CONTRARIAN VIEW: TRAINING MAY ENHANCE AIRCRAFT SURVIVABILITY AS MUCH AS COUNTERMEASURES

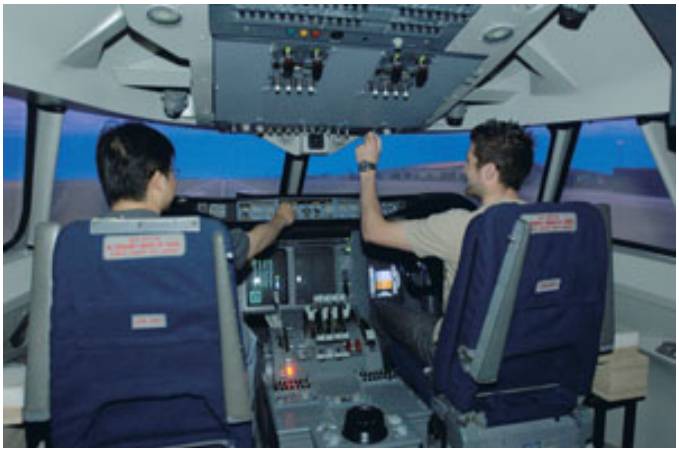
By Kevin McCarthy & Ken Dunlap

Countering MANPADS through Next Generation Pilot Training.

ABSTRACT

The threat posed by terrorists utilizing MANPADS to attack commercial airliners is well documented and understood. However, the range of measures necessary to protect airliners from this threat are neither fully developed nor studied. To date, the totality of efforts to develop protective countermeasures have focused on hardware based solutions. In this paper the authors argue that simulator training of commercial airline pilots may be as effective in enhancing aircraft survivability as hardware based solutions.

> *"When confronted with a catastrophic deteriorating mechanical situation, the single most effective countermeasure will be the human factor, which is the power of the human mind to assess the situation while instantly generating various alternative courses of action"*



Robust and Survivable, *if Only for a Few Minutes*

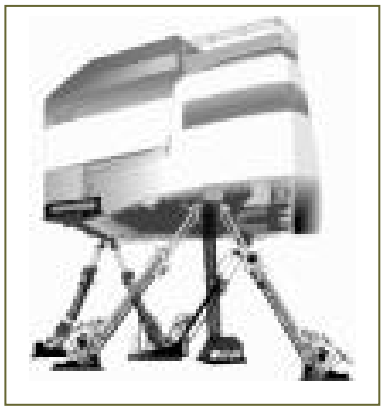
Transport category aircraft have proven themselves to be remarkably robust and survivable when engaged by the small anti-aircraft missiles we call MANPADS. The vast majority of aircraft larger than a Boeing 737 aircraft attacked by MANPADS often survived the initial hit and continued to fly. Contrary to popular opinion these weapons are not "one hit, one kill" systems when used on an airliner. MANPADS do however; inflict catastrophic damage that over the course of a short period of time may create cascading failures that lead to the loss of the aircraft.

The authors believe that the time period from attack to total loss of control of the aircraft may be sufficiently long enough for a specially trained pilot to safely land the aircraft. We call this time period $S_t\Delta$, or *Survivability Time*.

$S_t\Delta$ in the most basic sense is that period of time where the aircraft's inherent design and redundant backup systems continue to function until they are degraded by cascading failures caused by the missile impact and detonation. During $S_t\Delta$ the aircraft remains flyable on remaining primary or backup systems.

What is clear from the debriefings of military and airline pilots who have experienced a missile hit is that the aircraft does not fly "normally" during this degraded state. In many cases, pilots during $S_t\Delta$ were forced to develop "new" flying procedures and techniques to keep the aircraft controllable. Because these pilots were successfully able to think through a situation of cascading failures in real-time they were able to land their aircraft.

In this article the authors propose a new training program for commercial pilots which focuses on the handling of cascading unrelated failures. Such training will give pilots a survival advantage by allowing them to think through and practice their reactions in a simulator and not a disintegrating airplane.



