

# On Improving Tactical Decision Making

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## Abstract

This is a call for the formation of an industry taskforce to develop methods and products to aid aircrew decision-making during time critical situations. Why do we need better methods and products? Because poor decision making has been listed as the leading causal factor in over 70 percent of aviation accidents for the last 30 years. It is the richest area for improving aviation safety; it is also the toughest challenge in aviation. It is the only area not showing an improvement in aviation safety statistics. Aircraft design, manufacturing and maintenance have improved to the point that mechanical failure in air transport is causal in only 12 percent (1) of current accidents. These figures indicate we are building aircraft better, but not flying them any better.

### We Need Improved Tactical Decision Making now

A recent Flight Safety Foundation study of 76 approach and landing accidents (2) showed the most frequent causal factor to be poor decision making in 74 % of the accidents followed by non-compliance with SOPs at 72 %. Non-compliance with SOPs is also a decision error on the part of the crew, I.E. refused to follow the SOP, choose the incorrect SOP for the situation or was overwhelmed by 20 minutes worth of SOPs with only 10 minutes to live. These causal factor percentages are consistent with other accident findings for the last 30 years and they add up to more than 100% because almost all accidents have several causal factors that eventually break the safety chain.

What is unique about the decision requirements for pilots? Mainly time limitations. You can't park the jet while in-flight; can't get behind; can't spend too much time on any one thing. Multi tasking requires focus and prioritization along the lines of **Aviate, Navigate, Communicate and Manage Aircraft Systems.**

Over the years we have tried to anticipate every possible occurrence and provide a Standard Operations Procedure (SOP) for the best way to handle it. The modern pilot must choose the correct procedure from hundreds of pages of Federal Air Regulations, Flight Operations Policies and the Aircraft Operating Manual. Often these conflict and sometimes there is no exact SOP to fit the current situation, so the crew must

combine portions of one or more to get a flyable solution. Occasionally there is no procedure, but the crew must fly what pieces are left to limit the losses. For example, the United DC-10 with a failed number two engine and no hydraulic power for flight control.

Another unique decision requirement for pilots has to do with reconciling sensory conflicts. Instrument flight relies on symbols that correlate poorly with the natural reference points we use daily to orient ourselves. Instrument flight requires a very disciplined scan with multiple crosschecks to convince the pilot the aircraft is proceeding as intended, despite sometimes conflicting sensory signals. Night flight risks are approximately three times greater than flight in daylight. (3) Flight in IMC and night increases the risk dramatically over flight during day VMC conditions. Constant validation is also required because well-intentioned people can kill you. The ALAR study showed one third of the accident flights had incorrect or inadequate Air Traffic Control instructions, advice or service as causal factors. (4) In addition, either or both pilots can and will make errors. Constant crosscheck is essential!

Some of the following personality traits that are common in most pilots contribute to poor decision-making: Thrill seeker, Competitor, Invulnerable, Egocentric, Over Confident and Impulsive.

*Thrill seeker:* There is a "Need for Speed" among many pilots. They entered aviation for the thrill of flight. There is a huge adrenaline rush when hurtling their bodies at the Earth at high speed and recovering without injury. They are aware of the dangers associated with aviation, but enjoy the challenge of their skills being tested at high risk in the event of failure.

*Competitor:* Most pilots have excellent hand/eye coordination and they engage in many competitive sports. Few pilots can refuse a dare or a race.

*Invulnerable:* Pilots seem to have a low regard for their own safety. They will do things when alone that they would never do if passengers were along. This is borne out by the ALAR study that showed accident

rates to be eight times worse for ferry, repositioning and freight flights than accident rates in the same types of aircraft while carrying passengers. (5) Many people in risky businesses believe, "It will never happen to me." Pilots say, "It only happens to the ham fisted, no talent pilots!" Wisdom comes eventually, if they live long enough.

*Egocentric, Overconfident:* Most good pilots, at least to themselves, believe that they are the greatest. Commercial pilots have been winnowed from many "Wanna be's" and are tested several times per year for skills that few possess. It's natural that they begin to believe their own stuff after a while. The danger comes when they think they are better than they really are.

*Impulsive:* Pilots often yield to the impulsive instinct to go to ground when in danger. The classic example is of the light twin aircraft that loses an engine on takeoff. The aircraft is performing as well as can be expected on the remaining engine, but the pilot begins to worry that it will also fail in the next few minutes. Under these circumstances there are many examples of rushed approaches, overshot final turns, stalls and spins into the ground. It is why there are more fatal accidents with twins than single engine aircraft after an engine failure. Another reason is because of the simplicity of the decision making for the pilot of the single engine aircraft. The single engine pilot already knows there is going to be a crash, so attention is focused on maintaining control to limit losses.

