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HISTORY OF FLIGHT On September 9, 2002, approximately 1330 Pacific daylight time, a privately owned Cessna 175B airplane, N8195T, was substantially damaged when it impacted terrain following a loss of control while maneuvering at low altitude, after engine power was reportedly lost during initial climb after takeoff from the Arlington Municipal Airport, Arlington, Washington. The commercial pilot-in-command, who was the airplane's registered owner, was fatally injured in the crash. Three passengers (reportedly an employee of the Snohomish County, Washington, Surface Water Management Division, an AmeriCorps intern with the Snohomish Conservation District, and the city of Arlington's natural resources manager) were aboard the aircraft at the time of the accident. Two of the passengers (the intern and the city natural resources manager) were seriously injured in the accident, and one passenger (the county employee) received minor injuries.

The accident flight was operated by the pilot/aircraft owner, who was a volunteer pilot for LightHawk (a nonprofit environmental advocacy group based in Lander, Wyoming), and was coordinated by LightHawk. The reported purpose of the accident flight was to conduct an aerial survey of local watersheds in relation to salmon recovery issues. Visual meteorological conditions, with winds from 210 degrees true at 7 knots, were reported at Arlington at 1335, and no flight plan had been filed for the local 14 CFR 91 aerial observation flight. At 1232 on the day of the accident, the pilot departed Olympia, Washington, in order to fly to Arlington to pick up the aforementioned passengers.

The right rear seated passenger reported that shortly after takeoff she heard the pilot state, "Oh, oh, this doesn't look good," followed by the aircraft making a right turn. She did not recall any further events after this point.

The front right seat passenger stated that when the aircraft attained an altitude of about 200 to 300 feet, "the engine simply wound down. I heard no sputtering or backfiring." The passenger heard the pilot say, "Oh no, this isn't good." The passenger noticed no attempt by the pilot to re-start the engine, and thought that the right turn was made to turn back to the airport. During the turn, the aircraft dropped and hit the ground.

Witnesses reported to local police that they heard the aircraft's engine "popping" or "missing" shortly after takeoff from runway 16. They reported that at an altitude of approximately 200 to 300 feet above ground level, the aircraft began a sharp right turn, and that the aircraft then appeared to stall out of the right turn and impacted the ground in a steep right bank and nose-down attitude on the west side of runway 11-29.

PERSONNEL INFORMATION At the time of the accident, the pilot held a commercial certificate for airplane single and multi-engine land and an instrument

rating. The pilot's flight logbook was not located, however, during his last Federal Aviation Administration medical examination for a class three certificate dated December 21, 2000, he reported a total flight time of 1,845 hours, with 200 hours in the preceding six months. At the time of the December 21, 2000, medical examination, the pilot reported that he was not using any medications (prescription or nonprescription), and no serious medical conditions were identified.

AIRCRAFT INFORMATION The individual who refueled the aircraft at Pearson Air in Olympia, Washington, reported that between 1200 and 1230 on the day of the accident, he filled the accident aircraft's fuel tanks to the top. According to the aircraft maintenance logbook, the aircraft received its last annual inspection on May 10, 2002, at 3,558.11 hours aircraft total time. Comparison of the recording tachometer hours entered with the log entry for this inspection with the recording tachometer hours noted in the wreckage indicated that the airplane had flown 51.59 hours since the last annual inspection. The accident aircraft, which had a 175-HP Continental GO-300 series engine installed at original manufacture in 1960, had been modified by installation of a 180-HP Lycoming O-360-A1D engine. The engine log indicated that this engine was installed new on the accident aircraft during the 1966-1967 time frame in accordance with Supplemental Type Certificate (STC) number SA3-674. A January 27, 1978, engine log entry indicated that at 856.23 hours engine total time, the aircraft's propeller was exchanged for a newly overhauled one with new blades, and the engine underwent a major overhaul. The engine had accumulated 1,889.65 hours since the major overhaul at the time of the May 10, 2002, annual inspection, and (per the tachometer hours indicated in the aircraft wreckage) 1,941.24 hours since major overhaul at the time of the accident. Textron Lycoming Service Instruction No. 1009AQ gives the manufacturer's recommended time between overhauls (TBO) for this engine as 2,000 hours. According to the aircraft owner's manual, the aircraft's fuel system consists of two 26-gallon fuel tanks (one in each wing), of which 21 gallons in each tank is usable in all flight attitudes. An additional 4.5 gallons in each tank is usable during level flight only, and 1/2 gallon in each tank is unusable.

WRECKAGE AND IMPACT INFORMATION The aircraft came to rest inverted on the airport property, just west of the runway 11-29 pavement and approximately abeam the top visual approach slope indicator (VASI) light bar. Local police reported that a fire that broke out in the aircraft after impact was extinguished by individuals who responded to the accident site with hand-held fire extinguishers. The initial ground disturbance, located about 30 feet west of the runway edge, found buried in the soil was the right wing tip green lens cap. The magnetic bearing from this point to the resting point of the main wreckage was 290 degrees. The total distance from the point of initial impact to the main wreckage was 102 feet. Approximately 30 feet into the path, an area of significant ground disturbance was noted followed by lesser degrees of ground disturbances leading up to the main wreckage. The aircraft came to rest inverted

with the nose of the aircraft pointing back along the wreckage distribution path. NTSB and FAA investigators responded to the accident scene and performed an on-scene examination on September 9, 2002.

During the on-scene examination, the aircraft was righted by towing equipment and the fuel quantity in both tanks was visually checked after the aircraft was righted. During the righting process, fuel was observed leaking out of the left tank with the aircraft in a left-wing-low attitude (note: the two wing tanks are interconnected by a vent line.) Upon righting, a small quantity of blue fuel (approximately 1/2 to 1 inch deep in the bottom of the tank) was observed in the left tank, and no fuel was observed in the right tank. An individual who reported that he turned the aircraft's fuel selector to BOTH OFF at the accident scene at the request of the fire department reported to the NTSB that at the time he shut it off, he noted the fuel selector in the BOTH ON position (a setting that enables fuel feed from both tanks simultaneously). Following the aircraft's removal from the accident scene, investigators from the NTSB, FAA, Cessna Aircraft Company, Lycoming Engines, and Precision Airmotive Corporation (manufacturer of the engine's carburetor) performed a detailed wreckage examination at the Arlington airport on September 10, 2002.

MEDICAL AND PATHOLOGICAL INFORMATION The Snohomish County Medical Examiner's Autopsy Report for the pilot indicated that, "The cause of death of this 61 year old male is arteriosclerotic cardiovascular disease. Disseminated prostate cancer and positional asphyxia were contributory factors. …He was noted to be wedged in his plane … for an extended period of time." Toxicological samples were sent to the Federal Aviation Administration Civil Aeromedical Institute for analysis. The results of the analysis reported: No Carbon Monoxide or Cyanide were detected in blood. No Ethanol was detected in urine. 0.051 (ug/ml, ug/g) Hydrocodone was detected in blood. 2.032 (ug/ml, ug/g) Hydrocodone was detected in urine. 0.744 (ug/ml, ug/g) Hydromorphone was detected in urine. 0.022 (ug/ml, ug/g) Dihydrocodeine was detected in blood. 0.499 (ug/ml, ug/g) Dihydrocodeine was detected in urine. 0.07 (ug/ml, ug/g) Diphenhydramine was detected in blood. Diphenhydramine was present in urine. 147.9 (ug/ml, ug/g) Acetaminophen was detected in urine. 61.23 (ug/ml, ug/g) Salicylate was detected in urine. Hydrocodone is a prescription narcotic painkiller, used for the control of moderate to severe pain. Dihydrocodeine and Hydromorphone are active metabolites of Hydrocodone. Diphenhydramine (commonly known by the trade name Benadryl) is an over-the-counter antihistamine. Acetaminophen is a common pain reliever/fever reducer, often known by the trade name Tylenol. Salicylate is the active form of aspirin.

