Flight Operations Briefing Notes

Human Performance

Enhancing Situational Awareness

I   Introduction

This Flight Operations Briefing Note presents a definition of situational awareness. It explains the complex process of gaining and maintaining situational awareness, focuses on how it may be lost and proposes prevention and recovery strategies.

This briefing note is intended to help the reader gain and maintain situational awareness, to prevent falling into the traps associated with the loss of situational awareness and to avoid the adverse effects of the loss of situational awareness on flight safety.

II   Background Information

Situational Awareness is (Source: Mica Endsley – 1988):

- The perception of the elements in the environment within a volume of time and space
- The comprehension of their meaning
- The projection of their status in the near future.

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 enties and flight planning functions

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- **Spatial Orientation**: Awareness of geographical position and aircraft attitude

- **System Awareness**: Awareness of status of aircraft systems

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

III Statistical Data

Situational awareness is not just a theoretical notion and is pertinent to most accident or incident cases. It is real, and its absence causes accidents. Research from the Australian Transportation Safety Board (ATSB) indicates that human factors is a contributing cause in around 70 percent of all incidents and accidents. Approximately 85 percent of incident reports include a mention of loss of situational awareness. Degraded situational awareness can lead to inadequate decision making and inappropriate actions. This is illustrated in **Table 1**, which identifies causal factors involved in approach and landing accidents.

| Factor	% of Events
Inadequate decision making	74%
Omission of action or inappropriate action	72%
Non-adherence to criteria for stabilized approach	66%
Inadequate crew coordination, cross-check and back-up	63%
Insufficient horizontal or vertical Situational Awareness	52%
Inadequate or insufficient understanding of prevailing conditions	48%
Slow or delayed action	45%
Flight handling difficulties	45%
Deliberate non-adherence to procedures	40%
Inadequate training	37%
Incorrect or incomplete pilot/controller communication	33%
Interaction with automation	20%

Source: Flight Safety Foundation - Flight Safety Digest Volume 17 & 18 – November 1998 / February 1999

Table 1

Causal Factors in Approach and Landing Accidents

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IV   Gaining and Maintaining Situational Awareness

Situational awareness is having an accurate understanding of what is happening around you and what is likely to happen in the near future. As shown in **Figure 1**, situational awareness includes three processes:

- The perception of what is happening (Level 1)

- The understanding of what has been perceived (Level 2)

- The use of what is understood to think ahead (Level 3).
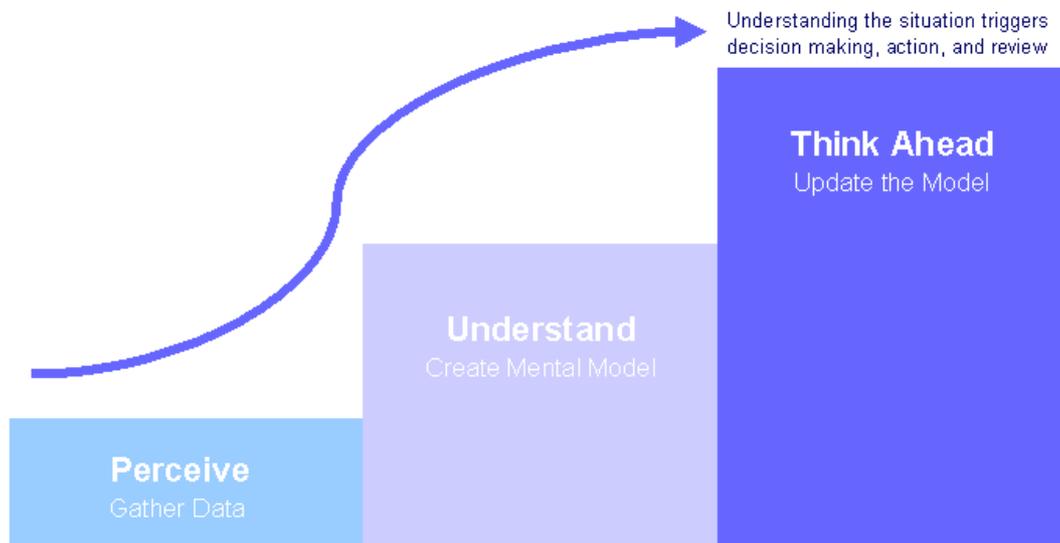
Source: Adapted from Endsley's definition

