AVIATION WEEK Intelligence NETWORK

Reclaiming Situational Awareness

James Albright September 09, 2019

Ask any fighter pilot about situational awareness and the response will focus on the best ways to turn the odds during aerial combat and how to improve one's survivability in any set of circumstances. While outside of military aviation our interests don't include the need to "apply steel on target," survival should be a top concern of all who fly. The problem with the term "situational awareness" is that its meaning has been appropriated by the academics. But does it take a Ph.D. and volumes of text to explain something so primal and basic for those of us who fly?

When I started my U.S. Air Force career 40 years ago, nobody spoke of situational awareness, but it was a top concern. My first instructors were Vietnam vets who emphasized that knowing the "vertical situation" was just as important as the "horizontal situation" in air combat. When flying in formation we practiced our abilities to keep a mental three-dimensional map of our part of the sky and the airplanes with which we shared it. During low-level navigation, 360 kt. just off the deck, we cradled the stick in one hand while propping a terrain chart just under the glareshield so as to minimize the travel time of our eyes between paper and dirt. All of this, of course, was meant to refresh the mental image of our environment even as we sped through it at incredible speed.

A German Taube plane hunted down by a French plane with a machine gun, 1914.

I first heard the actual term for this mental magic almost 10 years later. I was at the Air Force accident investigation course with 20 other service pilots learning to turn a crumbled aircraft pile and human remains into a list of causes and recommendations. “He lost his SA and now he’s a mort,” the fighter pilots would say. Mortality, I get that. But SA? Within a few years every Air Force pilot was talking situational awareness because it was a proven lifesaver in all cockpits.

In my world of flying the “heavies,” good situational awareness meant knowing where an instrument approach could get you in trouble or how the airplane’s deteriorating health could turn it from an aerodynamic masterpiece into a falling object with the glide characteristics of a rock. We were slow to embrace the technological SA afforded by Ground Proximity Warning Systems (GPWS) or Traffic Alert and Collision Avoidance Systems (TCAS), which meant most of our SA came from within ourselves or our crews. We embraced SA because it worked.

I believe the U. S. Air Force was the first to adopt the term “situational awareness,” though that might be service partisanship from a 20-year veteran. But I am ashamed to say it was also my service that did the most to obscure SA into what it is today, a talking point for academicians who wanted to make something simple (and useful) into something complicated (and just another topic for ground school). In 1995, the chief scientist of the U.S. Air Force — yes, we had one of those — turned SA into a “human factors construct.” Situational awareness was boiled down to perception of a situation, comprehension of that situation and projection of one’s future status. Very large charts and Venn diagrams with doctorate level terms started to obscure what was once simple.

Modern pilot flight displays can improve situational awareness with a single glance. Credit: JAMES ALBRIGHT

Fortunately, the rest of the flying world came to the rescue and we now have a concise and well-written guide on how to recognize good SA in Appendix 1 of Advisory Circular 120-51E, Crew Resource Management Training:

