IFALPA
The Global Voice of Pilots

Aircraft Design & Operation
Briefing Leaflet

03ADOBL01 April 2003

Aggressive Manoevering

When terrorists seized airborne aircraft and used them as weapons of mass destruction, airline pilots world-wide were forced to re-think their roles in the event that the airplane they might flying is hijacked. Before September 11th, this role was defined by strategy as one of negotiation, to ramp down the rage of the terrorists by listening to their demands, and by offering solutions while protecting the safety of passengers and crew. Control of the airplane remained with the pilots, although the destination was often a variable. The situation presented to four airline crews on 9/ 11 was distinctly different. The terrorists were trained and capable of eliminating the crew, and flying the fully fuelled wide-body aircraft into predetermined ground targets. There could be no negotiations. The hijackers were willing to die in the inferno of successfully completing their mission, or die while trying to do so.
To the airline pilot, the prospect of being killed led many to think that without weapons in the cockpit or cabin to protect themselves, the airplane itself could be used against terrorists through some sort of "aggressive aircraft manoeuvre", or AAM. Among many pilots, particularly those with military backgrounds, those with current aerobatic experience, and those simply so angry that they would attempt anything if a terrorist entered their cockpit, a variety of AAMs were suggested. Comments in the open press referred negative g pushovers, rapid pitch, roll, and yaw inputs, or rolling the airplane completely. The Rapid Response Team for Aircraft Security, formed by U.S. Transportation Secretary Norman Mineta, made the following recommendation:

"Recommendation 17: We recommend that within 30 days, airlines, pilots, and the FAA should jointly identify procedures in pilot training, including depressurization, and rapid descent, that could be adopted in an attempted hijacking to control a hijacker."

Industry meetings began in Seattle in late September 2001 on the subject of cockpit security. Among the many subjects mentioned were depressurization, introduction of a sleeping agent in the cabin, and the extreme option of taking control and piloting the airplane remotely from the ground. AAMs were also on the list, but at the time, the manufacturers and the airlines were working to identify just what manoeuvres were both possible and effective in a crisis situation. Both Boeing and Airbus performed flight tests to determine what kind of manoeuvres could be used, when they should be performed, could crews be trained to use them, and what would the negative effects be. Such manoeuvres would become "counter terrorist manoeuvres", or CTMs. A brief look at the manoeuvre capability of transport aircraft provides some insight into the magnitude of the problem:

During the attempted hijack of FedEx 705 The pilot flying, another, pulled the airplane into a steep climb, rolled to 140 degrees of bank, and performed a modified Split S manoeuvre in an effort to stop the hijacker's attack but to no avail.

- Pitch Axis – The elevator/stabilizer combination is de signed to provide acceptable control over a wide range of speed, configuration, and cg position. The pitch response of most conventionally controlled aircraft is proportional to airspeed and elevator deflection, and will allow the pi lot to reach and exceed design g limits depending on air speed. Fly-By-Wire (FBW) aircraft provide pitch re sponse according to control laws, and contain either hard or soft limits to avoid exceeding design G limits. At high altitude, where the speed range between stall and over speed is reduced, there is risk of stall buffet or overspeed, with the possibility of an aircraft upset.
- Roll Axis – The roll rate of most transport aircraft is by itself not sufficient to produce motion in the cabin Starting and stopping the roll can produce abrupt motions, but requires full control deflections and "shaped" inputs to be abrupt. Roll inputs in a FBW aircraft cannot be "shaped" in the same manner. The biggest problem with rolling manoeuvres is that bank controls the direction of the lift vector, and can easily produce an aircraft upset.

During the 1988 hijacking of VASP 375 the Captain performed a full 360 roll, and an intentional spin. Although the hijacker lost his footing during these manoeuvres, he did not lose control of his weapon.

Yaw Axis – The rudder/fin combination is sized for the worst case of engine failure at slow speed and maximum engine thrust on the remaining engine(s),or other foreseen asymmetric flight conditions. Rapid rudder movement, particularly rapid rudder reversals can produce loads on the vertical fin that exceed the limits to which the airplane was certified.

Members of the IFALPA ADO Committee participated in a flight demonstration in the A320, where we investigated motion about all three axes, and flew the airplane to its design limits, both positive and negative. The results of this and similar limited flight tests by Boeing and Airbus indicate that for a limited range of flight conditions, a CTM could be performed that would disrupt terrorist activity in the airplane, without exceeding airplane limits or causing an upset. But the overwhelming conclusion among the IFALPA ADO pilots, and within the industry is that such manoeuvres should not be attempted for the following reasons:

- The risk of upset is very high, particularly in non-FBW aircraft. Heavy buffet, extreme pitch attitudes, and stall or over speed are easily possible.

- A CTM may not be useful or effective in all flight conditions, and they would have to be flown as sustained manoeuvres throughout the cruise, descent, approach, and landing phases of flight, in a variety of weather conditions, day or night.

