SITUATIONAL AWARENESS

by Lt Col Bruno Beeckmans

Aviation has evolved over the years. The biggest safety wins were first through better airworthiness by design ands reliability and only later was the importance of human factors recognised. Now, a culture which embraces open (clear unguarded) communication, committed leadership and effective decision making is continuing to evolve globally. Situation awareness considers content and context. It zooms out to look at the big picture like a GENeralist and zooms in to look into the detail, like a specialist. If you can do the both you are a GEN-IAL-ist and have SA!

First of all it is important to understand that the human brain cannot multi-task. At best people can perform tasks in quick succession. A simple test using a blank sheet of paper may help convince you:

M	U	L	T	I	T	A	S	K
1	2	3	4	5	6	7	8	9

- **Test 1:** Start your watch, write MULTITASK on the top line then write1-9 on the next line, stop your watch.
- **Test 2:** Start your watch, write M, 1, U, 2, L, 3, etc., stop your watch.

M								
1								

Let me guess: your timing of the first task (maybe about 8 seconds) was quicker than that for the second (maybe about 13 seconds).

Any flight involves fulfilling a intention whilst performing error management so as to maintain the aircraft state vector (x, y, z, t, speed, acceleration, configuration, etc.) within intended/permitted limits. Risk is inherent in flying. An aviator must therefore master the art of risk management.

Risk management consists of identifying hazards, considering the specific component of each one, establishing the potential consequences in each case and finally determining its cause(s). Once the cause has been identified, mitigation can be put in place. That hazard is then labeled with a probability and an impact. I will limit myself to the hazard analysis.

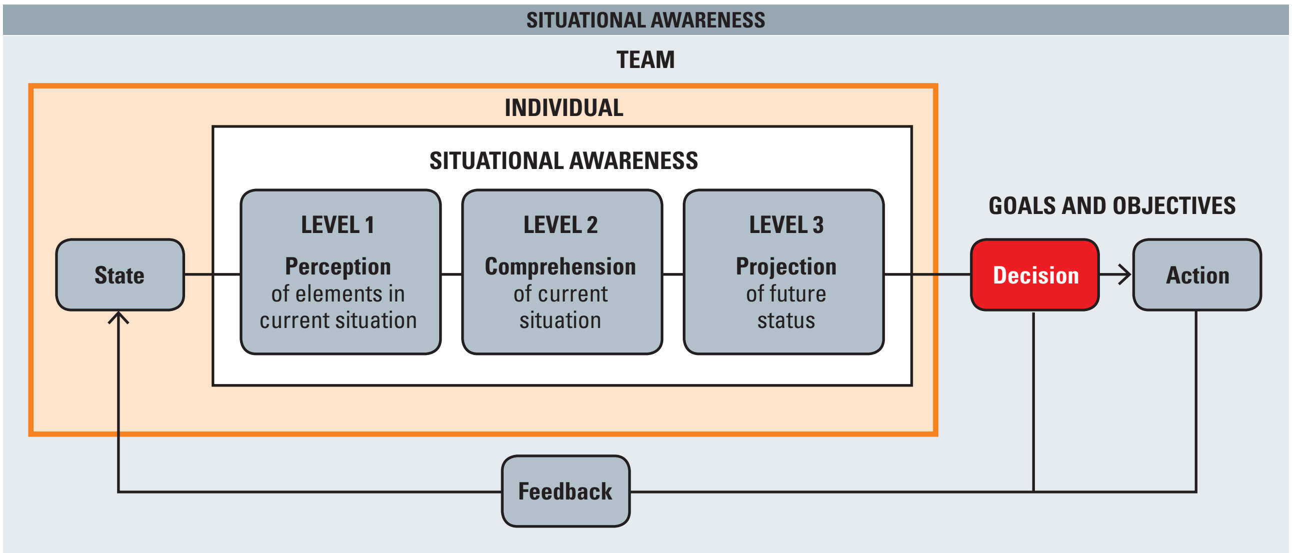
Endsley[1] has defined SA as:
"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future".