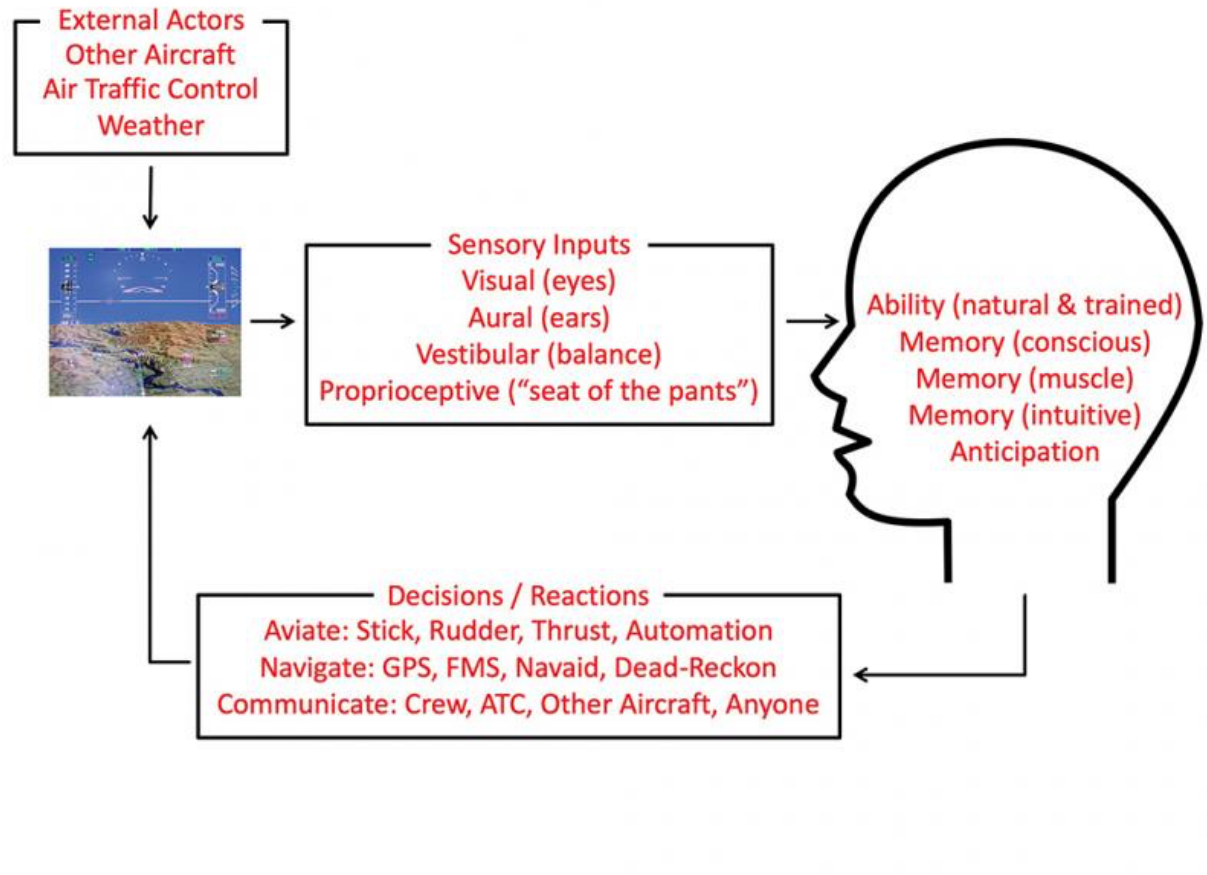
Active monitoring of all instruments and communications and sharing of relevant information.

Monitoring of weather and traffic information.

Avoiding “tunnel vision” caused by stress.

Being aware of factors that can degrade vigilance and watching for performance degradation in other crewmembers.

Staying “ahead of the curve” in preparing for planned situations or contingencies.



Credit: James Albright, BCA

As aircraft have become more automated, the SA task has had to encompass what the various actors behind the screens are doing. While each manufacturer has put its own spin on the issue, I like what Airbus has been saying about SA from early on. The main components of situational awareness are:

Environmental Awareness: Awareness of other aircraft, communications between ATC and other aircraft, weather or terrain.

Mode Awareness: Awareness of aircraft configuration and auto flight system modes. The latter includes such aspects as current and target speed, altitude, heading, AP/FD armed/engaged modes and the state of flight management system (FMS) data entries and flight planning functions.

Spatial Orientation: Awareness of geographical position and aircraft attitude.

System Awareness: Awareness of the status of aircraft systems.

Time Horizon: Awareness of time management (*e.g.,* fuel status/monitoring, time factor in smoke situation or emergency electrical configuration).