- An improperly performed CTM could lead to injury and death to crewmembers and passengers in the cabin. The effects in the cabin, as observed first hand, are extreme. Objects and people not secured in the cabin move rapidly and uncon trollably up and down. Consider the account from a Boeing 747, where the Captain was forced to manoeuvre to avoid a mid-air collision:
  "The Captain had just turned off the Fasten Seatbelt sign when the drama began. His evasive action included a vertical acceleration of -0.55g to +1.59g. Of the 411 passengers on board, 344 had kept their seatbelts fastened. Fifty-three of these people were injured, mostly lightly. But 35 of the 67 whose seatbelts were unfastened were injured. Seven passen gers and two cabin attendants were injured severely, mainly when they hit the ceiling or other people fell on them. One serving cart hit the cabin ceiling so hard that it remained lodged there."

- Even a properly performed CTM will cause several cautions and warnings to sound in the cockpit. Low oil pressure to the engines, hydraulic reservoir low, and other warnings will likely be annunciated, leaving the crew to deal with a new set of problems that the CTM has created.

- To properly perform the CTM, the pilot himself must be properly strapped in. All loose items must be stowed to avoid creating problems and distractions in cockpit.

- To be strategically effective, the cabin attendants and any law enforcement officers on board the flight would have to be aware that CTMs were coming, so they could prepare and react accordingly. Without knowledge of the cabin situation, the pilot could easily disable those who are in the best position to control the situation.

- Modern simulators can produce the pitch rates required to do an effective CTM, but they cannot produce the acceleration felt by the pilot in the real aircraft. This acceleration is an essential feedback cue that the manoeuvre is performed prop erly. In addition, neither the simulator nor the real aircraft has a suitable g meter, which is necessary accurately perform a CTM, regardless of flight conditions.

- The CTM required would be different between airplane models. A pilot recently trained in a new aircraft would have to be certain which variation of the manoeuvre is appropriate to the type flown, in the heat of an actual hijacking situation.

As further proof of the limited effectiveness of an AAM or CTM, consider two actual hijackings where AAMs were used, and the resultant outcomes: The first was VASP 375 on September 28th, 1988. The Boeing 737-200 was on a domestic flight in Brazil from Belo Horizonte to Rio de Janeiro. Without security screening, an armed individual had boarded the flight, and as the Captain began descent to Rio de Janeiro, the hijacker fired several shots through the cockpit door, wounding the jump seat pilot and damaging several instruments. The Captain ordered the door opened, and the hijacker entered with a gun, shot and killed the First Officer, then demanded that the Captain fly to Brasilia and crash the airplane into the Presidential Palace. The Captain initiated a climb to save fuel, and once in the area of Brazilia, selected a flight path that allowed clouds to block the view of the Palace. Running low on fuel, the Captain asked to land at nearby Gionia. The hijacker refused, and realizing that the situation was now desperate, the Captain performed a full 360 roll, and an intentional spin. Although the hijacker lost his footing during these manoeuvres, he did not lose control of his weapon. However, he was now threatened by passengers, which allowed the Captain to land the damaged airplane with one engine out for lack of fuel. The hijacker was detained following a gun battle with police[1].

The second was FedEx 705, a DC-10 that was dispatched from Memphis to San Jose. A jump seat pilot was aboard who was carrying some hammers and a spear gun in a guitar case. His intention was to take control of the airplane and crash it into the Federal Express cargo sorting facility in Memphis. During the climb, the hijacker burst into the cockpit and severely injured all three pilots with hammer blows to the head. The hijacker went back into the cabin and returned with a spear gun. When the Second Officer saw the spear gun, he grabbed it,and both he and the Captain began fighting with the hijacker. The pilot flying, another Federal Express Captain, pulled the airplane into a steep climb, rolled to 140 degrees of bank, and performed a modified Split S manoeuvre. The three fighting men disappeared into the cargo compartment during the manoeuvre.
The right seat Captain, then put the airplane on autopilot, and left the cockpit to assist the others. After several minutes of fighting, the left seat Captain returned to the cockpit and landed the damaged airplane in Memphis, with the fight still raging behind him[2].

In both of the cases mentioned above an armed hijacker attempted to take control of the airplane for the purpose of flying it into a target on the ground. In an act of desperation to sway the balance of a struggle on board the airplane, the pilots of both airplanes attempted manoeuvres they had never been trained to do. Both airplanes entered an upset, from which an upset recovery was necessary. Both airplanes sustained substantial damage during the manoeuvre. And, in both cases, the hijacker retained his weapon and continued to threaten the crew. On the positive side, in both cases the AAMs did create situations where the passengers and crew could gain some advantage.

All the information that IFALPA ADO pilots have gathered to date indicate that AAMs and CTMs are inappropriate, and perhaps the most dangerous thing that a pilot could do to resolve a situation where terrorists are attempting gain control of the aircraft. The important question to ask is “What is the proper course of action to take?” At the first indication that there is a potential hijacking situation aboard the aircraft, the pilot should attempt to get the airplane on the ground as soon as possible. Over populated land mass areas, this means beginning a rapid descent, similar to an emergency descent, to land at the nearest suitable airfield. The pilot’s objective now becomes denying the use of the airplane itself as a weapon. Hijackers need time to get into the cockpit. They need time and fuel and to reach their intended target. A rapid descent to a landing in minimum time lowers the risk to passengers, crew,and persons on the ground.

Note 1 The Black Box, by Ivan Sant’Anna
Note 2 The Heroes of Flight 705, by Dave Hirschman