There are 3 discrete stages in SA:

- Level 1 involves **perception** of the elements in the environment. This is the identification of the key elements or "events" that, together, define the current situation
- Level 2 involves **comprehension** of the current situation - the combination of level 1 events into a comprehensive pattern, or 'tactical situation' which defines the current status in operationally relevant terms to support rapid decision making and action.
- Level 3 involves the **projection** of the current situation into the future in an attempt to predict the evolution of the tactical situation. It supports short-term planning and, when time permits, option evaluation.

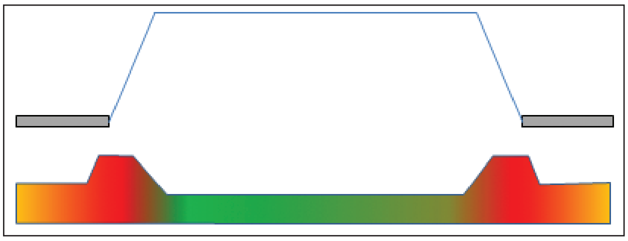
A decision taken without first reaching level 3 SA would be 'jumping to conclusions' and not the right thing to do. Action taken based on Level 3 SA is likely to affect the original state and thereby create a loop which must be re-run using the new state. Of course, SA should not only be viewed on an individual level, it must take account of interacting personnel - pilots, other aircrew, ATC, fire crew, etc.

Generic hazard	Specific components of the hazard	Hazard related consequences	Causes	Existing mitigations safety controls and/or requirements

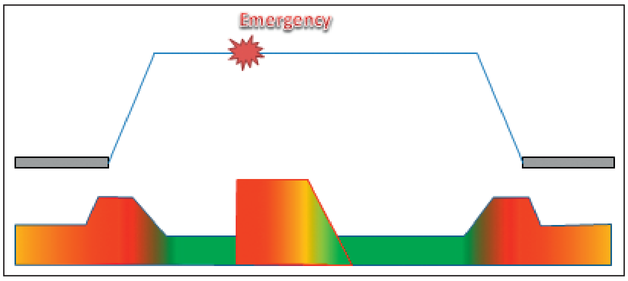


An Example to illustrate the concept

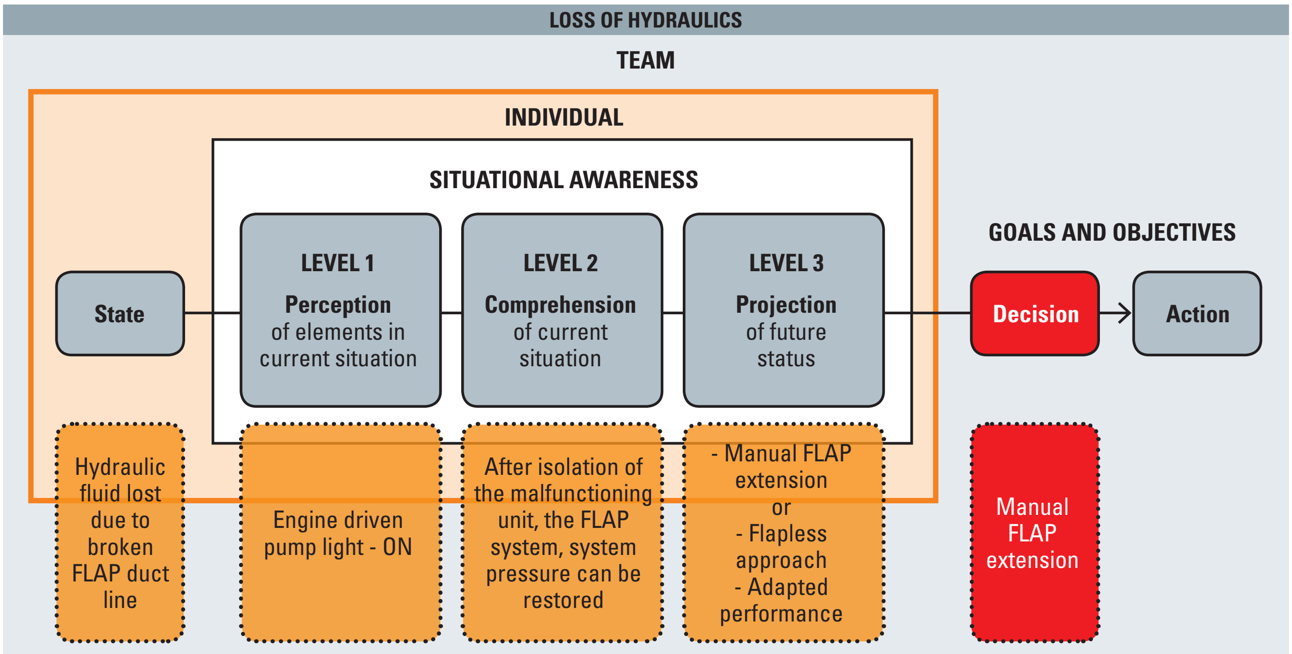
A crew takes-off on a regular mission, the profile is a standard cruise flight with associated workload as indicated - low.



