Situational awareness (SA)

CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

What is Situational Awareness?

Situational awareness (SA) is having an accurate understanding of 'what is going on' relating to the situation or system of context to you, whether you are flying or controlling aircraft, attending to passengers, or maintaining an aircraft or system. In operational terms, SA means having an adequate understanding of the current and changing state of a situation or system and being able to anticipate future system or environmental variations or developments.

In context SA means:

> Pilots: having an understanding of the existing inter-relationship of location, flight conditions, configuration and energy state of the aircraft, as well as any other factors that could be about to affect its safety (e.g. terrain, obstructions, airspace reservation and weather systems).
>
> Cabin crew: having an understanding of the current safety, welfare and behaviour of the passengers, position and status of fellow crew members, and the operational environment, while interpreting the cues during different flight phases and thinking ahead to anticipate potential developments (such as go-arounds, passengers becoming unruly or distressed, etc).
>
> Air traffic controllers: having an understanding of the traffic being managed, the current aircraft positions and flight plans, as well as predicting future states so as to detect and recognise possible conflicts, or potential unexpected changes.
>
> Maintenance engineers: having an understanding of the factors, conditions and systems that could affect the safe operation of the maintenance activity, now and in the future.

The Three Levels of SA

Defining SA, Dr Mica Endsley a leading researcher on SA, describes three key processes. These three processes can be considered as three hierarchical levels:

1. perception (noticing, scanning, gathering data) of what is happening
2. comprehension (understanding) of the meaning in relation to tasks/goals
3. projection (anticipation) of future states, using what has been understood to plan the most favourable course of action.

SA Level 1: Perception

The first level of SA is perceiving the current status of the environment or situation. This involves scanning your environment using your senses (such as vision and hearing, etc.), to gather information about the most important and relevant features and/or factors around you. Failing

to detect, or store data in memory, as well as misperceiving the data are potential problems that can impact this level of SA.

SA Level 2: Comprehension

The second level of SA is comprehending (understanding) the relevant information perceived. Our understanding can be built by combining the data we've gathered (perceived) from the real world with our knowledge and experience recalled from memory. This representation of the 'world' based on our knowledge, experiences and observations is known as a mental model. An important part of comprehension is thus building or adjusting our mental model in light of our observations of what is happening around us and our interpretation of what this means in terms of impacts on our goals and objectives. We can experience a breakdown in comprehension, when our mental model is flawed, due to incorrect information, or misinterpretation, etc.

SA Level 3: Projection

The third level is projection and involves the individual's capability to project (i.e., think ahead) to the future actions of the environment's elements and the future state based on the information perceived and comprehended. This is especially critical when systems have a high level of interdependency. If our mental model is incomplete or inaccurate then our ability to anticipate future events accurately is compromised.