Most current pilot decision making is based on Personal Experience, Hangar Flying, Simulator Training and SOPs. They have their good points and limitations.

*Personal Experience:* You will never live long enough to learn everything personally. Most procedures have blood behind them. Other pilots have illustrated hard lessons at the cost of their lives. Pilots must learn from the experience of others through aviation safety data sharing.

*Hangar Flying:* There is often as much knowledge shared through informal hangar flying as there is in structured education programs. All good pilots engage in, "What if" scenarios and learn from them.

**Simulator Training:** Excellent training can be experienced in the simulator in regimes that would be too risky for flight training. It provides "Pattern Recognition Primed Decision Making", but most current simulator sessions after checkout consists of a

repeat of the rating ride. Few new lessons are imparted during recurrent training and checking.

*SOPs:* You have all heard, "I'm a by the book kind of guy!" "If the SOP says it, I'm gonna do it even if it doesn't seem to make sense!" He will be right most of the time, but it indicates an inability to make decisions based on guidance not totally applicable to the situation.

There are some poor decision models currently being taught to pilots based on business decision models, acronyms and decision trees. Doctor Judith Orasonu, a NASA researcher who has participated in many pilot decision making studies says of these models, "Normative models are convenient, but inappropriate to the dynamic, time-pressured, knowledge based reasoning in the cockpit." What the Doctor said was, "Pilots don't use those methods, because there isn't enough time in-flight."

Some of the more effective decision training methods are listed below.

The FAA Advisory Circular (AC 61-22) "**Aeronautical Decision Making**" is a self test to determine bad attitudes and refers to the best ways to counter some of the pilot's hazardous tendencies as outlined in the personality characteristics we listed above.

**"Pattern Recognition Primed Decision Making,"** by Dr. Gary Klein. An example; the pilot notes on final approach that the airspeed has increased rapidly, the power is at idle and the descent rate has stopped. From prior simulator training he/she recognized the symptoms of a microburst outflow boundary and elects to make a maximum power escape maneuver.

**"SPOT,"** (Special Purpose Operational Training). The SPOT simulator setup starts with the aircraft frozen. The instructor briefs conditions until the crew is caught up with the ship. The simulator is released and soon thereafter a "Flight into volcanic ash," or "Blocked pitot static system," or "Complete AC buss failure" or "Uncontained fire in the fuselage" scenario is introduced. The instructor makes no comments until the aircraft crashes or the problem is solved. A discussion ensues, "What did you do right?" "What did you do wrong?" "Knowing what you know now that you didn't know then, would you like to try it again from, (various snapshots the instructor took during the exercise)?" This is simulation with high stress caused by high risk, heavy workload, conflicting information and minimum time to react. It emphasizes the priorities of, **Aviate, Navigate, Communicate and**

**Manage aircraft systems.** It requires a focus on what is essential now and what must wait. It builds true teamwork. "You fly, descend to -- go direct to --." 74% of the ALAR study accidents had the Captains flying! (6) It seems unlikely that the Captains suddenly become less capable after promotion, so there must be a failure in our system to teach effective flight management. SPOT LOFTs are a rich training method for improving flight management.

"*Naturalistic Decision Making*" is enhanced by training in high threat, high workload situations such as those outlined above in the SPOT scenarios. During the war over North Vietnam it was discovered that 50 percent of the losses occurred during the first 15 missions up North. If the crews could survive the first 15 the odds were they could survive the next 85 missions. To introduce the crews to the high threat, high workload and confusion that went on during combat in that arena, the Air Force introduced "Red Flag" training in Nevada. The loss rate improved dramatically along with effectiveness once the crews had been introduced to situations requiring good tactical decisions. An intensive debrief of every action and decision illustrated what worked and what didn't in combat.

SOPs are the right way most of the time. To be effective, SOPs must be clear, concise and free of conflict with the corporate goals which should be prioritized as; "Safety, Passenger Convenience and On Time Arrival."

"*What if*" is planning for the worst-case scenario. All good pilots do this. The pilot not flying mentally flies the aircraft also. The PNF thinks ahead of the aircraft and consults the PF when some action is overdue or he/she thinks of something that could affect the current situation. The crews talk and make plans for contingencies.