In a post-accident telephone interview with the NTSB, the pilot's wife reported that he had been diagnosed with prostate cancer in 1995, and at that time underwent cryosurgery followed by other non-invasive therapies. She further stated that in 1998 cancer was discovered in his lymph system, and that about a year prior to the accident he was diagnosed with bone cancer. Additionally, she

said that he had experienced life-long headaches, and had been put on Vioxx a couple of months before the accident. She reported that he used medications and participated in a daily one-on-one session with a Psychoneuro Immunologist for the purpose of dealing with the pain generated by the presence of the bone cancer, and as part of curative process. The autopsy confirmed the presence of cancer in the pilot's lymph nodes and large tumors involving the pilot's ribs.

Combating Unexpectedness

Flight instruction and training

Flight instructors must recognize what is happening internally with students and either reinforce positive reaction strategies and attitudes, or identify where restricted thinking exists in order to optimize the students' capabilities. Flight instruction should emphasize the following:

- Realistic scenario-based training.
- Recognizing and responding to ill-defined events.
- The inability to train for all possible surprising situations.
- Integration of thinking skills and emotional control, with the requisite "stick-and-rudder" skills necessary to successfully perceive, process and respond to any unexpected situation.
- If necessary, use maximum available flight control inputs and power. Employ alternate control strategies as required.
- Modify know procedures to novel situations.

Mental processes for maintaining situational awareness

The following mental processes should be considered during training and continuously revisited during flight operations:

- Reflexive — The reflexive process is purely instinctive, involving automatic reactions learned by the pilot.
- Reflective — The reflective process is a conscious, systematic thought process aimed at problem solving.
- Repeated reviewing — The repeated reviewing process involves intelligence gathering in which the pilot looks for changes in the flight environment that might affect the safety of the flight.

Improving judgement

Poor planning leads to poor judgement. Lack of familiarity with the airplane, the flight environment, operating procedures, the route of flight and the destination

airport can contribute to bad decisions.

- By deliberately seeking all available information in flight and during preflight planning, potential surprises may be discovered and remedied before they lead to unmanageable unexpected events.
- Continually evaluate the unfolding situation by consciously thinking and communicating about the condition of the environment, the aircraft, the pilots and the interactions occurring. Practice monitoring thoughts and actions by asking, *"What am I focusing on now; what is the state of the situation (e.g., aircraft attitude, flight path, altitude, velocity)?"*
- Continuously ask, *"What if?"* What should be done in the event of a flight control malfunction? What should be done during a dual engine failure? What if … ?

Airmanship attitude

Maintain *cognitive flexibility*, which is keeping an open mind to alternatives and possibilities at all times. Approach flying with an appropriate attitude (mental, physical and social) so that when you are faced with a surprising event, solutions become more apparent. Being cognitively flexible helps to counteract fixation tendencies and enhances your ability to handle unexpected events.

Threat and Error Management: a primer

- OCTOBER 24, 2012 10:36 AM BRENT OWENS+ 14 COMMENTS

Threat and Error Management (TEM) is not a term you hear much in general aviation circles, but it is widely adopted among airlines and is taking hold in corporate operators as well.

I am exposed to TEM through my employer who does Part 121 training under-pinned with the Threat and Error Management philosophy.

TEM is the brainchild of human factors researchers from the University of Texas and in a way it is not new, it is rather a modernized form of risk mitigation that accounts for the human(s) that are in the loop. With so many accidents attributed to pilot error and with modern airplane reliability it makes sense that we focus on the human part of the equation.

According to Dr. Helmreich: "The easiest way to understand Threat and Error Management is to liken it to defensive driving for motorists. The purpose of defensive driving is not to teach people how to drive a vehicle (e.g., how to shift a manual transmission) but to emphasize driving techniques that people can use to minimize safety risks (e.g., techniques to control rear-wheel skids). Similarly, TEM does not teach pilots how to technically fly an airplane; instead, it promotes a proactive philosophy and provides techniques for maximizing safety margins despite the complexity of one's flying environment. In this sense, TEM training can be framed as defensive driving for pilots."

This diagram illustrates what Threat and Error Management is and what it is trying to achieve.

Threats

Threats are anything that alone, or combined with something else, can have an adverse effect on the outcome of the flight. Threats occur outside the influence of the pilot, like weather, terrain, a complex procedure, or an aircraft malfunction. Threats require your attention and management if safety is to be maintained.

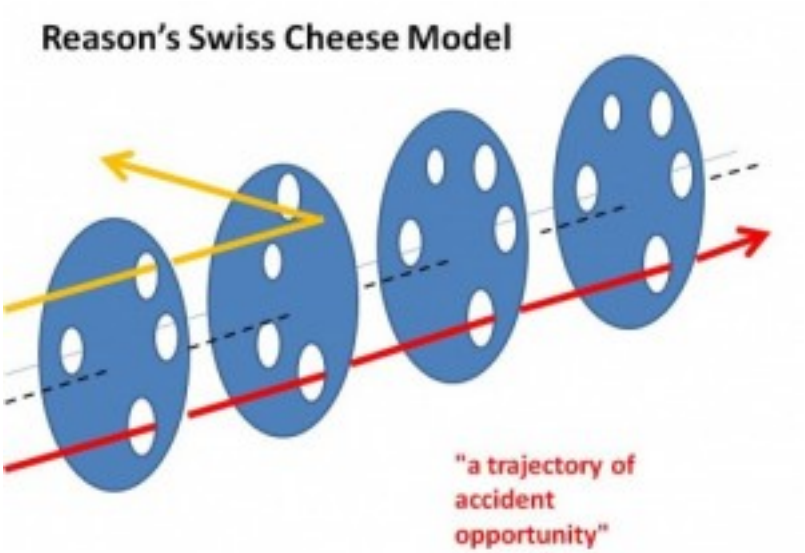
Errors

Errors are pilot actions or inactions that lead to a deviation of some kind. You are likely familiar with the myriad of pilot errors that occur.

TEM accepts that human error *will* occur — this is a shift from previous airline safety dogma. And you can see this in the amount of human factors engineering being used by manufacturers, operators, and training organizations that have adopted these techniques.

Undesired Aircraft State

In simple terms, the goal is to avoid an Undesired Aircraft State. Keep the airplane's vertical and horizontal flight path under our control and safe at all times.



The famous Reason model describes the error chain with a Swiss cheese illustration.

The Reason's Model

Physiologist James T. Reason's 1990 Swiss cheese model is a famous threat/error chain illustration. If the issue is allowed to get through all the barriers the outcome is usually not good. The idea is to place more barriers, and with fewer holes, in front of the problem.

How can it help me?

In an airline environment TEM involves scenario-based simulator training, Crew Resource Management, specialized line-checks, and incident reporting; none of which we have in our flying. Although it is not specifically designed for general aviation, there are certainly things we can do to apply it to our everyday flying.

TEM Philosophy

So you try to do everything right and something still goes wrong — now what?

There are three basic concepts you need to adopt: *anticipation, recognition, and recovery*.

- Anticipation: Staying alert, knowing that you can't possible predict everything that can go wrong. Maintaining a state of vigilance and avoiding complacency.
- Recognition: The sooner you recognize that something is not right, the faster you can act to mitigate that threat or error. Early recognition obviously aids recovery.
- Recovery: This is you intervening in what will soon become, or has already become, an undesired aircraft state.

Threat and Error Management is an ongoing process.

Here's a short list of techniques you are probably already using today.

Threat Management Techniques:

- Personal weather minimums
- Self-imposed proficiency requirements
- Proper aircraft maintenance
- Severe weather avoidance

Error Management Techniques:

Checklist discipline
Proper use of automation
Managing your resources (ground or flight)
Fatigue recognition
Distraction mitigation

Although we didn't dive deep into the details of Threat and Error Management, this article should provide an adequate introduction and hopefully provoke some thought about risk management in your flying.

Vintage Airplane Magazine Oct. 2006

BEST GLIDE

I was in a pilot briefing room, one dark grey day, getting the weather from the WSI station when I overheard the following conversation between an elderly gentleman and a young man who appeared to be in his twenties. The grey haired fellow was saying: "… but what about 'best loiter' speed? Wouldn't we want to use that speed in a glide, once we had our landing site below us?"

The young man replied: "No! There is only one speed to use once the engine has failed and that is the 'best glide speed' as published in the POH. That glide speed is also known as the 'best Lift over Drag (L/D) speed'. It is that speed alone that will give you the best glide performance because that is where the two curves for parasite drag and induced drag intersect."