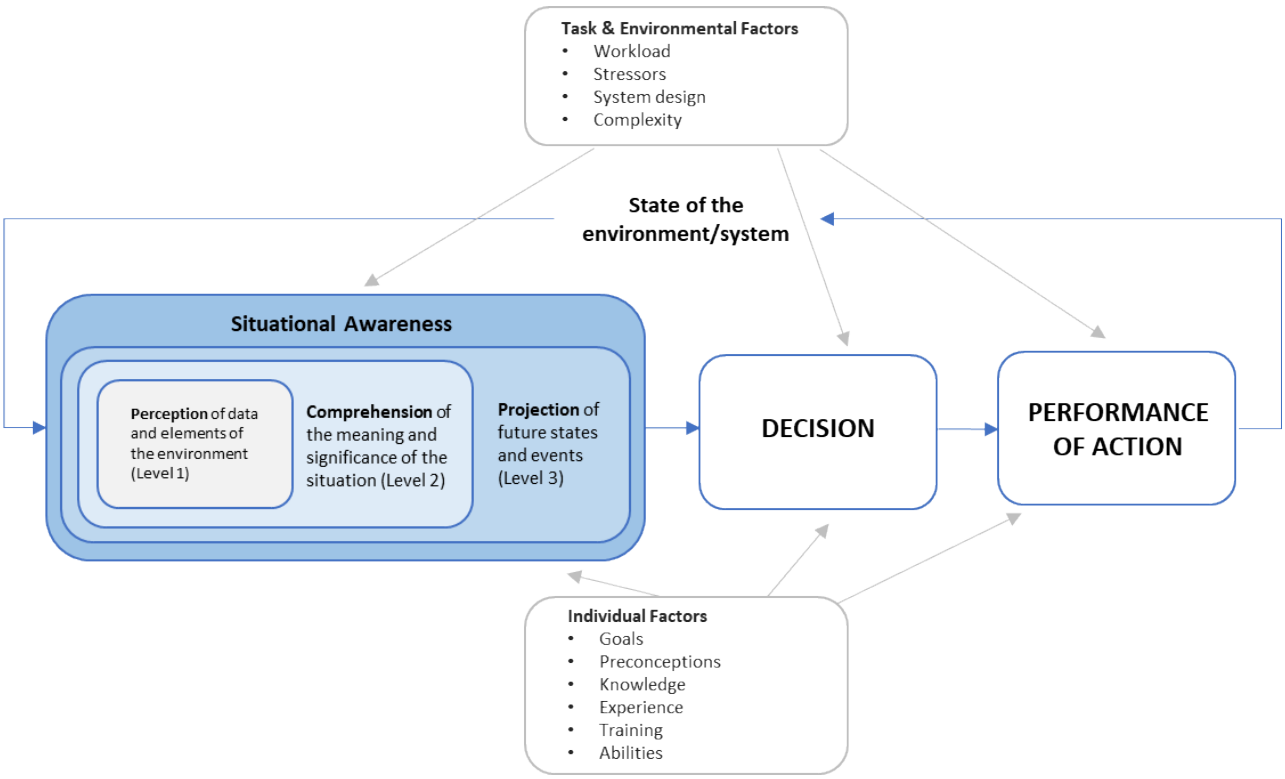

Figure 1. Endsley's model of situational awareness.

Why is SA important?

Reaching high levels of safety, productivity and quality are important objectives in operations. To achieve these goals, people performing safety-related duties need to be aware of their surroundings and the potential hazards they or others face. SA is vital for accurate decision-making in complex and dynamic environments, especially when a failure to recognise the problem or state that requires a decision or action, can result in accidents or serious incidents.

Not having or maintaining the appropriate SA can and has resulted in catastrophic accidents, with SA commonly noted as a contributing factor in multiple types of accidents and/or serious incidents, including:

- Loss of control in-flight
  CAANZ Safety Investigation Report 13/1524 - Departure from controlled flight
- Controlled flight into terrain (CFIT)
  CAANZ Safety Investigation Report 12/2242 – Controlled flight into lake
- Tail rotor strike
  ATSB Safety Investigation Report AO-2020-023 - Collision with terrain
- Loss of separation
  TSB Safety Investigation Report A18Q0069 – Loss of separation
- Avoidable Evacuation
  AAIB Safety Investigation Bulletin AAIB Bulletin: 9/2020
- Runway Incursion
  CAASA Investigation Report CA18/3/2/0799 - Rejected take-off due to runway incursion

Shared SA

Shared SA is a term used to express a collective sense of 'What is going' between multiple people. There are numerous situations within aviation where shared SA becomes important. These include multi-crew environments, ATC/pilot coordination in controlled airspace, Flight crew/cabin crew interactions and complicated maintenance tasks.

Shared SA can be considered an extension or supplement to the principles of SA as outlined above but requires additional communication and coordination between individuals. A shared understanding allows the crew/team to dynamically self-organise when confronted by environmental changes, and/or changes to the crew/team itself. This is important for team performance, enabling team members to share information and workload, monitor the behaviour of others and 'line up' expertise with task demands.

The extent to which shared SA is necessary differs depending on the circumstances, not all parties need to have the same level of SA. However, each party needs a sufficient level of SA to

complete their role effectively including interaction with others. Good communication is essential, too much or too little can have detrimental effect on the recipient's SA.

How to build and maintain SA

By being aware of what is happening around you and understanding how information, events and your own behaviour will affect your own goals, you have SA. Having SA doesn't happen by accident, it is a cognitive skill. You need to build and maintain SA to ensure that you are able to stay ahead of a situation and avoid being caught off guard or unprepared.