Figure 1

Gaining and Maintaining Situational Awareness

Level 1 — Perception: scanning, gathering data

To build a mental model of the environment, it is necessary to gather sufficient and useful data by using our senses of vision, hearing and touch to scan the environment. We must direct our attention to the most important and relevant aspects of our surroundings and then compare what we sense with experience and knowledge in our memory.

It is an active process that requires significant discipline, as well as knowing what to look for, when to look for it and why.

e.g., **Gather flight plan data:** Available routes, Available altitudes, Planned flight path, Dispatcher's concurrence with plan, Fuel reserve requirement, Arrival fuel requirement, Assigned runway, Planned climb profile, Planned airspeed profile …

Level 2 — Representation: understanding, creating our mental model

Our understanding is built by combining observations from the real world with knowledge and experience recalled from memory. If we successfully match observations with knowledge and experience, as shown in **Figure 2**, we have developed an accurate mental model of our environment. This mental model has to be kept updated with inputs from the real world by paying attention to a wide range of information.

Figure 2

Understanding the Situation by Matching Mental Model and Real World

e.g. **Understand flight plan data**: Deviation between plan and optimal profile, Safety/legal requirements, Aircraft capabilities and ATC requirements, Fuel reserves , Schedule deviation, Heading deviation, Altitude deviation, Airspeed deviation …

Level 3 — Projection: Thinking Ahead, Updating the Model

Our understanding enables us to think ahead and project the future state of our environment. This step is crucial in the pilot's decision making process and requires that our understanding, based on careful data gathering, is as accurate as possible. It simply is " Flying ahead of the aircraft".

e.g. **Project flight plan data**: Projected taxi time, Projected schedule deviation, Estimated time of arrival, Predicted fuel usage, Predicted fuel burn rate, Projected time available on current fuel, Predicted time to destination …

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V   Situational Awareness and Decision Making Process

Situational awareness is strongly related to the decision making process. **Figure 3** shows a simple model of the tight coupling between situational awareness and decision making. Situational awareness must precede decision-making because the operator has to perceive a situation in order to have a goal.
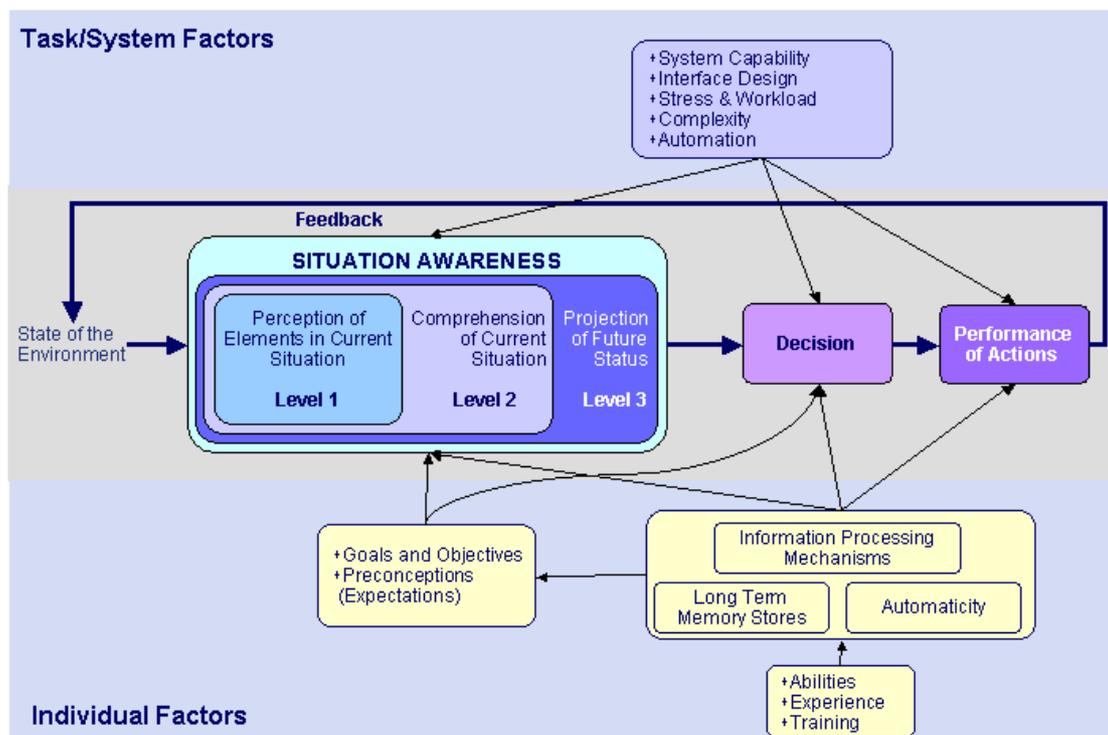
Source: Endsley, 1995