I was eager to hear the response to that. Whereas the term "best loiter" speed was a new one to me, I certainly was well familiar with the term "minimum sink speed" that every glider pilot is intimately acquainted with. The greybeard's response was: "Well yes, best L/D speed will give you the greatest distance covered in a glide, but once we are overhead our chosen landing site, wouldn't we be more concerned with a maximum time aloft to allow us to set up for our pattern and landing?"

The young man was adamant. "No! There is only one glide speed to use, and that is, as I said, the best L/D speed as published in the POH." As I looked at these two folks and took in their animated discussion I noticed that the younger man was wearing a shirt identifying him as an instructor with the local flight school. I must admit that I was taken aback. I had surely thought that the elderly gentleman was the instructor who was trying to lead his client, through a Socratic method, to a better understanding of the subtleties of what to do when the engine quits and the airplane suddenly turns into a glider.

Unfortunately there are many pilots, instructors included, who do not have a thorough understanding of what airspeeds to use in a glide. Certainly " best glide speed" is a very important one to be familiar with. This is indeed the airspeed where the resultant penalties of both induced drag, a by product of lift, and parasite drag, simply stated, the drag resulting from things in the way of the airflow around the aircraft, are equal.

This airspeed is typically found in the POH for the aircraft. But for those of us flying older aircraft that don't have a POH (and might not even have much of an operator's handbook either, for that matter) a published source of this airspeed might not exist. If that is the case, then using the "best rate of climb" speed (Vy) for your aircraft as your best glide speed will certainly have you very close to your best L/D speed.

We would most definitely use this airspeed if the engine has ceased to function while we are at altitude, and have some distance to cover as we glide to a suitable landing site. It is the glide speed that will allow us to maximize the distance covered in a glide. Let us also remember that even if we have that speed published in a POH

or owners manual, that speed, as published, is determined for use when at maximum gross weight.

Seeing as how too many of the engine failures that pilots experience come as a result of poor fuel management, it is certainly reasonable to think that the aircraft will weigh less than the certified max gross weight when the engine stops working. Keeping this in mind, remember to reduce that glide speed somewhat, to compensate for the lessened weight.

But let us now say that by utilizing the best L/D speed to maximize our glide, relative to distance, we now find ourselves overhead a chosen landing site with plenty of altitude left to lose, do we still want to maintain that same speed? This is the question the elderly gentleman at the start of this article had been posing. If distance to cover is no longer an issue, wouldn't our ability to maximize our time in the air, relative to altitude, be of greatest concern?

Glider pilots are very conversant with this speed as they seek to maximize their time in a thermal, and they refer to it as "minimum sink speed". Unfortunately it is a speed that we power pilots will probably never see in our POHs. (At least I have yet to see it there.) A good way to approximate that speed is to multiply the "clean" stall speed (Vs1) by 1.2. This should afford most pilots their best "minimum sink speed', maximizing their time aloft.

Let's also consider some of the other things that we can do to maximize (or for that matter minimize, if we find ourselves too high) our glide. Certainly our configuration will have a major effect on glide performance. Flaps (oops, I guess that leaves my Super Cruiser out) as well as gear (if you have a retractable gear airplane) can be used to control our descent rate. Certainly "getting dirty" will allow us to descend much more rapidly, if we find ourselves high. (In fact my Cardinal RG will rival a grand piano in it's glide once the flaps are fully deployed and the gear is down.)

However if we find ourselves getting low on our final approach in the engine silent mode, saving the flap deployment to the last possible moment can quite often afford a balloon up of anywhere from ten to thirty feet. If we have already deployed our flaps, either fully, or for that matter, partially, and realize we might be coming up short, then cleaning up the flaps, although initially yielding a sink, will allow us to accelerate and perhaps make the field. This would be similar to the way a glider pilot might work their spoilers and speed brakes while on final approach. We can do the same with our flaps.

I have often had pilots ask me about bringing the propeller to a stop to help in maximizing the glide. It is absolutely true that if we can stop the propeller we will get a significant reduction in drag, which will aid in maximizing the glide. But let's remember that in order to get the prop to stop we are going to have to slow down significantly, typically to an airspeed of less than 60 knots. To do this we will obviously need to pitch up, which will gain us some altitude. But it also means that

we might be flirting awfully close to our stall speed, and if we inadvertently stall as we endeavor to stop the prop, the altitude we loose as we recover from that stall will far outweigh any advantages we might have gained from stopping the prop. Therefore my advice is to not bother trying to stop the propeller unless you are really, **really** high, and you are positive you can't get the engine restarted.

While we are speaking of propellers, there are some things to consider, relative to maximizing our glide, if we have a constant speed, or controllable pitch propeller. When everything gets real quiet and we are at altitude, pulling the propeller control all the way aft, moving the propeller into course pitch, will add significantly to the distance we will cover in a glide, as the drag of the spinning propeller disc is reduced in course pitch. This advice is often found in the aircraft POH.

But that is as far as the POH goes. I have some other advice to offer. If I find myself in glider mode at altitude I will indeed pull my prop to course pitch, but once I find myself over my chosen landing spot I will put the propeller back into flat pitch (by moving the prop control all the way in). I consider this as akin to putting money in the bank. What I mean by this is that if I find myself coming up short on final approach, as a result of the increased drag that the now extended gear has created, I can now pull the prop control all the way out. As the propeller now "shifts" to course pitch the airplane will get "sucked" ahead to the runway.

I would like to discuss one more thing, relative to flying the traffic pattern when our airplane has become a glider. When flying with the engine running, we certainly endeavor to plan our turn from the base leg to final so that the airplane intercepts the extended runway centerline at the completion of our turn. It is what we have been striving to do from the day we began learning to land. Now obviously if we realize that we won't make it to the runway if we continue to the extended centerline on the base leg and the engine has ceased working, we turn towards the runway as soon as that realization hits home.

But what about when we find ourselves high, on the base leg? Certainly getting as dirty as we can both with flaps and gear will help. We can also forward slip to loose altitude. But so often I see pilots turn final as they approach the extended runway centerline even when they are way too high. What says we have to do that? (All our prior training and conditioning is what..) Instead, if you find yourself high, continue on through the centerline, and turn back when and as necessary to get yourself on the proper glide slope to your intended touch down point.

Remember, we have to use all the possible tools and techniques we have to get ourselves to a chosen landing site once the engine has stopped working. Regardless of whether it's a dark and grey day, or we have… blue skies and tailwinds.

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Editorial

by Tzvetomir Blajev

"Can training and everyday practice with normal operations provide the skills and knowledge to deal with the unexpected, unfamiliar, and very often never-experienced-before, situations? Surprising situations do happen to us. They sometimes trigger a physiological reaction known as the startle response. This is a knee-jerk and instinctive reaction to a sudden, unexpected external stimulus like someone firing a gun behind us when we were not expecting it.

The startle reflex normally triggers within 100 milliseconds of the stimulus, it is pre-emotional and contains physiological and subjective dimensions. The subjective dimension is very similar to fear or anger. Startle prompts an increase in the speed of your reaction and helps to focus attention. The reaction is autonomic for at least the first 1-3 seconds but may continue for as much as 20 seconds in extreme circumstances. In the jungle this is the fight-or-flight response when encountering something unexpected. And unexpected in the jungle is rarely good. Even if it is good, it is better to err on the safe side. Pure survival!

Coming back to modern times – pilots and controllers are sometimes confronted with rapid-onset, dynamically developing situations with different, sometimes opposing, strategies available. How should the situation be assessed to find the best strategy in a blink of an eye? And at the same time coping, potentially, with impulses for autonomic, startle-triggered, reactions.

Let us take as an example the situation where the stall protection system of an aircraft has been activated. In the past pilots flying multi crew public transport aircraft were generally advised that their response to such a warning should only involve the minimum reduction in aircraft attitude needed to recover from the ‘edge’ of the fully stalled condition. This advice implied that the loss of aircraft

altitude resulting from the recommended response should be minimised. Thus implication soon became a widely accepted objective in its own right. The important strategy to recover became obscured by a secondary consideration. The result was that pilots who did not understand the aerodynamics of the stall simply responded to this rare event in a way that failed to restore a normal flight condition. What is really important is that if an initial response is not effective, the result may be a much more difficult situation which in some flight conditions can follow very fast.