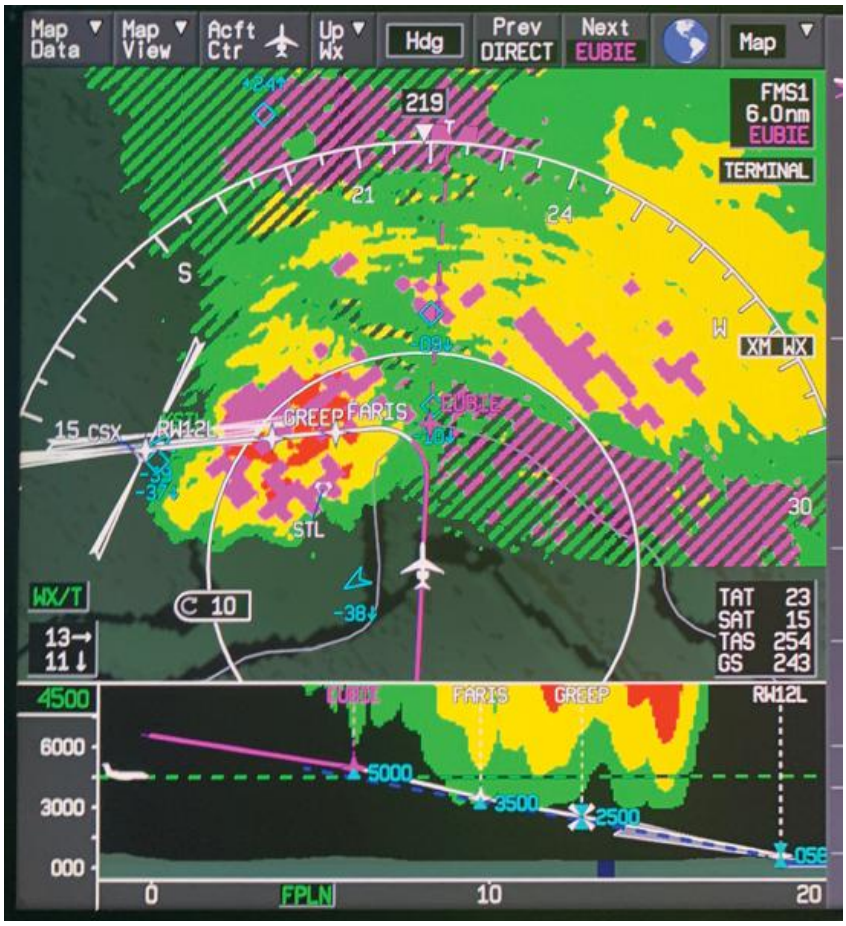
A pilot improving his weather SA in the 1960s. Credit: U.S. Air Force

At first glance, becoming situationally aware would seem to be all about gathering data. At the most primal level, we humans collect information with our eyes and ears. But as pilots, our inner ears (vestibular balance) and our "seat of the pants" (proprioceptive) senses can help or hinder our SA. One need only consider the many "graveyard spirals" suffered by non-instrument-rated pilots to realize not all inputs are valid. But the same can be said of other information sources, such as a plugged pitot tube leading to faulty airspeed and altitude information.

Looking at most SA models, including the one I've drawn here, it is easy to get lost in the long and winding road from environmental factors to cockpit avionics to you, the pilot, and finally to the decisions you make as a result. The typical approach is to closely analyze each element in the process in hopes of finding flaws to fix; thereby improving pilot SA. I think it is more productive to consider these elements as ground already covered. Let's skip that and go right to the task of improving our SA.

Collecting Better Intel by Becoming Better Users of Technology

When I started flying, the best source of weather was from an Air Force weather shop or the local Flight Service Station (FSS). Charts were hand-drawn every 6 hr., reflecting a meteorologist's best guess, and those charts were sent to selected stations. Once airborne, the best you could do would be to call the FSS or another ground station and hope to get an accurate verbal description of the weather ahead. Our radars had two colors: green and black. Reading the faint signals was an art and even a trained eye was fooled now and then.



A look at the weather prior to landing, using a 3-D radar in a Gulfstream GVII-G500. Credit: Stephen Testerman