Airline training simulator

MANPADS and Large Commercial or Military Aircraft

MANPADS were originally designed in the 1960's to be used as a low altitude air defense weapon to defend ground forces against attack by helicopters and fighter aircraft. The portability and speed of deployment of the weapon make it an ideal tool in these situations. In order to achieve this portability the warhead is quite small. Comparatively, the blast pattern is also small and concentrated. On a small fighter or helicopter this damage pattern will be catastrophic. However, current evidence suggests that when detonated against a large transport category aircraft, those larger than a Boeing 737, the blast pattern does not cause immediate destruction of the aircraft. We base this on recent attacks against DC-10, A-300, C-17, and C-5 aircraft.

While there are few attacks on which to draw empirical evidence, those that we have studied suggest a pattern. When small single aisle aircraft such as the B-727 and B-737 are hit by MANPADS they tend to be immediately destroyed. Larger widebody or military cargo aircraft tend to survive. While one might be able to conclude that increased size suggests increased survivability, a better conclusion is that training is all the more important for pilots of large transport category aircraft. Pilots of crown jewel aircraft such as the A-380,B-777, B-747, DC-10, B-767/757, A-340, and A-300 might be the best focus of training efforts.

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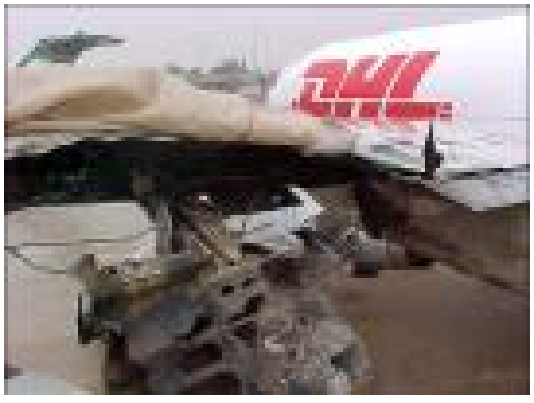

Civilian Airliner Hit by missile.

Why Should the USG Bother about Training Civilian Pilots?

The USG has a very good reason to worry about training civilian pilots. Every day they are moving USG personnel and equipment. DOD heavy lift requirements to quickly move men and material to world hotspots – continues to play an ever increasing role in DOD's agile quick response force projection model. Indeed, now more than any other time in our Nation's history, the ability to ensure "just in time" forces are transported and sustained with a supporting logistic tail to a region where they are immediately required becomes a critical variable in the strategic planning process.

Because the environment in which these flights take place may be inhospitable or threatening it is essential that pilots who have volunteered to participate in DOD/civilian programs – such as those outlined in DoDD 3005.7, Emergency

Badge of the Civil Reserve Air Fleet

Requirements, Allocations, Priorities, and Permits for DoD Use of Domestic Civil Transportation – be able to effectively resolve in-flight emergencies caused by man-portable air defense systems (MANPADS) strikes, in-flight bombings or hazardous materials release inside the cabin/cockpit and hijackings.

Training an Airline Pilot to Survive

Over the last 75 years the methodology by which airline pilots deal with mechanical malfunctions or environmental hazards has evolved greatly. In the early days of commercial aviation nearly one half of commercial pilots died on the job from various causes. There was little regulation or structure as to how critical situations would be handled. Pilots who survived in those early days often spent hours anecdotally recounting their experiences to colleagues and less experienced pilots. Over the years the FAA came about and assumed the role of overseeing safety regulation and training. Through this system, anecdotes became scenarios to be examined and a list of critical actions developed to be used when a similar situation arose. In this manner a tremendous knowledgebase was established for many situations and previously unthought-of scenarios. In the later third of the 20th century flight simulators became invaluable in testing various procedures and most importantly allowing pilots to train to handle a situation, which would never be intentionally created in an aircraft. The FAA oversaw the entire training regime with a constant view toward improving the procedures and standardizing the procedures.

A case in point is the weather phenomena, which we now call *windshear*. Once it was scientifically established that this condition existed and that it was the cause of several airline crashes, the FAA set about building a simulator-training module to

teach pilots how to handle the situation when it arose. Over the years this module has been refined and improved and is still a core event of every simulator flight. Since the development of this training there have been almost no aircraft losses due to windshear. The FAA has every reason to anticipate this will continue to be the case and all pilots will continue to practice the necessary maneuvers in simulators.

