MANUAL INPUT

UPSET PREVENTION AND RECOVERY DEPENDS UPON A PILOT'S ABILITY TO INITIATE QUICK, DECISIVE, MANUAL ACTION.

BY SCOTT DIERINGER

Imagine yourself in the right seat of a Boeing 737 airliner cockpit. A cabin full of passengers depends on you and the captain to take them safely to their destination. A glance through the windshield during a routine descent reveals a blanket of white clouds underneath you as far as the eye can see.

The day has been uneventful from the moment you woke up, but suddenly your quiet reverie is shattered as you begin to encounter light chop. The turbulence seems to be escalating. The captain turns on the seat belt sign and directs the flight attendants to take their seats. Sudden, unexpectedly heavy turbulence takes you by surprise, and the aircraft rolls. It reaches 45 degrees of bank and the nose begins to fall as the captain deactivates autopilot and initiates aileron and rudder inputs to counter the disturbance. The aircraft does not respond….

This is the scenario confronted by the crew of United Airlines Flight 578, a Boeing 737 bound for Chicago from St. Louis, in December 2001. At this point, the crew was hand-flying an aircraft full of people without the aid of autopilot or automatic power adjustments. In other words, they were relying on manual handling skills that were significantly different from their day-to-day repertoire of manual flying skills.

MANUAL HANDLING

Manual handling skills, according to the International Civil Aviation Organization (ICAO) *Manual on Aeroplane Upset Prevention & Recovery Training*, are appropriate pitch, power, roll, and yaw inputs made to avoid or correct undesired flight path deviations, and to arrest any divergence to avoid, prevent, or recover from an upset. These manual flying skills are the foundation for all piloting skills in the early stages of training, but they are increasingly atrophying in today's age of advanced, highly automated aircraft. Acquiring a vital understanding of the aerodynamic effects that occur beyond the normal flight envelope—and the use of assertive, potentially full-deflection control inputs required in airplane upset situations—are not part of civil training requirements for airline pilots today.

COMPETENCIES

The International Air Transport Association (IATA) recognizes eight core competencies required by today's airline pilot, ranging from communications to leadership. All have direct, transferable application to the type of in-flight upset scenario described above. Although all competency areas have specific considerations in the face of an unanticipated upset event, no competency is as dramatically affected as is the competency of "Aircraft Flight Path Management by Manual Control."

Unfortunately, some of the ways that manual handling skill requirements are influenced by an aircraft upset are counterintuitive, and may not fully make sense to a pilot who has not been in that situation before. This is where a new segment of flight training, which has appeared in the last two decades, comes to the fore. Upset prevention and recovery training (UPRT) is flight training focused on addressing the academic knowledge and practical skills necessary to properly deal with an upset event.

SKILLS AND NEEDS

The table on the following page summarizes critical points as they relate to IATA's "Aircraft Flight Path Management by Manual Control" competency, clearly showing the contribution that UPRT provides in enhancing pilots' ability to safely negotiate a broader range of situations which could result in loss of control of the aircraft.

Simulators are used in concert with in-aircraft training to show pilots crew coordination concepts in upsets, and that the skills learned during UPRT in an aerobatic-capable aircraft are directly transferable to their aircraft or any other. **Mike Reyno Photo**