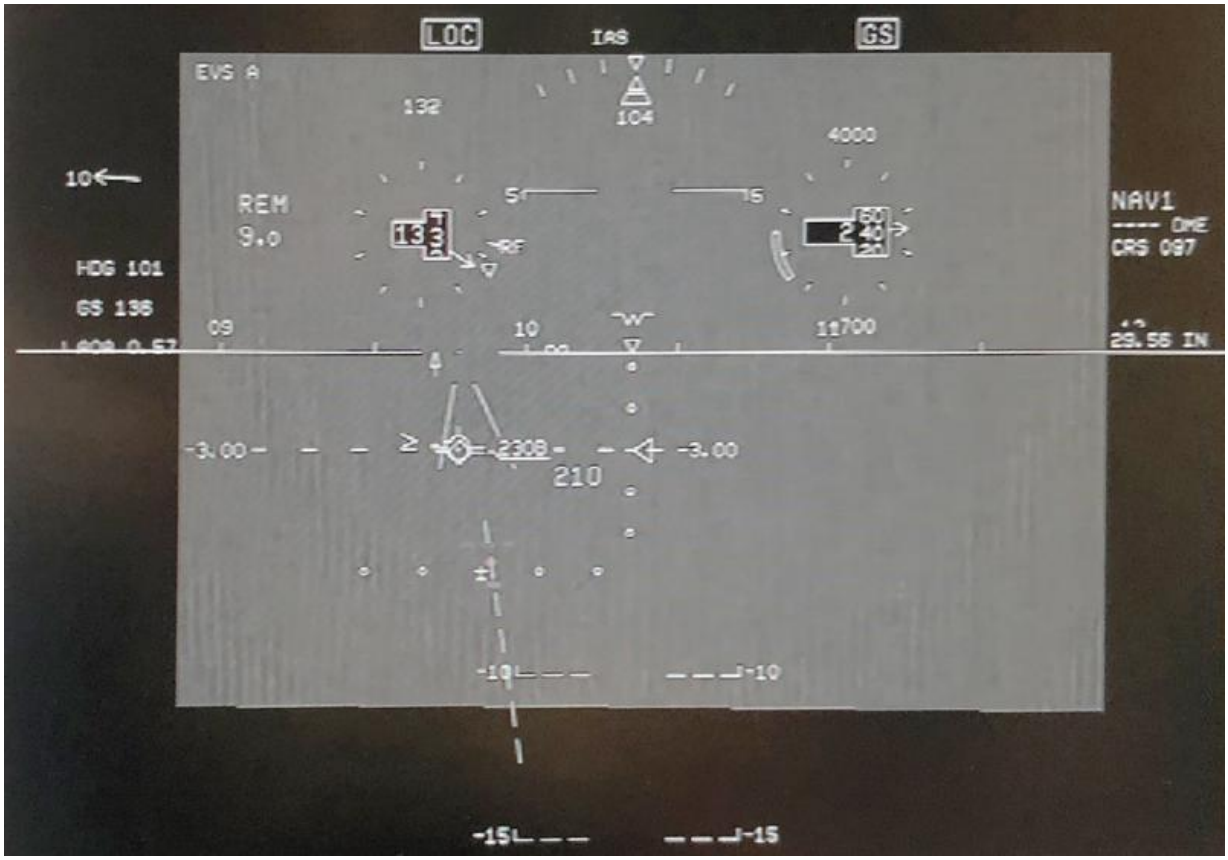
These days, with an XM weather account, you can have the best images available from a ground-based network of 159 Doppler radar stations based throughout the U.S., stitched into one image on your cockpit avionics as if it were a real-time image. (There is actually a 10- to 20-min. delay, but that is nearly real-time.)

With an inflight internet connection, you can do even better. Not only will you be privy to the latest weather, but you can get news of ATC delays, volcanic activity, or even civil unrest that makes the flight plan you filed hours before less than optimal. Even without that airborne connection, a few minutes of internet surfing prior to takeoff can greatly improve your SA. While many of these cockpit upgrades can be very expensive, you can equip yourself with an inexpensive iPad and take screenshots (press the "Home" and power buttons simultaneously), which you can use later in the flight.

Avoiding Target Fixation

Fighter pilots will tell you there is a real danger to becoming so fixated on a target you are trying to destroy — be that a ball-bearing factory or an enemy fighter – that you run the risk of flying right into it. This kind of "target fixation" is also a problem for those of us simply trying to make it to Point B unscathed. You cannot narrow your focus on the objective while forgetting about the rest of the world. I think the best example of this is the low-visibility landing.

I've flown many Category II instrument landing system (ILS) approaches to minimums and never seemed to have any trouble spotting the approach lights in time to make the landing or go-around decision. In fact, over my many years of doing this, I've only had to go around a handful of times. These approaches were in large aircraft (Boeing 747) and small (Gulfstream III), all equipped only with the minimum equipment needed for a Cat II ILS.



The best technology is useless if you donâ€™t know where to look. In this photo, the 1,000-ft. roll bars (horizontal approach lights) can be seen below the synthetically drawn runway, but only if you are looking for them.

A little more than 10 years ago I added a head-up display (HUD) with an enhanced flight vision system (EFVS) and forward looking infrared (FLIR) camera. The magic of being able to see through clouds and not having to repeatedly move my eyes from the cockpit instruments (heads down) to the runway (heads up) promised to make this easy! It did not. I was suddenly struggling to see the approach lights and this caused a missed approach or two. It took me a while to identify the problem: me.

