"Get your SA out of your pocket!" This is a familiar expression in pilot training. It simple means, get your head up, your mind active, and figure out what is going on around you because you are missing it! Kent Magnuson of the USAF Safety Life Sciences Division studied U.S. Air Force mishaps from 1989 through 1995. He found that lost situational awareness because of channelized attention was the single largest contributing factor cited in these mishap reports. It was actually tied with decision making (a closely related topic) as the largest contributor to accidents in the Air Force.

There are a number of formal definitions of situational awareness. Dr. Mica Endsley is perhaps the world's foremost researcher in the area. She defines situational awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley 1989). *Human Factors* journal, which covers many topics relevant to safe and efficient flight, defines situational awareness as "the

pilot's ability to stay aware of evolving aspects of the flight environment that might become relevant should unexpected circumstances develop" (*Human Factors* 1995). The term is best captured by Crew Training International, which trains many military units in the concepts of crew resource management (CRM). It is clear that good situational awareness is central to CRM, which has the goal of the crew's efficiently using all resources in and outside of the aircraft. Crew Training International defines situational awareness (SA) as the central answer to these three questions:

What has happened?

What is happening?

What might happen?

If the pilot has a good grasp on the answers to these three questions, he or she is likely to have "good" situational awareness. Crew Training International further emphasizes that good situational awareness requires that the pilot be aware of the three physical dimensions (the x, y, and z planes), as well as the fourth dimension of time and how these four dimensions converge. Knowing what is occurring, what has occurred, and what likely will occur in these four dimensions is the essence of situational awareness.

Returning to Endsley's work for a moment, she points out that there are three levels or processes within situational awareness. They have some overlap with the three questions from Crew Training International. The first is the ability of the pilot to *perceive* key features and events in the dynamic environment (e.g., there is motion on the right side of the windscreen I didn't see before; there is a hydraulic gauge that is higher than the others). The second is the ability to *understand* the meaning of those events (e.g., a small aircraft tracking westbound; the hydraulic level has fallen by 1 quart in the last hour). The final

process is the pilot's ability to *project* or *predict* the future implications of these changing features (we are on a collision course and I need to take evasive action; at this rate I will lose left hydraulics and the braking system in an hour). These processes represent different levels of situational awareness. To get to the deeper levels, one must have covered the entry levels. What this work tells us is that situational awareness is not an either/or proposition. It isn't the case that the pilot "has" situational awareness or he or she doesn't "have" situational awareness. It is a continuum, and the pilot can fall anywhere along this continuum. The pilot who perceives the change in the environment but stops there has little situational awareness. The pilot who sees the change, understands the change, and is able to project what this means for his or her aircraft has high situational awareness. I emphasize that situational awareness is a cumulative process. To get to the deeper levels of situational awareness, the pilot must have the entry levels mastered. Let's look at some pilots whose lost situational awareness almost cost them their lives.

Medium to Large and a Little Low

"We are categorized as a medium to large transport. I was flying as pilot in command (PIC). We had done a good briefing of the approach en route and put the approach plates away. It was just the beginning of the bad weather season in Texas. We were on approach into Dallas/Ft. Worth (DFW) airfield and cleared for ILS Runway 18R at 3000 ft MSL. We had a load of passengers heading into the Metroplex. Dallas was to our left and Ft. Worth to our right. It was the end of a long day and the fourth day of our trip. We were established on the localizer inside of 10 mi, cleared to descend to 2400 ft MSL. The controller asked us to "keep up the speed" until the FAF (final approach fix) for spacing, so we maintained 180 knots.

We were below glideslope, and I initiated a gradual descent. At 1900 ft MSL it hit me. I realized we were inside the FAF below glideslope and descending! Upon recognition, I immediately initiated a correction back to glideslope, at which time Approach Control made a radio call advising of a low-altitude warning. Glideslope was captured, and an uneventful safe landing was made on Runway 18R." (ASRS 420146)

Why so low?

The PIC who submitted the report did a nice job in analyzing his own problem. I'll cover the good point first. The crew accomplished a good approach briefing during its "drone time" at altitude as it neared the point where the en route decent was accomplished. That takes care of the good point. Oh, I guess we should also commend the pilot for catching the error in flight and mitigating the error with corrective action.