Do you believe that we in ATC never encounter similar situations? Really? Think about the example in the case study of this edition of HindSight. On initial contact with the crew there is an indication of '*fuel at minimum*'. What should the Controller do first? Give the requested '*direct to the destination*', ask if the crew wish to declare an emergency or first coordinate with the adjacent ATC centre? The Controller elected to immediately give a direct route and this, in hindsight, may have helped to save the lives of the people in the aeroplane.

Knowing in hindsight what happened and what would have been the best decision(s) is very easy, but how do we know this when the decision is still to be taken? More than one option may seem credible and there may not be enough time to analyse them. Hindsight bias is one of those features of human thinking that delivers results which are different from those we can get if we analyse the situation with the help of statistics. The idea of 'hindsight bias', which also inspired the name of our magazine, was formulated by two scientists in the 1970s – Amos Tverski and Daniel Kahneman.

A few months ago, Kahneman published another book [1] which I would like to spend some time discussing from the perspective of our current theme. In his new book Kahneman describes our thinking process as consisting of two systems – System 1 and System 2. System 1 thinks fast, is unconscious, intuitive and effort-free. System 2 thinks slow, is conscious and analytical. System 1 recognises patterns in a fraction of a second, and '*automatically produces an adequate solution to the challenges*'. System 2 is systematic but tires easily; therefore it usually accepts what the fast System 1 tells it.

These systems are not actually two distinctive agents in our head. Not really, says Kahneman. Rather, they are "useful fictions" – useful because they help explain the traits of the human mind.

One may think System 2 is in charge, but the reality is that System 1 is the boss most of the time. This is for good reasons, because System 1 is for the most part very good at what it does; it is very sensitive to subtle environmental cues and signs of danger. It kept our ancient ancestors alive. There is simply too much going on around us for System 2 to analyse everything in depth.

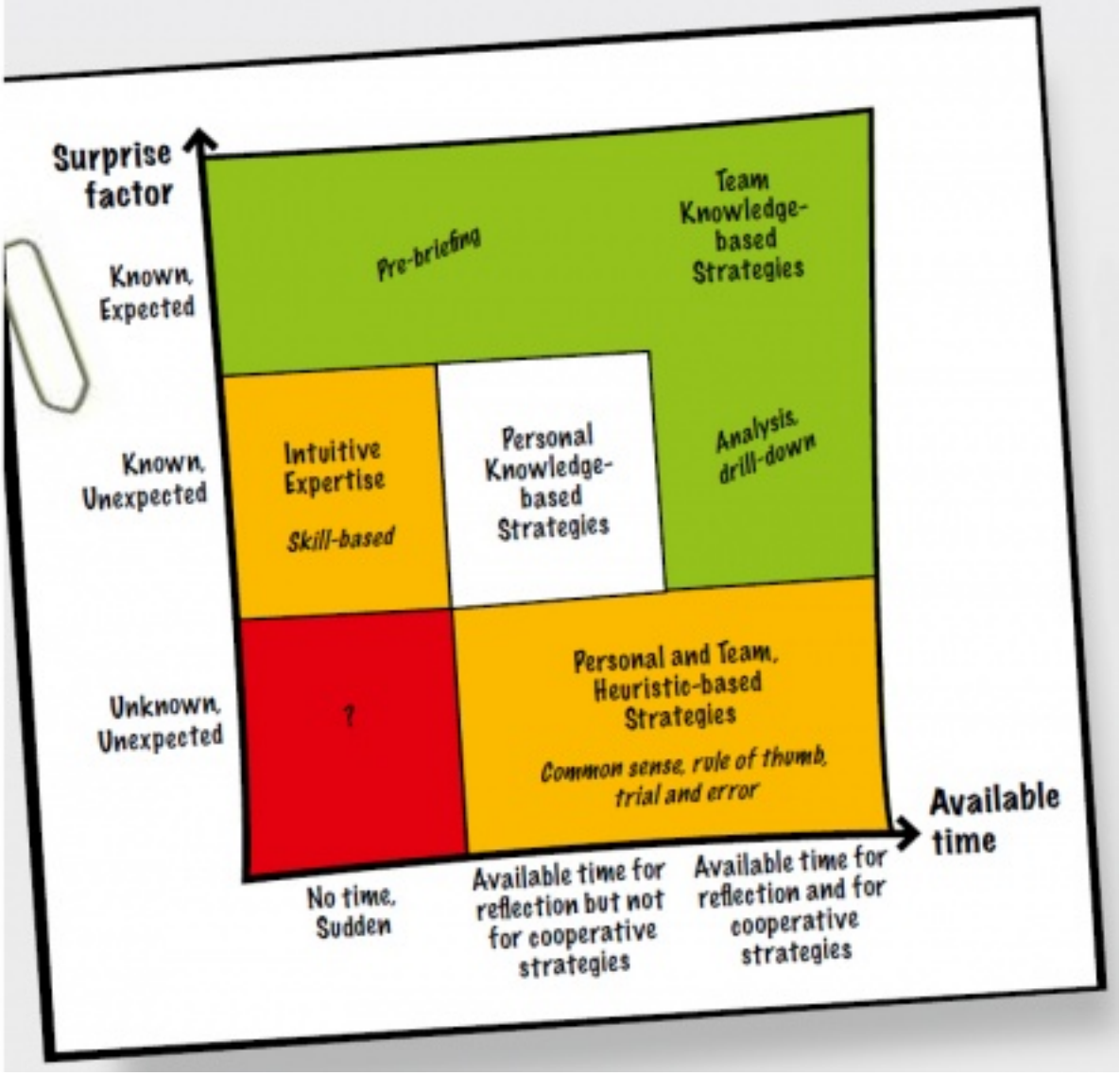
Another benefit of System 1 is the '*expert intuition*' which comes from experience. Expert intuition can be learnt by prolonged exposure to situations that are "*sufficiently regular to be predictable*", and provided quick feedback is given to

the expert on whether he did the right or the wrong thing. This is how experts develop their unconscious"*pattern recognition*" mechanism to get the right answer quickly. A trained expert (Kahneman gives as an example a fire fighter) can unconsciously, and almost immediately, produce the right response to complex emergencies.

All the marvels of System 1 come at a price. The high speed is paid for. System 1 works in an oversimplified world, it assumes WYSIATI ("*what you see is all there is*"), and it has no doubt whatsoever in its thinking process. System 1 is notoriously bad at the sort of statistical thinking often required for good decisions, it jumps easily to conclusions and it is subject to various irrational biases, including the already mentioned hindsight bias. Speed is achieved at the expense of precision. System 1 is "quick and dirty". We do not want our reaction in aviation emergency situations to be like this, do we?

But System 1 does well most of the time; it is because of System 1 that we have our (good) performance and intuitive expertise. Not relying on it will deny us all the benefits as well. Kahneman implies that knowing the fallacy of our behaviour won't help a lot to overcome it. It helps if more then one person is involved and they cooperate. Because it is easier to recognise someone else's errors than our own, working in a trained team, with ongoing feedback mechanisms, is part of the ideal solution.

System 1 is always working, but the situations that happen to us occur with varying degrees of surprise for it. Similarly, the amount of time available for our System 2 to take over from System 1 and analyse in-depth the issue before making a decision varies. I was thinking how to map graphically the distinctive situations, which are associated by the different combinations of surprise for System 1 and available time for System 2.



I have attempted to visually represent the diversity of these combinations above. There are situations, represented in green, where there is either sufficient time for the crew to adopt knowledge-based strategies or which can be reasonably expected, such as wind shear encountered when approaching to land at an airport with significant convective weather in the vicinity. In this latter case the expectation can trigger a pre-briefing for the actions required if an actual encounter occurs, and although the situation is sudden and there is no time for System 2 type of thinking, after the encounter the strategy is still knowledge-based. An example of such a team knowledge-based strategy is the Airbus 380 emergency landing in Singapore in 2010.

Other situations involve unforeseen or highly unlikely events but with sufficient time available either for personal or team System 2 type thinking. The available knowledge-based strategies are generic rather than specific.

