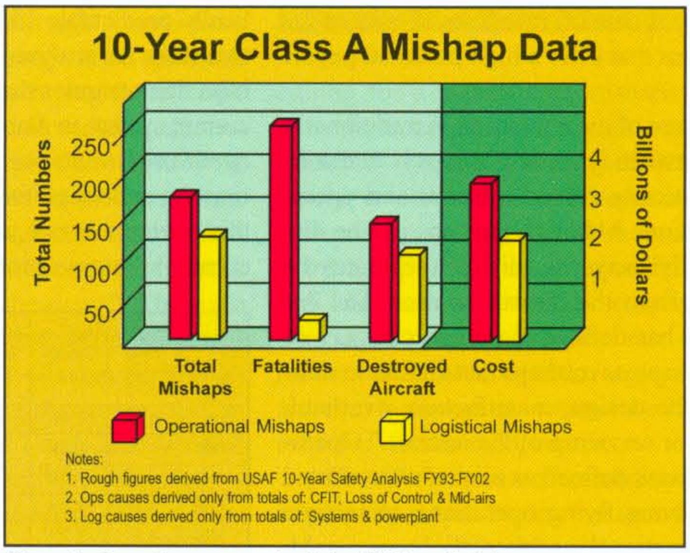

Figure 3: Operations versus Logistical Mishap Data[5]

In the case of another mishap, investigators determined that attention management was the reason a pilot impacted the ground in a fatal mishap. Analysis concluded the pilot "did not recognize the excessive nose-low attitude", despite a functioning Ground Collision Avoidance System audible warning. Although there were a few additional contributing factors, the pilot was attempting to perform his mission in a professional manner, but he was unable to properly assess the elements combining to create his mishap. No recommendations were produced from this mishap. In essence, the current system had nothing further to offer.

Essential to understanding these case mishaps is despite all previous mishaps of a similar nature in the past, the pilots were *unaware* of their *own* impending mishap. All of the education, rules and media intended to prevent pilots from entering dangerous situations, in addition to the inherent desire of all pilots to avoid losing an aircraft, failed to prevent these mishaps. *Every* mishap of this nature includes a certain lack of awareness on the part of the pilot. Contrast the individual's lack of impending mishap awareness to the corporate awareness of the USAF. The very same system of mishap investigations has allowed the USAF to have excellent awareness of the elements that combine during a mishap. The problem is to *properly* transfer this corporate safety knowledge to the individual pilot so he can use it real time to prevent his own potential mishap when faced with adverse conditions. Education, publication changes and hardware modifications are necessary, but *hands-on training* must pick up where the rules and classroom stop. Training is the traditionally effective means to teach a person to perform a task or avoid undesired actions, and this should be no exception. The entire USAF approach to producing world-class pilots revolves around training programs second to none. Yet when it comes to analyzing the training a typical USAF pilot receives in regard to mishaps, there is little integration of hands-on training to prevent operational mishaps.

Take the F-15 training syllabus as a singular example of typical aircraft training syllabi. From the 52.5 hours of hands-on simulator training and 69.2 hours of practical aircraft time depicted in the 2003 F-15AC B00AT syllabus, *none* of those hours are directly dedicated to training the lessons learned from the investigation of operations mishaps. For accuracy, however, there is a reference to discuss spatial disorientation during the Instrument Refresher Course six-hour block of academic instruction, and there is also a flight-training requirement to recover from an unusual attitude in the instrument proficiency phase. Even this single instance of disorientation training is usually relegated to the trainee closing his eyes for a moment while his backseat instructor puts the aircraft into an unusual attitude. The trainee is then directed to recover. This 60-second slice of hands-on training, coupled with similar short set-ups in a simulator, is essentially the sum total of hands-on "device" training F-15 pilots receive to guard against spatial disorientation, which is one of the USAF high-loss mishap scenarios among fighters! Any additional device training which does occur to counter problems such as disorientation, CFIT, midair collisions, etc, is usually passed on by individual instructor techniques, and not necessarily through a formalized syllabus built to properly recreate case scenarios. Even the excellent disorientation simulator used at the Advanced Instrument Course has only been available to a limited number of aviators.