These codified procedures have followed from investigations of accidents and accounts of critical situations. Massive efforts have been expended to determine cause and effect of many situations. A logical chain of events is created and the experts can reasonably predict how component failure will affect the overall system of an airliner. This has been a tried and true method for developing procedures, which has created the safest transportation system in the world. With the advent of terrorism attacks on airliners and the possibility of MANPADS or other standoff weapons being deployed against them, it is time to take an alternative look at the scenario. When a missile hits an airliner, assuming it survives the initial blast, there will be massive unrelated component failures. This cascading mechanical degradation will defy logic and render all previously scripted procedures null. As there are a multitude of possibilities for the situation to follow there is no readily available procedural to develop. It is in this situation that the pilot must regress to earliest days of aviation. It will take the power of the human mind, combined with in-depth understanding of the airplane and it's capabilities, to bring the situation to a successful conclusion. In this case the metric for success will be in getting the aircraft on the ground with the minimum loss of life.

"Training a commercial or military pilot in command of a large aircraft to react to a missile hit must focus on getting the aircraft to the ground in the shortest possible time. "

An Alternative Training Concept

Training a commercial or military pilot in command of a large aircraft to react to a missile strike must focus on getting the aircraft to the ground in the shortest possible time. Time consuming scripted actions, such as checklist completion, controllability checks, and procedural diligence may lead to the loss of the aircraft.

The authors in this article suggest that a new type of training can be developed for catastrophic situations that rely on what we call "minimum safe actions necessary for landing." This "do whatever it takes to land" training may give crews enough time to successfully land during $S_t\Delta$, or *Survivability Time.*

The authors believe that pilots can be trained to this standard. However, it will be critical that the trained pilot understand that this technique be only used during a probable missile attack. Pilots must not ignore previous training and employ the missile attack survival training during run of the mill emergencies.

MANPADS Survival Training

The authors believe that any training must combine massive mechanical failure, fire, loss of thrust and

impaired flight controllability. These tend to be the mix of failures experienced by crews who have been hit by a MANPADS. Additionally, total failure of the today's sophisticated warning systems and electronic checklists must be incorporated. The only parameter given to the airplane pilot for each situation is to land the aircraft.

In one scenario the authors subjected the crew of a large crown jewel airliner a B-777, failure of both engines destroyed by missiles while 12 miles from the airport, typical of a dual missile engagement, approximately 4000 feet above the ground. At this point the airliner is essentially a 500,000-pound glider. There are no FAA procedures for gliding this airliner and other landing scenarios with any number of preconceived malfunctions proved to be un-survivable. Through utilizing simulator experimentation it was determined that an experienced crew will develop in real time unthought-of techniques that allow for a safe fully controllable landing.

A real life illustration of this behavior pattern is seen in the case of United Airlines flight 232, piloted by Captain Al Haynes in the summer 1989. Capt Haynes' DC-10 suffered a catastrophic uncontained failure of the tail mounted center engine. The exploding debris severed all three hydraulic systems disabling the primary flight controls and jamming the backup mechanical controls. Capt Haynes is an outstanding airman with a very comprehensive understanding of the DC-10 and aerodynamics. Controlling the aircraft with the thrust of the two remaining engines Capt. Haynes was able to make an emergency landing in Sioux City, Iowa. Tragically, 112 passengers died when aircraft control was lost on the runway. However, human factors prevented a certain disaster and 184 people survived when the mind out thought the deteriorating mechanical systems.

Fourteen years later Captain Eric Genotte of DHL airways sat through a seminar in which Capt Haynes recounted his experience. On November 2, 2003 that same captain was piloting an Airbus A-300 out of Baghdad International Airport when it was hit by what was probably a MANPADS SA-7. The explosion destroyed all hydraulic systems – there are no mechanical backups on this aircraft – rendering it un-flyable. The Belgium pilot took Capt Haynes "training" to heart and certainly had considered what he would do in a similar situation. With his aircraft severely damaged and in flames, utilizing what has become called propulsion control – that is flying the aircraft with engine power alone – he successfully landed the aircraft with no injuries. The aircraft was totally destroyed in the process yet the human factor prevailed.