In the HUD-less airplane my eyes were traveling from the instrument panel to the glareshield where I expected to see the runway. Between those two points, just below the expected runway point, the approach lights lie in wait. With the HUD, my eyes no longer had to make the long trip from heads down to heads up. I was fixating on the flight path vector (FPV), which would be placed exactly where the runway's touchdown zone was expected. I was getting target fixation. The time to spot the approach lights at minimums before having to go around can be measured in fractions of a second. But even with multiple fractions, having target fixation robbed me of the view. Once I figured this out, I started scanning the lower half of the HUD routinely. And low-visibility approaches were easy once again.

Employing the Intel With the Most Basic of Rules: Aviate, Navigate, Communicate

Ponder this: How many pilots are in a modern flight deck? When I flew with flight engineers, I would have answered that there were three. Now, without the engineer, I still say three. Our autopilot is pretty good. Two or three? Either answer is better than just one.

If the status of the airplane's viability as an air machine is in doubt, a pilot should be dedicated to the task of keeping the machine airworthy. Make an announcement of that fact with the clear understanding that this pilot will concentrate exclusively on this task: "I will fly the airplane, you sort everything else out." There are two reasons for doing this. First, you should not multi-task when the airplane's

flyability is in doubt. Second, if part of your brain is dedicated to stick and rudder chores, the decisions made by the rest of the brain will be degraded.

Automation can be a phenomenal aide: It can automatically ensure there is sufficient power, that the airplane is pointed in the right direction, and that you have enough airspeed. But automation can also be the cause of what ails you. It is up to you to decide. To that end, the flying pilot must get back to basics and assess the situation. Is the automation keeping the airplane in steady, coordinated flight? Airspeed and altitude stable? If not, make adjustments to the automation and if that fails, cancel automation modes as necessary. Let the other pilot know what is going on, such as, "Good autothrottles, but the autopilot is confused. I am hand-flying the airplane, we are stable."

When the chips are down, it is often best to give the lesser experienced pilot the airplane and have the more experienced pilot do everything else, including giving the flying pilot "big picture" instructions.

The navigation imperative can be as simple as, "Get us out of this valley" to as complicated as "Where in the heck are we?" Fortunately, this problem has gotten easier over the years.

The amount of faith you put in the GPS is inversely proportional to the accuracy required. If you are in the middle of the ocean, having a GPS position is great. In the middle of a narrow valley, it depends on your system. Remember also that a GPS can give you an altitude readout to verify or discount a suspect altimeter.

An FMS can be the least accurate navigation tool on the flight deck, depending on its health and the status of its sensor inputs. Aircraft systems knowledge is key here.

If you are down to using ground-based navigational aids, be wary of readings outside a navaid's service volume and be especially careful with non-directional beacons, which can be worse than non-directional!

What about communications? When the stress level goes up, we have a tendency to latch onto the first solution that comes to mind and start to tune out alternate ideas. An especially willful captain with a good reputation can unknowingly shut off other crewmembers with better ideas, without them even realizing what has happened. Here are a few techniques.

State the nature of the problem and entertain ideas. Do not immediately critique ideas that are obviously wrong — they could stimulate ideas that are obviously right. Formulate a plan and articulate it. Do not end your discussion with "Do you agree?" Instead, try "What am I not thinking about?" If "group think" has taken over, try to stimulate alternatives. "Has anyone heard of this happening before? What did that crew try?"

Remember you have resources outside the airplane, too, i.e. phone a friend. The people on the other side of the radio can be very helpful when it comes to figuring out items of navigation ("Where am I?") and communication ("Who should I be talking to now?"), but be careful when asking about aviating questions. Many air traffic controllers are private pilots who think they understand high-performance aviation but may not.

To that point, in 1996, the pilots on AeroPeru Flight 603 lacked enough air sense to realize their blocked static ports were causing airspeed as well as altimeter problems. Unfortunately, ATC only fed to that deficit. Their Boeing 757 was experiencing classic blocked static port symptoms and when the air traffic controller reported their transponder readout agreed with what the pilots saw in the cockpit, all concerned believed the altimeters were working. Everyone on the airplane died as a result, but the controller lived on.

There is a community of aviators out there and that is especially evident when one of our group is in trouble. You will see this when flying oceanic or in remote areas. The universal pilot interplane frequency in most of the world is 123.45. Keep a listening watch when in oceanic or remote airspace, and perhaps you can come to the rescue of a fellow aviator.