Sometimes, I hope very rarely, the situation develop suddenly and will be both unexpected and unknown. Then there is not much in the way of a preformed strategy available. What one needs to do is to prevent or reduce the likelihood of such situations.

There are known but unexpected situations with sufficient time for personal reflection but not for use of team resources. An example of this would be the Airbus 320 ditching in the Hudson River in 2009 after the loss of almost all engine thrust following a multiple engine bird strike at low level.

Finally, there are those cases that combine unexpected but relatively frequent and known situations with sudden development and no time for reflection. If these cannot be prevented then the best strategy is to train for them extensively so that an optimum reaction becomes second nature and is more likely to be intuitively applied if needed. This is the famous rule for becoming an expert by spending 10,000 hours on training and practice. Take your time!

Intuitive reaction is not always bad; it helped us survive in the Darwinian sense. Flying and providing air traffic control to modern aircraft, however, is less of a reaction from the jungle and more about preparation. It is true that the design of aircraft and ATC systems should be human-centred, accommodating instinctive human reactions. But this assumes that someone will know everything about humans and their reactions and will successfully integrate this into the design of machines and procedures.

Obviously, this is not fully achievable and there will be situations that surprise us. If these situations have potentially dangerous outcomes, if what is at stake is an accident, then when confronted with emergencies one should be equipped to adopt the best available strategy which minimises '*blink*' and maximises '*think*'. The challenge is how to train the professionals to '*think slow*' but faster".

Psychological Hazards

There are several factors that may interfere with a pilot's ability to act promptly and properly when faced with an emergency.

- **Reluctance to accept the emergency situation.** A pilot who allows the mind to become paralyzed at the thought that the airplane will be on the ground, in a very short time, regardless of the pilot's actions or hopes, is severely handicapped in the handling of the emergency. An unconscious desire to delay the dreaded moment may lead to such errors as: failure to lower the nose to maintain flying speed, delay in the selection of the most suitable landing area within reach, and indecision in general. Desperate attempts to correct whatever went wrong, at the expense of airplane control, fall into the same category.

- **Desire to save the airplane.** The pilot who has been conditioned during training to expect to find a relatively safe landing area, whenever the flight instructor closed the throttle for a simulated forced landing, may ignore all basic rules of airmanship to avoid a touchdown in terrain where airplane damage is unavoidable. Typical consequences are: making a 180° turn back to the runway when available altitude is insufficient; stretching the glide without regard for minimum control speed in order to reach a more appealing field; accepting an approach and touchdown situation that leaves no margin for error. The desire to save the airplane, regardless of the risks involved, may be influenced by two other factors: the pilot's financial stake in the airplane and the certainty that an undamaged airplane implies no bodily harm. There are times, however, when a pilot should be more interested in sacrificing the airplane so that the occupants can safely walk away from it.

- **Undue concern about getting hurt.** Fear is a vital part of the self-preservation mechanism. However, when fear leads to panic, we invite that which we want most to avoid. The survival records

favor pilots who maintain their composure and know how to apply the general concepts and procedures that have been developed through the years. The success of an emergency landing is as much a matter of the mind as of skills.

Types of Emergency Landings

The different types of emergency landings are defined as follows.

- **Forced landing.** An immediate landing, on or off an airport, necessitated by the inability to continue further flight. Atypical example of which is an airplane forced down by engine failure.
- **Precautionary landing.** A premeditated landing, on or off an airport, when further flight is possible but inadvisable. Examples of conditions that may call for a precautionary landing include deteriorating weather, being lost, fuel shortage, and gradually developing engine trouble.
- **Ditching.** A forced or precautionary landing on water.

A precautionary landing, generally, is less hazardous than a forced landing because the pilot has more time for terrain selection and the planning of the approach. In addition, the pilot can use power to compensate for errors in judgment or technique. The pilot should be aware that too many situations calling for a precautionary landing are allowed to develop into immediate forced landings, when the pilot uses wishful thinking instead of reason, especially when dealing with a self-inflicted predicament. The non-instrument rated pilot trapped by weather, or the pilot facing imminent fuel exhaustion who does not give any thought to the feasibility of a precautionary landing accepts an extremely hazardous alternative.

Terrain Types

Since an emergency landing on suitable terrain resembles a situation in which the pilot should be familiar through training, only the more unusual situation will be discussed.

Confined Areas

The natural preference to set the airplane down on the ground should not lead to the selection of an open spot between trees or obstacles where the ground cannot be reached without making a steep descent.

Once the intended touchdown point is reached, and the remaining open and unobstructed space is very limited, it may be better to force the airplane down on the ground than to delay touchdown until it stalls (settles). An airplane decelerates faster after it is on the ground than while airborne. Thought may also be given to the desirability of ground-looping or retracting the landing gear in certain conditions.

A river or creek can be an inviting alternative in otherwise rugged terrain. The pilot should ensure that the water or creek bed can be reached without snagging the wings. The same concept applies to road landings with one additional reason for caution; manmade obstacles on either side of a road may not be visible until the final portion of the approach.

When planning the approach across a road, it should be remembered that most highways, and even rural dirt roads, are paralleled by power or telephone lines. Only a sharp lookout for the supporting structures, or poles, may provide timely warning.

Trees (Forest)

Figure 16-4.Tree landing.

Although a tree landing is not an attractive prospect, the following general guidelines will help to make the experience survivable.

- Use the normal landing configuration (full flaps, gear down).
- Keep the groundspeed low by heading into the wind.
- Make contact at minimum indicated airspeed, but not below stall speed, and “hang” the airplane in the tree branches in a nose-high landing attitude. Involving the underside of the fuselage

and both wings in the initial tree contact provides a more even and positive cushioning effect, while preventing penetration of the windshield. [Figure 16-4]

- Avoid direct contact of the fuselage with heavy tree trunks.
- Low, closely spaced trees with wide, dense crowns (branches) close to the ground are much better than tall trees with thin tops; the latter allow too much free fall height. (A free fall from 75 feet results in an impact speed of about 40 knots, or about 4,000 f.p.m.)
- Ideally, initial tree contact should be symmetrical; that is, both wings should meet equal resistance in the tree branches. This distribution of the load helps to maintain proper airplane attitude. It may also preclude the loss of one wing, which invariably leads to a more rapid and less predictable descent to the ground.
- If heavy tree trunk contact is unavoidable once the airplane is on the ground, it is best to involve both wings simultaneously by directing the airplane between two properly spaced trees. **Do not attempt this maneuver, however, while still airborne.**

Water (Ditching) and Snow

A well-executed water landing normally involves less deceleration violence than a poor tree landing or a touchdown on extremely rough terrain. Also an airplane that is ditched at minimum speed and in a normal landing attitude will not immediately sink upon touchdown. Intact wings and fuel tanks (especially when empty) provide floatation for at least several minutes even if the cockpit may be just below the water line in a high-wing airplane.

Loss of depth perception may occur when landing on a wide expanse of smooth water, with the risk of flying into the water or stalling in from excessive altitude. To avoid this hazard, the airplane should be “dragged in” when possible. Use no more than intermediate flaps on low-wing airplanes. The water resistance of fully extended flaps may result in asymmetrical flap failure and slowing of the airplane. Keep a retractable gear up unless the AFM/POH advises otherwise.

A landing in snow should be executed like a ditching, in the same configuration and with the same regard for loss of depth perception (white out) in reduced visibility and on wide open terrain.