Contrast this lack of training pilots receive for the operationally-caused mishaps to the training given for logistically-caused mishaps. The same F-15 syllabus devotes simulators TR-2 through TR-8 to both basic procedures and training to contend with system malfunctions. System malfunctions in various forms are the essential element of logistically-caused mishaps. Student pilots also receive ten hours of hands-on training in part-task trainers for Situational Emergency Procedure Training, the twelve hours of hands-on training in high fidelity simulators during TR simulator sessions and at least one simulated minimum fuel recovery in the jet itself. Several hands-on training hours are devoted to training a new pilot to bring back a severely disabled aircraft.

This disparity in scenario training between operationally- and logistically-caused mishaps is also suggested in the mishap statistics. In a year where there were roughly as many operationally and logistically-caused mishaps, there is a large disparity in the end results of the mishaps. In FY01, there were 10 mishaps citing operations as the cause, which resulted in eight fatalities and 13 destroyed aircraft. In contrast, the eight mishaps with logistical causes had zero fatalities and only five lost aircraft. In other words, pilots appear well trained to bring back an aircraft with a system failure serious enough to result in Class A damage. The operationally-caused mishaps are usually the direct result of a pilot's *inability* to contend with a given set of conditions conducive to a mishap. The tried and true course of action to overcome any specific inability has always been through proper training, and this should be no exception.

As a result, the systemic change necessary to achieve a significant reduction in mishaps is to begin a comprehensive campaign that takes the lessons learned from operationally-caused mishaps and provide operators with training that truly recreates the insidious nature of an operator's mishap. This training can be conducted through simulated or actual devices, but must duplicate the operating environment with enough fidelity to feed in the conditions of the impending mishap in a subtle fashion. The pilot must be allowed *to fly himself* (or herself) into the regimes that have claimed the lives of pilots before, since true learning will only occur when the pilot *realizes at that critical moment* he has in fact caused a (simulated) mishap or managed to narrowly avoid it. By incorporating this conceptual framework of "scenario realization training" into the current USAF approach to safety and training, money and resources can be applied in the precise manner to mitigate these risks and achieve real mishap reductions.

To achieve the desired results of this mishap "realization" training, the perceived emphasis must be placed on a performance-related task such as a tactical employment checkride. It would be of less value in many cases for a pilot to walk into a simulation, knowing he had to concentrate on a "safety" scenario where he may be expected to meet with demise. By setting the stage in the pilot's mind that he will be evaluated based on his ability to properly employ his aircraft in a significantly challenging scenario, the real training can be accomplished as case scenarios of marginal weather or lost wingman factors are appropriately added to create an impending mishap. The goal, in part, should be to train the flight leads to monitor their wingmen throughout critical stages of employment, and to train wingmen to properly assess their environment, even if they lack the knowledge that they may be rejoining on the wrong aircraft. The scenarios should be built based on comprehensive case studies of all operationally-caused mishaps and incorporated at the various ground-level training a pilot receives throughout his or her career. The approach must be comprehensive enough to incorporate the actual aircraft when appropriate and high-fidelity simulators capable of duplicating the necessary elements of the aircraft and mishap. The key is to capture that very moment a pilot realizes (or altogether misses) the impending mishap and then evaluate and instruct to the various breakdowns that led to the failure, which is a standard training practice. Sensors and monitoring equipment can be added to the training devices to determine where the pilot is concentrating, and profiles can be built to determine behavioral differences between effective and ineffective pilot techniques.

Education, publication changes and hardware modifications are necessary, but hands-on training must pick up where the rules and classroom stop.

Although the discussion has been limited thus far to aviation, the concept applies to other situations. Consider in 2002 where 20 USAF personnel were killed in motorcycle mishaps. Investigations revealed these mishaps were attributed to "operators" as the cause. Typically the rider was riding too fast for the conditions or encountered an unexpected hazard. In fact, 98 percent of all USAF ground mishaps result from the action or inaction of individuals[6]. In short, they are "operationally" caused mishaps.