Building SA

- Manage workload: Shift tasks away from busy times, delegate tasks and anticipate future workload. Communicate with your team and brief others on what you expect.
- Think ahead: Anticipating the future or thinking ahead allows you to compare the projected state or environment with your objectives or goals, so you can plan your next steps.
- Make risk assessments: Think about what could happen, ask yourself *"what if?"*

Maintaining SA

- Communication and information exchange: Communication quality (rather than quantity) is important. There is no one size fits all approach to keep others in the loop, therefore the way communication takes place needs to be specific to the context, the people involved and their tasks and responsibilities. If there are any signs of miscommunication or indications of degraded SA, speak up.
- Attention management and planning: SA is about knowing what is going on around you. This requires you to continuously be attentive, set priorities, and monitor what is going on in the environment, focusing on the elements that are important to achieve a certain task or objective. Be prepared to readjust your plan if required.
- Seek information and check your understanding: Know what information is important, when to seek it, and where to find it. To ensure you have all the relevant and accurate information to make decisions, use multiple sources to cross check information to ensure you understand the situation. If you feel unsure or uneasy about a situation, check for contradictory elements or information to validate your data.

Factors that can impact SA

SA may sound like a simple concept, but many factors can impact on your awareness of the situation and we must continually monitor for cues which may indicate that your SA is compromised.

Workload

It's easier to overlook important information when you have a high volume of work. Having a lot to do with limited time, is unfortunately a common occurrence. Trying to accomplish everything and not having the time, tools or resources to do so can lead to task saturation, and often we can become too busy to recognise that we are trying to do too much.

Overload

Achieving SA requires more than having lots of information available. As humans we are limited in terms of how much information we can process (such as from displays, communications, documentation and alarms). We also have limits on how may 'items' we can store in our memory. It is important that we identify what and when information within the context of a problem or scenario is needed.

Underload

Prolonged monitoring tasks or those that can introduce the 'boredom factor', can lead to performance degradation, including reduced alertness, and poor decisions. The decline in a person's ability to sustain attention and remain alert over an extended period of time is termed the vigilance decrement.

Distraction

We have limited ability to divide attention amongst tasks and generally, have to switch attention back and forth between tasks. This leaves us vulnerable to losing track of the status of one task when our attention is drawn away from the task at hand, or while engaged in another task.

Insufficient or poor communication

Incomplete, inaccurate, and/or poorly communicated information can result in a flawed mental model and impact a person's ability to make accurate decisions.

Stress and fatigue

Fatigue and stress can also reduce the ability to make important observations, interpretations and decisions, and if left unmanaged can increase the risk of errors.

Culture and organisational 'norms'

Just because we have always done something in a particular way doesn't necessarily mean it will always be appropriate for the current situation.

Cognitive biases

As humans we all have limitations on our cognitive abilities and information processing capabilities (i.e., attention and perception) and thus some factors and/or biases can distort the way we perceive situations.

- Inattentional blindness - The phenomenon of failing to perceive what would appear to others as 'in plain sight', often referred to as the 'looked-but-failed-to-see' effect.
- Confirmation bias - The tendency to search for evidence or interpret information that is consistent with a presently held view or understanding of the current situation, even in the light of contradictory information.

How to detect loss of SA

It is important to look for indicators that your SA has degraded. The following issues may suggest that you do not have SA.

- Confusion: you are uncertain or uneasy about a situation or information.
- Poor communication: you are giving or receiving vague or incomplete information/statements.
- Fixation: you are focused on one task or element to the exclusion of everything else.
- Distraction: you are frequently switching attention, not focused on the primary task.
- Non-compliance: you are not following standard operating procedures or regulatory requirements.
- Expected checkpoints not met: things aren't going to plan; time, progress, workload.
- Ambiguous or contradictory information: you can't resolve conflicts, information from two sources does not agree or make sense.

How to recover SA

If you recognise that your SA has degraded, the following points may help you recover the 'big picture', enabling you to re-build your SA.

- Follow rules, procedures and standard operating procedures.
- Communicate and speak up if you're unsure or find yourself uncertain or confused.
- Manage stress, distraction and workload, take time to think and expand your focus to avoid fixating on one task and succumbing to tunnel vision.

References

Bolstad, C. A., & Endsley, M. R. (1999). Shared mental models and shared displays: An empirical evaluation of team performance. *Proceedings of the 43rd Meeting of the Human Factors & Ergonomics Society, 43*(2), 213-217.

Endsley, M. R. (1995a). *A taxonomy of situation awareness errors*. Aldershot, England: Avebury Aviation, Ashgate Publishing Ltd.

Endsley, M. R. (1995b). Measurement of situational awareness in dynamic systems. *Human Factors, 37*, 65-84.

Endsley, M. R. (1995c). Towards a theory of situation awareness in dynamic systems. *Human Factors, 37*, 32-64.