Engine Failure after Takeoff (Single-Engine)

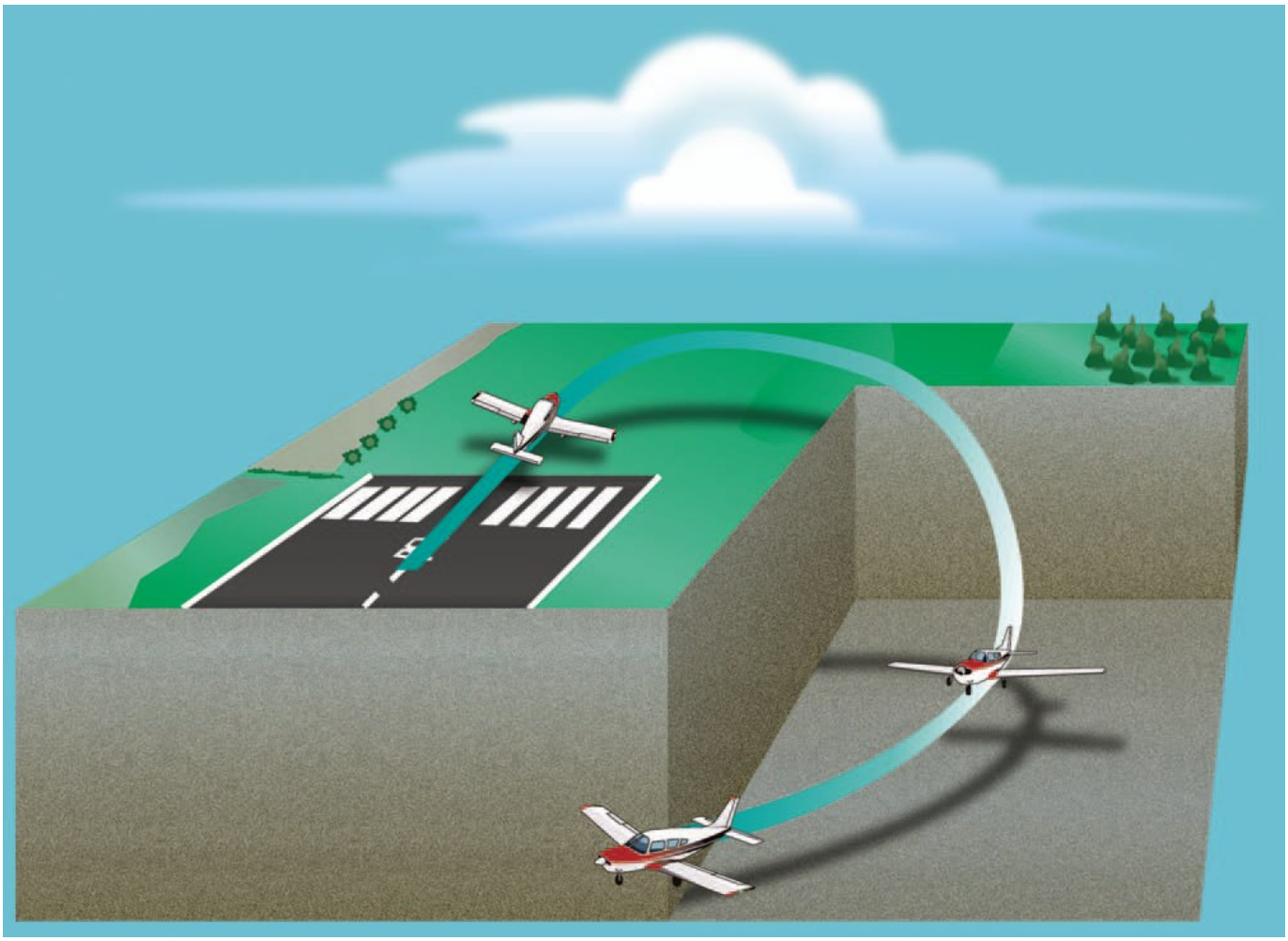


Figure 16-5. Turning back to the runway after engine failure.

The altitude available is, in many ways, the controlling factor in the successful accomplishment of an emergency landing. If an actual engine failure should occur immediately after takeoff and before a safe maneuvering altitude is attained, it is usually inadvisable to attempt to turn back to the field from where the takeoff was made. Instead, it is safer to immediately establish the proper glide attitude, and select a field directly ahead or slightly to either side of the takeoff path.

The decision to continue straight ahead is often difficult to make unless the problems involved in attempting to turn back are seriously considered. In the first place, the takeoff was in all probability made into the wind. To get back

to the takeoff field, a downwind turn must be made. This increases the groundspeed and rushes the pilot even more in the performance of procedures and in planning the landing approach. Secondly, the airplane will be losing considerable altitude during the turn and might still be in a bank when the ground is contacted, resulting in the airplane cartwheeling (which would be a catastrophe for the occupants, as well as the airplane). After turning downwind, the apparent increase in groundspeed could mislead the pilot into attempting to prematurely slow down the airplane and cause it to stall. On the other hand, continuing straight ahead or making a slight turn allows the pilot more time to establish a safe landing attitude, and the landing can be made as slowly as possible, but more importantly, the airplane can be landed while under control. Concerning the subject of turning back to the runway following an engine failure on takeoff, the pilot should determine the minimum altitude an attempt of such a maneuver should be made in a particular airplane. Experimentation at a safe altitude should give the pilot an approximation of height lost in a descending 180° turn at idle power. By adding a safety factor of about 25 percent, the pilot should arrive at a practical decision height. The ability to make a 180° turn does not necessarily mean that the departure runway can be reached in a power-off glide; this depends on the wind, the distance traveled during the climb, the height reached, and the glide distance of the airplane without power. The pilot should also remember that a turn back to the departure runway may in fact require more than a 180° change in direction.

Consider the following example of an airplane which has taken off and climbed to an altitude of 300 feet AGL when the engine fails. [Figure 16-5]. After a typical 4 second reaction time, the pilot elects to turn back to the runway. Using a standard rate (3° change in direction per second) turn, it will take 1 minute to turn 180°. At a glide speed of 65 knots, the radius of the turn is 2,100 feet, so at the completion of the turn, the airplane will be 4,200 feet to one side of the runway. The pilot must turn another 45° to head the airplane toward the runway. By this time the total change in direction is 225° equating to 75 seconds plus the 4 second reaction time. If the airplane in a power-off glide descends at approximately 1,000 f.p.m., it will have descended 1,316, feet placing it 1,016 feet below the runway.

In-Flight Fire

A fire in flight demands immediate and decisive action. The pilot therefore must be familiar with the procedures outlined to meet this emergency contained in the AFM/POH for the particular airplane. For the purposes of this handbook, in-flight fires are classified as: inflight engine fires, electrical fires, and cabin fires.

Engine Fire

An in-flight engine compartment fire is usually caused by a failure that allows a flammable substance such as fuel, oil or hydraulic fluid to come in contact with a hot surface. This may be caused by a mechanical failure of the engine itself, an engine-driven accessory, a defective induction or exhaust system, or a broken line. Engine compartment fires may also result from maintenance errors, such as improperly installed/fastened lines and/or fittings resulting in leaks.

Engine compartment fires can be indicated by smoke and/or flames coming from the engine cowling area. They can also be indicated by discoloration, bubbling, and/or melting of the engine cowling skin in cases where flames and/or smoke is not visible to the pilot. By the time a pilot becomes aware of an in-flight engine compartment fire, it usually is well developed. Unless the airplane manufacturer directs otherwise in the AFM/POH, the first step on discovering a fire should be to shut off the fuel supply to the engine by placing the mixture control in the idle cut off position and the fuel selector shutoff valve to the OFF position. The ignition switch should be left ON in order to use up the fuel that remains in the fuel lines and components between the fuel selector/shutoff valve and the engine. This procedure may starve the engine compartment of fuel and cause the fire to die naturally. If the flames are snuffed out, no attempt should be made to restart the engine.

If the engine compartment fire is oil-fed, as evidenced by thick black smoke, as opposed to a fuel-fed fire which produces bright orange flames, the pilot should consider stopping the propeller rotation by feathering or other means, such as (with constant-speed propellers) placing the pitch control

lever to the minimum r.p.m. position and raising the nose to reduce airspeed until the propeller stops rotating. This procedure will stop an engine-driven oil (or hydraulic) pump from continuing to pump the flammable fluid which is feeding the fire.

Some light airplane emergency checklists direct the pilot to shut off the electrical master switch. However, the pilot should consider that unless the fire is electrical in nature, or a crash landing is imminent, deactivating the electrical system prevents the use of panel radios for transmitting distress messages and will also cause air traffic control (ATC) to lose transponder returns. Pilots of powerless single-engine airplanes are left with no choice but to make a forced landing. Pilots of twin-engine airplanes may elect to continue the flight to the nearest airport. However, consideration must be given to the possibility that a wing could be seriously impaired and lead to structural failure. Even a brief but intense fire could cause dangerous structural damage. In some cases, the fire could continue to burn under the wing (or engine cowling in the case of a single-engine airplane) out of view of the pilot. Engine compartment fires which appear to have been extinguished have been known to rekindle with changes in airflow pattern and airspeed.