In the cruise, a hydraulic leak occurs - workload becomes higher.



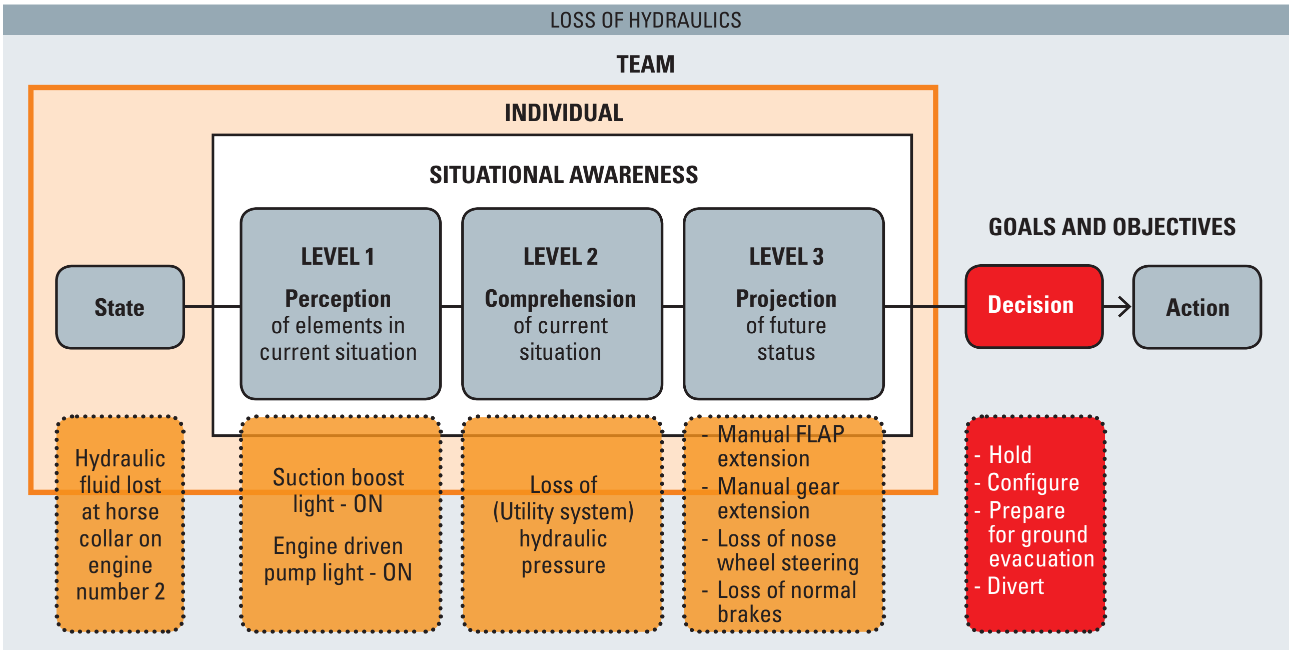
The crew is alerted to the leak by the illumination of a light in the flight deck and after isolating the leak, which is in the malfunctioning flap line, they anticipate either the extension of the flaps manually or a flapless landing.