What are the characteristics of expert decision making? Dr. Rich Adams of the Florida Institute of Technology has produced decision making models for the Crop Dusting Industry and advises the FAA on Aeronautical Decision Making. He has defined the elements of expert decision making below.

These are seven distinguishing characteristics of expert decision making that have been identified in many fields of expertise. They have particular importance in exploring how pilots use their knowledge, training and experience to overcome adversities in everyday flight.

- Experts have the ability to perceive large meaningful patterns due to the organization of their knowledge base. This organization is based upon experience and training. The pattern recognition and recall occurs so rapidly that it takes on the appearance of insight or intuition.
- Elaborations, associations and inferences expedite long-term memory recall. Automatic information processing frees up working memory.
- The knowledge of experts is highly procedural and goal oriented. Concepts are bound to procedures for their applications and to situations under which those procedures are useful.
- Experts can solve problems quickly for three reasons. They are faster at skill based tasks. The faster skill performance frees-up working memory for processing other aspects of the problem. They can arrive at a solution without conducting extensive search of memory.
- Experts are both routine and adaptive decision-makers. Either type is fast, accurate and nearly automatic. Experts possess the adaptive ability to creatively respond and develop solutions to knowledge lean or ambiguous situations.
- Experts develop the capability to revise procedures and to simultaneously access multiple possible interpretations of a situation. The development of this capability is influenced by task demands and experience.
- The greater the knowledge bases and different knowledge associations allow experts more time to predict problem difficulty on the basis of underlying principles and more time to monitor accurately how they should allocate their time for solving problems.

Dr. Adams showed us how to recognize expert decision-makers. Our challenge is to teach our pilots to become experts. How can we do it? I suggest the following:

- Form an industry taskforce comprised of members of academia, research, unions, regulators, manufacturers of airframes and avionics, along with air carrier operations and training. The Flight Safety Foundation used this concept very successfully to study Controlled Flight Into Terrain and Approach and Landing Accident Reduction. The Taskforce approach resulted in several products that have been accepted by the industry as “Best Practices” to improve aviation safety. The CFIT/ALAR Taskforce has also provided us with a sound database describing "**WHAT**" contributes to accidents.
- The taskforce charter is to find out "**WHY**" dedicated, experienced and normally conservative crews make disastrous decisions. There are no pilots who wake up in the morning and say, "Today I think I'll violate several SOPs, kill myself and all my passengers!" and yet they sometimes do. Aircrew survivors of accidents asked to explain why they made the decisions that led to the accident almost always say, "I don't know. It seemed like the best plan based on the information we had at the time."
- The next charter is to find out "**HOW**" to provide better information to the crews to allow them to make better decisions. The crew is exposed to hundreds of rules, SOPs and instructions. There are reams of data, but what they need is timely, valid information to aid them in decision making.
- "**WHEN**" we find out "**HOW**," the ultimate charter is to improve tactical decision making in all phases of training and checking. It could be as simple as combining aids or portions of current decision aids that provide sound information to the crews. Examples are:
  - Clear, concise SOPs,
  - AC 61-22 “Aeronautical Decision Making” (ADM),
  - “Pattern Recognition Primed Decision Making” or
  - SPOT simulator training for better “Naturalistic Decision Making.”
- Better avionics could provide timely information regarding aircraft position, attitude, energy state, current winds affecting the aircraft and stopping ability on contaminated runways. Better information yields better decisions.
- Decision making could be improved by operationally limiting the automatic modes of descent, climb, approach and go-around to one mode that is best for cockpit standardization. 74 percent of the accident flights were flown by the Captain, which indicates there was poor cockpit situational awareness. If there are five automatic ways of doing every maneuver, the Copilot has no way of knowing which mode or action the Captain will use next. This effectively prevents mentally flying ahead of the aircraft. The Copilot must wait to be told what the Captain is doing or wishes to be done. If the Captain becomes overloaded and misses something essential, the Copilot will seldom catch it under those conditions. “Keep It Simple Stupid” is an old tried and true method to improve decision-making and should be applied to automation use unless there is some benefit to using multiple modes that override the benefits of simplicity and standardization.

These are some of the things that come to mind to improve Tactical Decision Making, but we may find entirely new ways to meet our goals. In any case there is an urgent need to create expert decision making pilots to assure continued improvement in aviation safety.

References:

1. Boeing Safety Staff
2. Flight Safety Foundation Flight Safety Digest, “Killers in Aviation” PG 34
3. “Killers” PG 4
4. “Killers” PG 34
5. “Killers” PG 4
6. “Killers” PG 34