The primary problem with this crew was complacency. Complacency is defined as "a feeling of contentment or satisfaction, self-satisfaction, or smugness" (*The American Heritage Dictionary*). It is this smugness or self-satisfaction that leads us to take things for granted and let our guard down. Complacency is no friend of situational awareness. In fact, they are arch enemies. Unfortunately, two things that often lead to complacency are characteristics of airline crews in particular. High experience and routine operations are precursors to complacency. The more experience we gain, the more confident we feel, which in turn can lead to complacency—"been there, done that." As the old saying goes, familiarity breeds contempt, and it also breeds complacency—that sluggish inattention that we have all experienced both in and out of the cockpit. Complacency is closely related to experience and comfort. Chuck Yeager, "Mr. Right Stuff,"

says it is the number one enemy of experienced pilots. That is how two instructor pilots flying the two-seat T-37 (note: no student is aboard) are able to land gear up, with a fully functioning gear system.

Complacency can be seen in several places in this study. It was the beginning of bad weather season, so the crew was not spooled up for the approach; they had been doing a lot of visual approaches. Visual approaches are convenient and expeditious for both aircrews and the flying public, not to mention the controllers whose job is to expeditiously and safely direct aircraft to a landing. However, visual approaches can make a crew sloppy. When actual instrument approaches are called for, the pilot can be rusty or not proficient. It can take a while to get back in the swing of things. Furthermore, by the PIC's own admission, they were not anticipating low ceilings, so they didn't even have the approach plate out. This corresponds with Endsley's entry level of situational awareness: perceiving that features are changing in the dynamic environment. To get to the deeper levels of situational awareness, you must have the entry levels. By not perceiving the lower ceiling, they did not understand that an instrument approach was required, and they therefore did not predict the need for their approach plates.

Complacency can often be compounded by physical condition. There is an old sports cliché that says "fatigue makes cowards of all of us." There is a corollary in the aviation world: Fatigue makes slugs of all of us. When we are fatigued we are much more susceptible to complacency or putting our mind on autopilot while our body "does the couch potato." That was certainly the case here, as the crew had been on the road with long work hours for four days. Even when we stay within the company or other organization's crew rest policy, we can be fatigued. Most people don't sleep better on the road,

and they don't eat as well either. Couple that with changes in time zone, and your body is much more susceptible to fatigue.

A tear in the space/time continuum

There is a phenomenon known as *time distortion*. Time distortion can occur in one of two ways. Time can become elongated. In everyday life, you have no doubt experienced an occurrence when time seemed to stand still. Something that happened over just a few minutes or seconds seemed to last much longer. Maybe it was during a marriage proposal or that shot in the big game or when you first see that good friend you haven't seen in years—those magic moments. As most know, a similar phenomenon can occur in the cockpit. I've heard pilots describe a hard landing when they really "pranged it on" for several minutes, when the landing probably occurred over a 10- or 15-s period. Yet, they can see every excruciating detail. The same goes for an in-flight emergency, perhaps a near midair collision. Time can seem to be longer.

Time can also seem to become shorter. Known as *time compression*, this is when everything seems like it is in fast-forward on a tape player. You are going like an SR-71 (Mach 3+) mentally. It often seems that we get in this predicament with the help of our good friends, air traffic control (ATC). ATC has a tough job, which is getting tougher; it is called upon to move traffic safely and expeditiously between sectors and to sort out and sequence a growing number of aircraft in and around major airfields such as DFW. The controller here was undoubtedly trying to get the sequencing right at DFW to get as many planes as possible on the tarmac without causing any undue delays for following aircraft. I salute ATC for its efforts; it has a tough job. The result here

was a crew rushing the approach and time compression. The crew was well above approach speed (180 knots) as it neared the FAF. ATC also gave the aircraft an abnormal clearance. The crew was cleared to a lower altitude at a critical point instead of just intercepting glideslope at a stable altitude of 3000 ft MSL. Any time we are rushed or given an out-of-the-ordinary clearance, our usual safety habit patterns can be broken. When both occur at the same time, we are particularly susceptible to dropping something out of the cross-check.

Déjà Vu All Over Again

It was a Tuesday evening. It had been a good flight, and the crew was almost in Denver. Weather conditions there were clear and a million, though it was after nightfall. Frank was the first officer (FO) of the Boeing 727 passenger airliner with about 5000 h, 500 of those in the "27." Ed was the captain with even more flight hours and experience in the 727. They were cleared for a visual approach to Runway 35L at Denver. They made a modified right base and were approaching final at about a 50-degree angle. The captain was flying, descending at a normal airspeed and rate. Everything seemed fine. Both the captain and the first officer fixated on Runway 35R, thinking it was Runway 35L. They had a glideslope indication on their attitude directional indicators (ADIs) with both ILSs tuned correctly to Runway 35L. As they approached the final for Runway 35R, Frank and Ed then noticed at the same time that they had no localizer intercept, and they realized what had happened. They both looked at Runway 35L, and Ed started correcting to intercept the final for Runway 35L. Just then, the tower controller said "Low altitude alert; climb immediately to 7000 ft!" They were at about 6000 ft at the time. (ASRS 420927)