But the action taken has reset the initial state and the loop which must be closed and the SA development process re-run. Not doing this would create a hazard which can be analysed as follows:

Generic hazard	Specific components of the hazard	Hazard related consequences	Causes	Existing mitigations safety controls and/or requirements
Focus on solution	N/A	Lacking to see new situation	Human nature. Lack of metal flexibility	Focus on hazard identification rather than solution Performing the SA feedback loop

Let's now assume that 'Murphy' is on board and that despite the earlier correct initial response, a total loss of hydraulic fluid subsequently occurs. Transposed into the SA model, the appropriate action follows. The crew works swiftly and SA is maintained throughout the team. Operational Risk Management is (again) performed using the Abnormal/Emergency Checklist and the effect of the hazard is contained. The team now includes ATC and Base operations who are informed. It is a busy time at Brussels National - the home base of the C-130 as well as the main Belgian civil airport - and when ATC are advised that after landing, the runway will be temporarily blocked because the aircraft cannot be taxied without nose wheel steering, they request that the aircraft diverts to a nearby air base at Beauvechain. Base Ops and the airbase are informed and the fire services at the latter are put on standby. A perfect example of Team Resource Management.



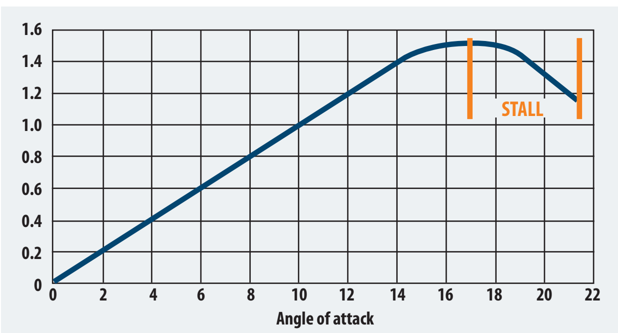
Without keeping ATC in the picture by projecting a significant consequence of the aircraft status, a short delay in clearing the landing runway could have surprised them. Keeping up with reality is part of the SA deal.

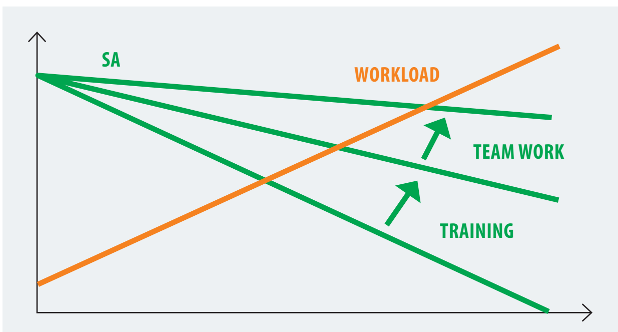
SA Examined

Now let's dig deeper into SA. The Generic Hazard of 'Loss of SA' can be based on two possibilities - the wrong decision is taken or no decision is taken. The hazard-related potential consequences are either an unsafe condition or a crash.

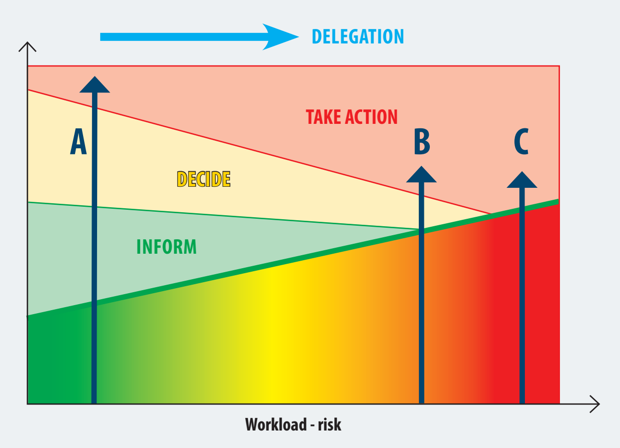
Any event during flight can be classified as normal, abnormal or emergency. Different workloads apply to each. If one views flying an aircraft as achieved through error management, which is linked to SA, then the achievement of SA can be seen as inversely proportional to workload. Any aviator will be familiar with following graph:

Take the CL axis as individual SA and the AOA axis as workload. Although the SA is not solely a function of workload, the parallel is that at some point an individual's SA is going to stall. The most important lesson to remember is that everybody subject to this law, justifying the need for both assertiveness and a questioning culture. It is useful to look at workload more closely. The steepness of the curve can be trained and increased with experience, it will be affected by the circadian rhythm, the mental freshness and mostly: the interaction with SA-feeders.