Figure 3

Situational Awareness and Decision Making

Our actions are driven by goals. To help us act to achieve our goals, we use our mental models to anticipate the outcome of our action. This can be thought of as a feed-forward process.

The more we anticipate accurately, the more efficient we become in our tasks, the more energy we save, and the more we can preserve resources for unexpected situations.

Conversely, by comparing the results of our actions with set goals, we can modify our actions or, if necessary, our goals. This feedback is vital to the success of the process.

Feedback and anticipation help keep our mental picture of the world aligned with the real world.

A major loss of situational awareness occurs when inappropriate mental representations are activated in spite of real world evidence. People then act "in the wrong scene" and seek cues confirming their expectations, a behavior known as confirmation bias.

In other words, situational awareness influences our decision making and allows us to stay ahead of the aircraft:

- It helps us develop a mental picture of the world around us and use that mental picture to anticipate the future, to feed-forward

- Because of the close coupling of real-world feedback, mental anticipation and adaptation of actions, we adjust our mental picture and modify our actions. If what we expect to happen and what is really happening does not coincide, we may even adjust our goals. This is often coupled with a feeling that we have lost "control".

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VI Losing Situational Awareness

Many factors can cause a loss of situational awareness. Errors can occur at each level of the process previously described. **Table 2** lists a non-exhaustive series of factors related to loss of situational awareness and conditions contributing to these errors.

Level 1: Perception

• Data is not observed, either because it is difficult to observe or because the observer's scanning is deficient due to:
    – Tunnel vision
    – Passive, complacent behavior
    – High workload
    – Distractions and interruptions
 • Visual Illusions
 	
 E.g. Focusing on recapturing the LOC and not monitoring the G/S.

Level 2: Understanding

• Use of a poor or incomplete mental model due to:
    – Deficient observations (Level 1 problem)
    – Poor knowledge / experience.
 • Use of a wrong or inappropriate mental model
 • Confirmation bias: perceived information is misunderstood. Expecting to observe something and focusing our attention on this belief can cause seeing what you expect rather than what is actually happening.
 	
 E.g. Applying a fuel imbalance procedure without realizing it is an engine fuel leak.

Level 3: Thinking Ahead
• Over-reliance on the mental model and failing to recognize that the mental model needs to change.   E.g. Expecting an approach on a particular runway afther having received ATIS information and being surprised to be vectored for another runway.

Table 2

Typical Factors Involved in Loss of Situational Awareness

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VII   Best Practices, Prevention Strategies and Lines-of-Defense

Build Situational Awareness :

- **Set specific objectives**
    - Define flight targets and data gathering

- **Set priorities**
    - Follow SOPs

- **Prepare for anomalies**
    - Consider visual illusions, missing information, etc.