The pilot must be familiar with the airplane's emergency descent procedures. The pilot must bear in mind that:

- The airplane may be severely structurally damaged to the point that its ability to remain under control could be lost at any moment.
- The airplane may still be on fire and susceptible to explosion.
- The airplane is expendable and the only thing that matters is the safety of those on board.

Electrical Fires

The initial indication of an electrical fire is usually the distinct odor of burning insulation. Once an electrical fire is detected, the pilot should attempt to identify the faulty circuit by checking circuit breakers, instruments, avionics, and lights. If the faulty circuit cannot be readily detected and isolated, and

flight conditions permit, the battery master switch and alternator/generator switches should be turned off to remove the possible source of the fire. However, any materials which have been ignited may continue to burn.

If electrical power is absolutely essential for the flight, an attempt may be made to identify and isolate the faulty circuit by:

1. Turning the electrical master switch OFF.
2. Turning all individual electrical switches OFF.
3. Turning the master switch back ON.
4. Selecting electrical switches that were ON before the fire indication one at a time, permitting a short time lapse after each switch is turned on to check for signs of odor, smoke, or sparks.

This procedure, however, has the effect of recreating the original problem. The most prudent course of action is to land as soon as possible.

Cabin Fire

Cabin fires generally result from one of three sources: (1) careless smoking on the part of the pilot and/or passengers; (2) electrical system malfunctions; (3) heating system malfunctions. A fire in the cabin presents the pilot with two immediate demands: attacking the fire, and getting the airplane safely on the ground as quickly as possible. A fire or smoke in the cabin should be controlled by identifying and shutting down the faulty system. In many cases, smoke may be removed from the cabin by opening the cabin air vents. This should be done only after the fire extinguisher (if available) is used. Then the cabin air control can be opened to purge the cabin of both smoke and fumes. If smoke increases in intensity when the cabin air vents are opened, they should be immediately closed. This indicates a possible fire in the heating system, nose compartment baggage area (if so equipped), or that the increase in airflow is feeding the fire. On pressurized airplanes, the pressurization air system will remove smoke from the cabin; however, if the smoke is intense, it may be necessary to either depressurize at altitude, if oxygen is available for all occupants, or execute an emergency descent.

In unpressurized single-engine and light twin-engine airplanes, the pilot can attempt to expel the smoke from the cabin by opening the foul weather windows. These windows should be closed immediately if the fire becomes more intense. If the smoke is severe, the passengers and crew should use oxygen masks if available, and the pilot should initiate an immediate descent. The pilot should also be aware that on some airplanes, lowering the landing gear and/or wing flaps can aggravate a cabin smoke problem.

Emergency Descents

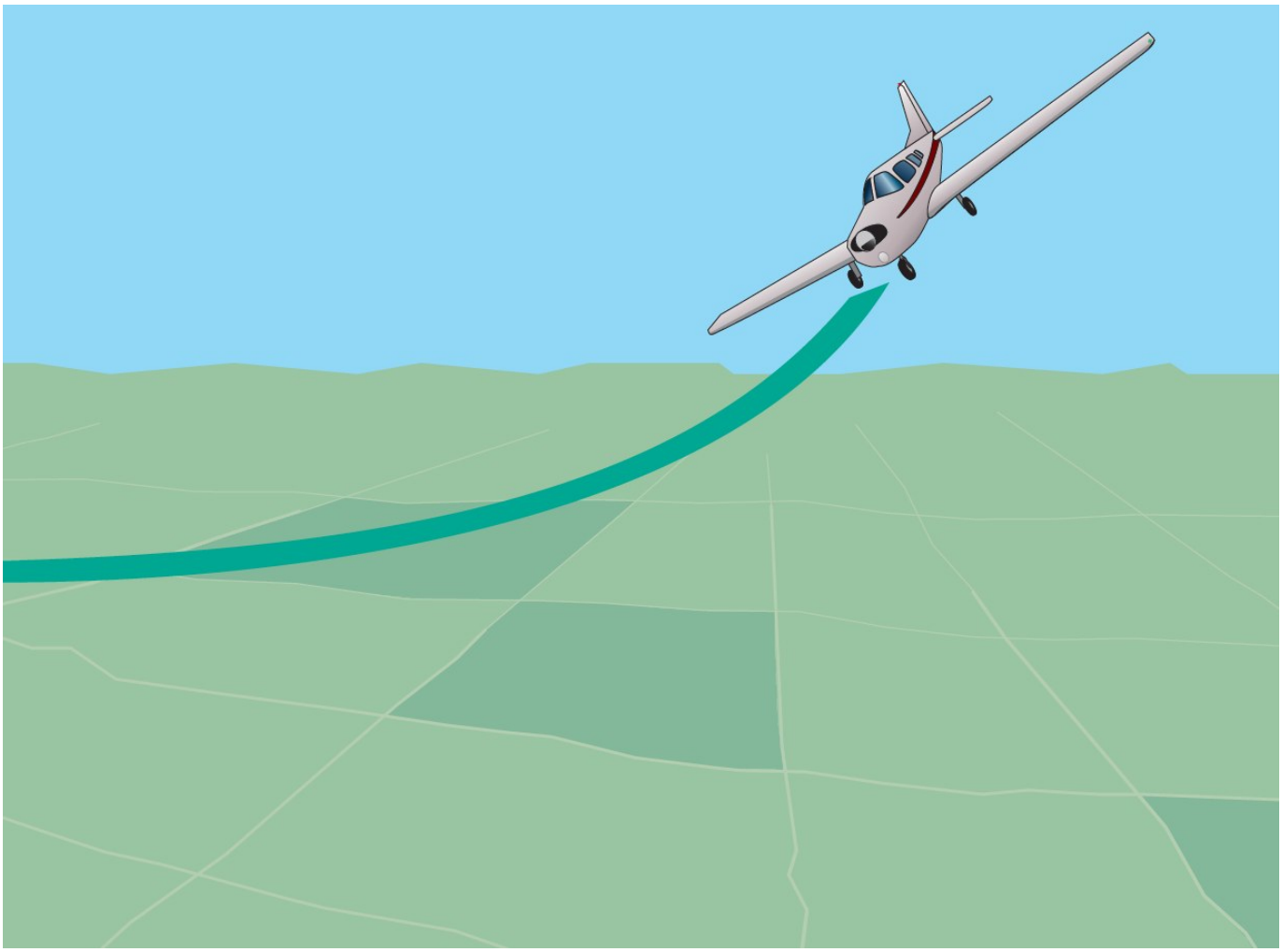


Figure 16-6. Emergency descent.

An emergency descent is a maneuver for descending as rapidly as possible to a lower altitude or to the ground for an emergency landing. [Figure 16-6] The need for this maneuver may result from an uncontrollable fire, a sudden loss of cabin pressurization, or any other situation demanding an immediate and rapid descent. The objective is to descend the airplane as soon and as rapidly as possible, within the structural limitations of the airplane. Simulated emergency descents should be made in a turn to check for other air traffic below and to look around for a possible emergency landing area. A radio call announcing descent intentions may be appropriate to alert other aircraft in the area. When initiating the descent, a bank of approximately 30 to 45°

should be established to maintain positive load factors (“G” forces) on the airplane.

Emergency descent training should be performed as recommended by the manufacturer, including the configuration and airspeeds. Except when prohibited by the manufacturer, the power should be reduced to idle, and the propeller control (if equipped) should be placed in the low pitch (or high revolutions per minute (r.p.m.)) position. This will allow the propeller to act as an aerodynamic brake to help prevent an excessive airspeed buildup during the descent. The landing gear and flaps should be extended as recommended by the manufacturer. This will provide maximum drag so that the descent can be made as rapidly as possible, without excessive airspeed. The pilot should not allow the airplane’s airspeed to pass the never-exceed speed (V_{NE}), the maximum landing gear extended speed (V_{LE}), or the maximum flap extended speed (V_{FE}), as applicable. In the case of an engine fire, a high airspeed descent could blow out the fire. However, the weakening of the airplane structure is a major concern and descent at low airspeed would place less stress on the airplane. If the descent is conducted in turbulent conditions, the pilot must also comply with the design maneuvering speed (V_A) limitations. The descent should be made at the maximum allowable airspeed consistent with the procedure used. This will provide increased drag and therefore the loss of altitude as quickly as possible. The recovery from an emergency descent should be initiated at a high enough altitude to ensure a safe recovery back to level flight or a precautionary landing.