Training

"Controlling the aircraft with the thrust of the two remaining engines Capt. Haynes was able to make an emergency landing in Sioux City, Iowa."

How do we create another United Captain Al Haynes or DHL Captain Eric Genotte? We train them. We give pilots the chance to think through their actions on the ground rather than in the air. We give them time to plan ahead.

The authors estimate that "planning ahead" would take

only one-hour classroom discussion combined with a thirty-minute initial session in the simulator. That's all pilots need to begin the mental preparation to deal with a life and death scenario where their aircraft is engaged and hit by a MANPADS. Airline pilots make life/death decisions as a routine part of any flight and they are fully capable of expanding this decision tree. Once given the unending list of possible problems and the only acceptable solution being a safe landing they will, as they have, devise and improvise a solution.

In the broadest sense, pilots need this training to give them the "OK" that there are certain situations where deviating from the "FAA Approved solution" is the only reasonable course of action to save their aircraft.

We believe that Civil Reserve Air Fleet pilots, in the service of the USG, should be trained first. Next in line must be pilots of crown jewel aircraft.

The authors recognize that the FAA will need to be a strong partner in this training program. Their participation is vital. However, we will be asking this agency to think outside of the box when it comes to pilot training. But, even if countermeasures are approved for commercial aircraft, this training will still be critical. That is because we will need to answer the question of what do you do next if your countermeasures have failed?

Training is Today, Countermeasures are for Tomorrow

As the DHS Special Projects Office closes in 2007, it is necessary to ask ourselves, "What can we do today to protect airliners against the threat of MANPADS?"

Clearly, a hardware based solution is costly and time consuming. The first $200 million dollars of investment in R&D funding by USG, has fielded less than two dozen countermeasure systems that can be deployed immediately. How do we get to six thousand systems to protect our commercial airliners? Do we want to deploy six thousand systems? Whether the metric is cost or production time, the authors doubt that systems can be fielded before 2009.

Training of commercial pilots is the only immediate solution to protecting our commercial fleet. We know that $S_t\Delta$, or *Survivability Time* is a fact. If we do nothing to provide pilots with the tools and training they need to maximize this window of opportunity we are doing them a great disservice.

About the Authors

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Kevin McCarthy is an experienced policy, operations, and government affairs practitioner. He has over thirty years operational, aviation threat assessment, and risk analysis experience. During a career flying large transport category aircraft he concurrently specialized in all aspects of aviation security. Following a tour with the USAF, McCarthy spent 27 years as a command pilot with a major US airline, culminating as Captain of a B-777 in worldwide operations. McCarthy held the first industry position, representing the security interests of 65,000 airline pilots to the US Intelligence Community. He is well respected as a forceful and effective adviser, consultant, and sector leader in aviation security; White House & Congressional offices, Departments of Defense & Homeland Security, and industry leaders seek his unique expertise. McCarthy holds a BS degree in Earth & Space Science and has received advanced counterintelligence education at the CI Centre, Alexandria, VA.

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Ken Dunlap is a long time commercial airline security executive. In various capacities, including as Manager of Homeland Security Programs, he helped United Airlines recover from the events of 9/11. Ken has been a leader in developing information sharing and critical infrastructure protection programs for the airline industry. He has worked with aerospace prime contractors to explore next generation sensor systems to protect airports and aircraft from chemical, biological, and radiological agents. He has served as an expert on the protection of airliners from MANPADS to the National Defense University, the Homeland Security Council, and the Coalition Provisional Authority. Additionally, he has worked as a research and teaching assistant for former UN Ambassador Jeane Kirkpatrick, and as a personal staff member to the Chairman of the House International Relations Committee, Clem Zablocki. He holds a M.A. in National Security Studies and B.A. in Government from Georgetown University. Ken has logged over 7000+ hours as both a commercial and military