The same pattern of training deficiencies can be seen in the motorcycle program as was noted for aviators. The 2003 Motorcycle Safety Foundation's Riding and Street Skills Instructor Guide is the course used to train USAF motorcyclists before they are legally permitted to operate a bike as an Air Force member. Within this course, Modules 1 through 20 are dedicated to teaching and practicing basic *operator skills* such as shifting, turning, stopping and adjusting speed. Only in Module 10 is there a reference to "evasive maneuvers". This motorcycle course is mandatory training, yet it does not incorporate the lessons learned from the various USAF investigations of motorcycle mishaps. It is an operator *skill-based* training that does not incorporate hands-on training to deal with operator mishaps, much as with the approach to training pilots.

...true learning will only occur when the pilot *realizes at that critical moment* he has in fact caused a (simulated) mishap or managed to narrowly avoid it.

The profile of the "at risk" motorcyclist is the young airman with a sense of youthful "invincibility". The motorcycle has always been under his control, and the mishap lessons learned from the USAF safety culture are related to this operator only during the classroom education, not while he is operating the bike. The lessons of excessive speed for the conditions, loss of control and unexpected hazards do not truly become personal until the rider experiences a serious loss of control for the first time from his own failing. It's that moment of lost control and an impending mishap that truly teaches the need for discretion and awareness of mishap potential.

Once again, the difficulty is properly transferring the lessons learned from motorcycle mishaps to the rider in a more personal realization. Where classroom education leaves off, hands-on training must begin in order to achieve results. This would require either specialized simulators or specially modified motorcycles capable of allowing the operator to ride into the conditions conducive for a mishap to occur in a controlled environment. Training the operator to realize the true nature of a loss of control based upon the lessons learned from previous mishaps is management of the correct risk.

Another variation in this type of hands-on scenario training has been used to teach the effects of alcohol and driving. Drivers negotiate a controlled course with pop-up stopping challenges. Each driver navigates the course successive times after given increased amounts of alcohol. Their deteriorating performance was readily evident in a much more personal manner than through classroom education. The entire event was videotaped for evaluation, so the trainees saw first-hand the effects that even a small amount of alcohol had on their personal ability to perform in the driver's seat.

The current USAF safety system has been refined over time to produce a near continuous reduction in mishaps, and rules are in place to guard against dangerous scenarios. Unfortunately, operationally-caused mishaps continue to cost both lives and resources. This should come as no surprise, however, since USAF pilots are not trained to the same levels in preventing these mishaps compared to systems failure training and skill-based training. Fortunately, the same time proven approach of training can equip operators with the necessary set of skills and awareness to overcome the breakdowns leading to most operationally-caused mishaps. Since the current system produces a quantifiable result, the best hope of beating the statistical odds and achieving a 50 percent reduction in mishaps is to fully merge the lessons learned from operationally-caused mishaps into a fundamental restructuring of initial training syllabi and continuation training. Devices should be built to ensure this training is "hands-on" training, and the conceptual approach should ensure trainees are guided into the conditions conducive to a mishap for the opportunity to actually realize that critical moment of failure. Given the high payoff potential associated with mitigating the risk of operationally-caused mishaps through proper scenario based training, conscious decisions can be made at the strategic level to allocate the resources necessary to make the comprehensive changes.

References:

[1]Memorandum for Secretaries of the Military Departments, Subject: Reducing Preventable Mishaps, May 19, 2003

[2]Air Force Safety Center (AFSC) web page: http://afsafety.af.mil/AFSC/RDBMS/Flight/stats/usaf1097.html

[3]AFSC web page: http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/usaf_opslog_89_00.html

[4]AFSC web page: http://afsafety.af.mil/AFSC/files/tome2.pdf (slide #9)

[5]Compiled from the Ten Year Air Force Safety Analysis: http://afsafety.af.mil/AFSC/files/tome2.pdf

[6]AFPAM 36-2241 vol 1, Paragraph 12.35.3