When the descent is established and stabilized during training and practice, the descent should be terminated. In airplanes with piston engines, prolonged practice of emergency descents should be avoided to prevent excessive cooling of the engine cylinders.

Inadvertent VFR Flight into IMC

It is beyond the scope of this handbook to incorporate a course of training in basic attitude instrument flying. This information is contained in FAA-H-8083-15, **Instrument Flying Handbook**. Certain pilot certificates and/or associated ratings require training in instrument flying and a demonstration of specific instrument flying tasks on the practical test.

Pilots and flight instructors should refer to FAA-H- 8083-15 for guidance in the performance of these tasks, and to the appropriate practical test standards for information on the standards to which these required tasks must be performed for the particular certificate level and/or rating. The pilot should remember, however, that unless these tasks are practiced on a continuing and regular basis, skill erosion begins almost immediately. In a very short time, the pilot's **assumed** level of confidence will be much higher than the performance he or she will actually be able to demonstrate should the need arise.

Accident statistics show that the pilot who has not been trained in attitude instrument flying, or one whose instrument skills have eroded, will lose control of the airplane in about 10 minutes once forced to rely solely on instrument reference. The purpose of this section is to provide guidance on practical emergency measures to maintain airplane control for a limited period of time in the event a VFR pilot encounters IMC conditions. The main goal is **not** precision instrument flying; rather, it is to help the VFR pilot keep the airplane under adequate control until suitable visual references are regained.

The first steps necessary for surviving an encounter with instrument meteorological conditions (IMC) by a VFR pilot are:

- Recognition and acceptance of the seriousness of the situation and the need for immediate remedial action.
- Maintaining control of the airplane.
- Obtaining the appropriate assistance in getting the airplane safely

on the ground.

Recognition

A VFR pilot is in IMC conditions anytime he or she is unable to maintain airplane attitude control by reference to the natural horizon, regardless of the circumstances or the prevailing weather conditions. Additionally, the VFR pilot is, in effect, in IMC anytime he or she is inadvertently, or intentionally for an indeterminate period of time, unable to navigate or establish geographical position by visual reference to landmarks on the surface. These situations must be accepted by the pilot involved as a genuine emergency, requiring appropriate action.

The pilot must understand that unless he or she is trained, qualified, and current in the control of an airplane solely by reference to flight instruments, he or she will be unable to do so for any length of time. Many hours of VFR flying using the attitude indicator as a reference for airplane control may lull a pilot into a false sense of security based on an overestimation of his or her personal ability to control the airplane solely by instrument reference. In VFR conditions, even though the pilot thinks he or she is controlling the airplane by instrument reference, the pilot also receives an overview of the natural horizon and may subconsciously rely on it more than the cockpit attitude indicator. If the natural horizon were to suddenly disappear, the untrained instrument pilot would be subject to vertigo, spatial disorientation, and inevitable control loss.

Maintaining Airplane Control

Once the pilot recognizes and accepts the situation, he or she must understand that the only way to control the airplane safely is by using and trusting the flight instruments. Attempts to control the airplane **partially** by reference to flight instruments while searching outside the cockpit for visual confirmation of the information provided by those instruments will result in inadequate airplane control. This may be followed by spatial disorientation and complete control loss.

The most important point to be stressed is that the pilot **must not panic**. The task at hand may seem overwhelming, and the situation may be compounded by extreme apprehension. The pilot therefore must make a

conscious effort to relax.

The pilot must understand the most important concern— in fact the only concern at this point—is to keep the wings level. An uncontrolled turn or bank usually leads to difficulty in achieving the objectives of any desired flight condition. The pilot will find that good bank control has the effect of making pitch control much easier.

The pilot should remember that a person cannot feel control pressures with a tight grip on the controls. Relaxing and learning to “control with the eyes and the brain” instead of only the muscles, usually takes considerable conscious effort.

The pilot must believe what the flight instruments show about the airplane’s attitude regardless of what the natural senses tell. The vestibular sense (motion sensing by the inner ear) can and will confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in airplane attitude, nor can they accurately sense attitude changes which occur at a uniform rate over a period of time. On the other hand, **false** sensations are often generated, leading the pilot to believe the attitude of the airplane **has** changed when, in fact, it has not. These false sensations result in the pilot experiencing spatial disorientation.

Climbs

Figure 16-13. Level climb.

If a climb is necessary, the pilot should raise the miniature airplane on the attitude indicator no more than one bar width and apply power. [Figure 16-13] The pilot should not attempt to attain a specific climb speed but accept whatever speed results. The objective is to deviate as little as possible from level flight attitude in order to disturb the airplane's equilibrium as little as possible. If the airplane is properly trimmed, it will assume a nose-up attitude on its own commensurate with the amount of power applied. Torque and P-factor will cause the airplane to have a tendency to bank and turn to the left. This must be anticipated and compensated for.

If the initial power application results in an inadequate rate of climb, power should be increased in increments of 100 r.p.m. or 1 inch of manifold pressure until the desired rate of climb is attained. Maximum available power is seldom necessary. The more power used the more the airplane

will want to bank and turn to the left. Resuming level flight is accomplished by first decreasing pitch attitude to level on the attitude indicator using slow but deliberate pressure, allowing airspeed to increase to near cruise value, and then decreasing power.

Turns

Figure 16-12. Level turn.

Turns are perhaps the most potentially dangerous maneuver for the untrained instrument pilot for two reasons.

- The normal tendency of the pilot to over control, leading to steep banks and the possibility of a “graveyard spiral.”
- The inability of the pilot to cope with the instability resulting from the turn.

When a turn must be made, the pilot must anticipate and cope with the relative instability of the roll axis. The smallest practical bank angle should be used—in any case no more than 10° bank angle. [Figure 16-12] A shallow bank will take very little vertical lift from the wings resulting in little if any deviation in altitude. It may be helpful to turn a few degrees and then return to level flight, if a large change in heading must be made. Repeat the process until the desired heading is reached. This process may relieve the progressive overbanking that often results from prolonged turns.

Descents

Figure 16-14. Level descent.

Descents are very much the opposite of the climb procedure if the airplane is properly trimmed for hands-off straight-and-level flight. In this configuration, the airplane requires a certain amount of thrust to maintain altitude. The pitch attitude is controlling the airspeed. The engine power, therefore, (translated into thrust by the propeller) is maintaining the selected altitude. Following a power reduction, however slight, there will be an almost imperceptible decrease in airspeed.

However, even a slight change in speed results in less down load on the tail, whereupon the designed nose heaviness of the airplane causes it to pitch down just enough to maintain the airspeed for which it was trimmed. The airplane will then descend at a rate directly proportionate to the amount of thrust that has been removed. Power reductions should be made in increments of 100 r.p.m. or 1 inch of manifold pressure and the resulting

rate of descent should never exceed 500 f.p.m. The wings should be held level on the attitude indicator, and the pitch attitude should not exceed one bar width below level. [Figure 16-14]

Combined Maneuvers

Combined maneuvers, such as climbing or descending turns should be avoided if at all possible by an untrained instrument pilot already under the stress of an emergency situation. Combining maneuvers will only compound the problems encountered in individual maneuvers and increase the risk of control loss. Remember that the objective is to maintain airplane control by deviating as little as possible from straight-and-level flight attitude and thereby maintaining as much of the airplane's natural equilibrium as possible. When being assisted by air traffic controllers from the ground, the pilot may detect a sense of urgency as he or she is being directed to change heading and/or altitude. This sense of urgency reflects a normal concern for safety on the part of the controller. But the pilot must not let this prompt him or her to attempt a maneuver that could result in loss of control.