- **Make risk assessments**
    - Ask, "what if?"

- **Manage workload**
    - Shift tasks away from busy times, delegate, anticipate.

Maintain Situational Awareness :

- **Communicate**
    - Keep all crewmembers and external participants (e.g., company flight dispatch / flight watch office) in the loop

- **Manage attention**
    - Set priorities, avoid distraction, adjust monitoring to flight phase urgency

- **Seek information**
    - Use your senses
    - Know WHAT is important, WHEN to seek for and WHERE to find it
    - Validate your data
        - Cross-check – Use multiple sources of information when available
        - Use rules of thumb when data are not available.

- **Check your understanding**
    - Check for contradictory elements in the real world
    - Apply experience and lessons learned.

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- **Think ahead**
  - Brief others on what you expect
  - Compare projected state with objectives
  - Set markers for confirmation and information (define "next targets" at each point of the whole flight and "approach gates" during descent / approach)
  - Compare actual state with expectations and objectives
  - Readjust your plan if required.

Detect Loss of Situational Awareness :

- **Look for clues of degraded situational awareness**
  - Ambiguity – Unclear flight plans or ATC instructions
  - Fixation – Focusing on one thing to the exclusion of everything else
  - Confusion – Uncertainty or misunderstanding a situation or information
  - Preoccupation – Everyone focusing on non-flying activities; nobody flying the aircraft
  - Unresolved discrepancies – Contradictory data or personal conflicts
  - Expected checkpoints not met – Flight plan, profile, time, fuel burn
  - Poor communications – Vague or incomplete statements
  - Broken rules – Limitations, minimums, regulatory requirements, failure to follow SOPs
  - No time – Falling behind the aircraft.

Recover Situational Awareness :

- **Go to the nearest STABLE, SIMPLE and SAFE situation**
  - Follow rules, procedures and SOPs
  - Change automation level (user a lower level of automation or revert to hand-flying)
  - Buy time (request delaying radar vectors, a hold or an extended downwind leg).

- **Communicate** – Asking for help is not a sign of weakness

- **Recover the big picture**
  - Go back to the last thing you were sure of
  - Assess the situation from different perspectives, with different sources
  - Expand your focus to avoid fixation and tunnel vision
  - Manage stress and distraction
  - Take time to think / Use that time / Be willing to delay flight progress.

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VIII   Summary of Key Points

- Situational awareness is essential for flight safety and its influence and impact are pervasive

- Situational awareness is gained by using the senses to scan the environment and compare the results with mental models

- Planning, communication and coordination for upcoming flight phases, goal setting and feedback are essential ingredients of Situational Awareness and decision-making

- Inattention, distraction and high workload threatens situational awareness

- To prevent the loss of situational awareness :

    – Implement proven best practices: sterile flight deck, standard calls, CRM, golden rules, instrument scan, …

    – Follow strictly company SOPs.

IX   Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes should be reviewed along with the above information:

- **Human Factors Aspects in Incidents and Accidents**
- **CRM Aspects in Incidents and Accidents**
- **Error Management**
- **Effective Pilot / Controller communications**
- **Managing Interruptions and Distractions**
- **Optimum Use of Automation**
- **Standard Calls**
- **Conducting Effective Briefings**
- **Operations Golden Rules**

X   Additional Reading Material / Websites References

- Enhanced Safety through Situation Awareness Integration in training (ESSAI); Air Transport Portal of the European Commission – Research – 5TH Framework Programme: **http://ec.europa.eu/transport/air_portal/index_en.htm**

- Guidelines for Situation Awareness Training; Air Transportation Division – Branches - Air Carrier Training Branch – Training Aids: **http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/**

- Situation Awareness Information Requirements for Commercial Airline Pilots; MIT / International Center for Air Transportation – Research – 1998: **http://web.mit.edu/aeroastro/www/labs/ICAT/**

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