MANUAL FLIGHT PATH MANAGEMENT	NORMAL AIRLINE OPERATIONS	SKILLS REQUIRED IN AN UPSET EVENT	ENHANCED KNOWLEDGE AND MANUAL HANDLING SKILLS PROVIDED BY UPRT
FLIGHT CONTROL INPUTS	Smooth, progressive, small deflections	Rapid, assertive, up to full deflection	Demonstrates full range of flight control inputs and effects, shows differences and benefits from authoritative control inputs
MANUAL HANDLING (AUTOPILOT NOT ENGAGED)	Rare	Exclusively (unless manufacturer recommends leaving autopilot engaged during an upset)	Identifies limits of automation and allows manual handling practice which increases proficiency and confidence
G (ACCELERATION) MANAGEMENT	Striving for as close to 1 G as possible	Target between 0.5 G up to the aircraft limit load (as required)	Examines the full operational range of aircraft positive G load limits available for flight path management. Includes reduction to less than 1G for a variety of benefits. Dispels dangerous instinctive pilot behaviours such as an inappropriate, instinctive "Pull" response
ENERGY MANAGEMENT	Smooth and precise thrust inputs and changes	Potentially large, rapid, and/or approximate (but measured) inputs	Introduces techniques necessary to quickly decrease, increase, or maintain aircraft energy state dependent on the situation present or developing
AIRPLANE ATTITUDE CONTROL	Typically much less than 45° of bank, 25° of pitch nose high, or 10° nose low	Potentially up to 90° of pitch and 180° of bank (all attitudes possible)	Disconnects common misperceptions between aircraft attitude and other flight characteristics, exposes pilots to full range of flight attitudes that all aircraft can experience
AIRSPEED CONTROL	From V_{ref} approach speed to near maximum speeds of V_{Mo} and M_{MO}	Well below stall speeds to maximum limit or beyond. Sometimes this is an airspeed limit (V_{MO}), sometimes a Mach limit (M_{MO})	Demonstrates differences in aircraft behaviour and stability characteristics present below stall speed. Illustrates differences in acceleration and handling response throughout the full range of airspeeds.
CONTROL FEEDBACK, FEEL, RESPONSIVENESS	Relatively narrow range of control inputs provided when flying manually (autopilot disengaged)	Broad range of flight control responses encountered in dynamic maneuvering situations	Exposure and training in the full range of control inputs which may be required to prevent or recover from unexpected upset encounters

As the chart shows, skills required during *normal airline operations* are significantly different, and in some cases, opposite from, the *skills required in an upset event*. While there may be times when crews practice more abrupt control movements (V1 cuts, nose low unusual attitudes), there are very few times they actually use these inputs. The proficiency gained through comprehensive and focused training specific to the upset environment provides the *enhanced knowledge and manual handling skills provided by UPRT* as a safety net for pilots if they are confronted with an escalating upset event which was not successfully prevented through awareness and avoidance.

UPSET PREVENTION & RECOVERY TRAINING

Recognizing the increased threat of loss of control in-flight accidents (LOC-I), ICAO has made recommendations regarding proper UPRT in a manual on the subject published last year. An integrated UPRT program includes academic instruction on subjects like aerodynamics, stall characteristics, and aircraft performance at high attitudes. Comprehensive UPRT then combines this academic knowledge with in-aircraft flight training in an appropriate aerobatic aircraft. The all-attitude maneuvering capabilities of aerobatic aircraft allow the development of mental models for aircraft behaviours outside of the normal envelope. This practical skill development leads to pattern recognition which can help to prevent developing upsets and, if necessary, promote safe recovery.

As the last component of the UPRT triad recommended by ICAO, flight simulators are then used to practice these newly learned skills in an environment more representative of the professional pilot's normal operating environment than a typical aerobatic-capable aircraft. This shows pilots that the skills learned during UPRT in the aerobatic airplane are directly transferable to their aircraft or any other aircraft.

The crew of United 578 saved their aircraft and all aboard by applying appropriate upset recovery techniques as a team, particularly by doing something that is largely counterintuitive: they *pushed* to increase the effectiveness of their roll control.

DON'T BECOME A STATISTIC

Pilots may meet all regulatory training requirements and be well versed in manual handling skills required of them on a day-to-day basis, but those abilities differ significantly from the skills that are needed in an upset situation.

There is very little time to act in order to prevent or recover from an airplane upset. Consequently, crucial UPRT skills must be learned in advance so they are available if required. To that point, ICAO has recommended that all pilots receive training in UPRT "in actual flight" prior to commercial licensing.

To quote Louis Pasteur, "Chance favours the prepared mind." Regardless of the particular aviation authority, it is accepted by an ever-growing consensus that it is time to enhance the manual handling skills of professional pilots through comprehensive UPRT.

Scott Dieringer is an advanced upset recovery instructor at Aviation Performance Solutions (APS). Expanded versions of Skies articles by APS are available at apstraining.com/skies. Aviation Performance Solutions (APS) specializes in reducing the risk of loss of control in-flight globally through integrated upset prevention and recovery training solutions.

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