Like a stall, loss of SA is easily predicted if not gradually encountered. But workload is a personal experience. People have no gauge, so although increased workload can be apparent in observed behaviour, an individual's workload assessment should be verbalised to team members because others may not have time to observe as they may themselves be (over)loaded. In general one can state the higher the workload, the higher the need for delegation and interaction.



From the picture above we can discern 3 situations: A, B and C.

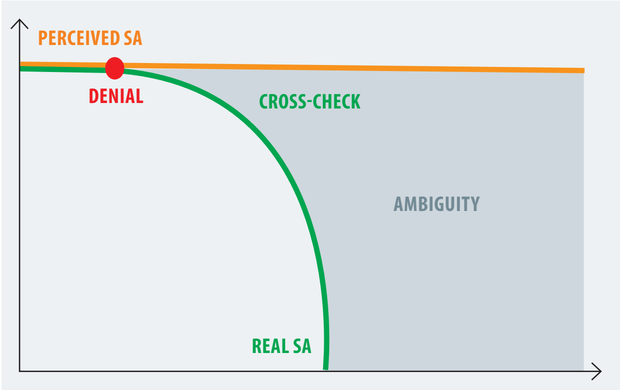
- A is a low workload/risk situation with plenty of time available so a collaborative decision on the action to be taken is possible.
- B is a medium workload/risk situation with less time to respond, e.g. reaching decision height on an approach it's 'continue/land' or 'go around'
- C is a high workload/risk situation and an immediate response is required - think of a corrective TCAS RA or an EGPWS "PULL UP" warning.

When workload is low, the information threshold should be low to ensure a smooth input on which to build SA. Understanding workload will help crew members understand when to feed information and when not to . In the event that workload increases, task distribution should be clearly defined and delegation by the aircraft commander becomes key.

Technology can be a great help in automatically setting information thresholds - by protecting cognitive capacity. The software which delivers these thresholds is predictable whereas humans are not so establishing an in depth 'Service Level Agreement' within any SOP is essential: vital information MUST be passed on to the flying pilot at all time and non-essential info-flow must be avoided. Pilots must know what to expect from each other and so standardisation is paramount. Techniques are allowed for Individual SA, whereas procedures (which are often adopted techniques) apply to Team SA. The art of communication must be understood too. Of course this can be learned 'on the job', but it is better to consider it in the classroom first!

Understanding SA means recognising that it is a time-bound concept, that it is lost rapidly the second you 'stall' because of workload or interruption or distraction. Letting people sort things out by themselves to regain SA tends to be time-consuming. A more efficient way is to admit the loss of SA and allow the rest of the Team to respond with that knowledge. To ensure shared or Team SA is maintained, , briefing is essential - before take off or during flight - and must be given time it deserves. And of course, from the shared SA perspective, the SA "state vector" extends beyond the aircraft state vector (x, y, z, t, etc) as other factors such as ATC instruction, positional awareness, aircraft energy management, Checklist status, intra crew communication come into play.

Finally, and perhaps most important of all, we must not forget that SA has two dimensions, perceived SA and real SA and it is clear that any gap between the two must be minimised. Denial of this possibility must not be an option.



In some situations a 'state' may present itself similarly for different reasons (causes) creating ambiguity. So it is paramount to perform an in-depth (engineering) analysis, i.e. to 'sniff before you buy'. Once someone puts a label on a situation it can lead to others following on that basis, so a sound questioning culture with assertiveness (not aggressiveness) is essential. A suspicion must be validated to rule out probability, assuming amounts to staking odds. Zooming out and falling back on a rule of thumb can be a helpful method to avoid being lured into false conclusions.

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