If you don't have a satellite phone, you should get familiar with HF phone patch procedures and at least have the frequencies listed on the oceanic en-route charts available. Most of the people on the other side of the radio are not air traffic controllers but work for commercial services out to make money. If you need to get in contact with someone, they will work to make that happen. Of course, you will get a bill,

but chances are you will be happy to pay it.

With or without a satellite phone, you should never leave home without a list of critical phone numbers. For me, that list includes those of my aircraft mechanic, my aircraft manufacturer's 24-hr. emergency hotline and MedAire.

Detecting a Loss of SA

How do you know you've lost situational awareness when you are not aware of your situation? It is a conundrum. It has happened to me more than a few times and I've noticed it in others while seated in the "all knowing" comfort of a jump seat while administering a check ride. I've noticed that when confronted with evidence that a loss of SA was happening or was imminent, some pilots become upset and agonize over "How could this have happened?" Other pilots will be in denial or offer excuses, such as "It could have happened to anyone." I am in the first group and I think that is the healthier group because we are likely to ask the follow-on question: "How do I prevent this from happening again?" That is the critical question.

I think you can detect an imminent loss of SA by being on the lookout for a few syndromes that are indicative of that loss. These include:

The "What's it doing now?" syndrome — If the aircraft automation commands a change in aircraft horizontal or vertical navigation that surprises you, you either have an automation problem or you have lost SA.

The "Why's it doing that?" syndrome — If an aircraft system starts to act up, chances are it is a systems-related problem. But it could also be an error in programming or other user input due to the user's confusion caused by a loss of SA.

The "I guess we are there" syndrome — If the airplane gets to an event sooner than you expected, for example, if you get a vertical alert announcing the top of descent, you may have lost SA.

The "It's awfully quiet on the radio" syndrome — If you are preoccupied in the cockpit and realize you haven't heard anything on the radio for a while, you or ATC may have missed a handoff. You have lost SA.

The "We are there already?" syndrome — If you get to an event sooner than anticipated and suddenly feel rushed, you may have lost SA.

It all boils down to this: If the airplane gets to some point in space and time before your brain does, you have lost situational awareness.

Getting Your SA Back

We pilots are a diverse crowd and we are products of our experiences. If you've lost your situational awareness the cure may be unique to you. But, on the other hand, some of my solutions might work for you:

(1) Fly the airplane. Make sure one pilot is devoted to keeping the airplane right-side-up, the airspeed indicator above the stall and below the red line, the altimeter where it should be (usually that means level flight), and the nose pointed away from the edges of the air. (The edges of the air are the ground, water, other objects and extraterrestrial space.)

(2) Make the automation make sense. The autopilot and autothrottles can greatly simplify your SA or they can be the cause of your problem. Once you've evaluated the aircraft's attitude and speed trend, decide what part of automation is helping and what part is hurting. Disable the latter and take over manually. Let the other pilot know, "I am hand-flying," so he or she will know your attention is going to be devoted exclusively to that task. In a similar fashion, evaluate the aircraft's navigation and decide what components of the flight management system need to go.

(3) Evaluate the big picture. It may be helpful to verbalize the situation from the very big picture to the smaller details as a way of getting your brain back into the game. "We are still at cruise altitude, our airspeed is right at planned Mach, the FMS says we are on course, but our heading doesn't make sense."

(4) Buy time. If things are not going well, if you have enough fuel, and if there isn't a dire reason to get the airplane on the ground, look for a way to buy time. Ask for a holding pattern or delay vectors.

(5) Communicate. It never hurts to ask for some help, and that can come from air traffic control, other aircraft, your home base or somebody from the company that built the airplane.

(6) Step back and reassess. If your current view isn't helping, step back and take a look from another perspective. "What would they have told me to do on day one at initial?" or "What would Wilbur and Orville have done?"

(7) Calm down. Take a breath and take stock of what you have going for you and what is working against you.

I am not a fighter pilot, but I've known a few, many of whom have been combat tested. For them, situational awareness is a tool meant to keep them on the giving (and not receiving) end of the trigger. It is a tool needed for survival. It is a tool that military aviation has stamped into my DNA.

Don't let the academics glaze your eyes over with talk about goals, preconceptions and perceptions. Take SA back and add it to your tool bag. Do that, and you improve your odds of survival in what can be a dangerous occupation.