HUMAN PERFORMANCE IN THE SPOTLIGHT:
DISTRIBUTED SITUATION AWARENESS

In this series, human performance issues are addressed by leading researchers and practitioners in the field. **Paul Salmon** gives some insights into distributed situation awareness and implications for digitalisation.

What is situation awareness?

At a simple level, situation awareness (SA) is the term used in Human Factors to describe the awareness that people have of 'what is going on' around them while performing dynamic tasks. The concept first emerged in aviation during the First World War and has gone on to become one of the most studied and debated topics in Human Factors. Though the initial focus was on the awareness held by individuals, this has now expanded to consider the SA of teams, organisations, and even entire sociotechnical systems. The relationship between SA and performance is complex, however, and it is widely acknowledged that SA is a critical consideration when designing work and work systems. It is especially pertinent to consider SA when designing and introducing advanced automation.

What is distributed situation awareness?

The idea behind distributed situation awareness (DSA) is that, in sociotechnical systems, no one person or 'agent' has all of the awareness required for the system to function effectively.

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Can different agents have the same awareness of a situation?

Our research has demonstrated that different agents have different views on a situation, even when they have access to the same information. Each agents' SA is influenced by their goals, the tasks they are performing, and their experience of similar situations. The fact that different agents have different SA has implications for system design. Rather than attempt to achieve 'shared SA' where all agents have the same awareness of a situation, we have found that 'compatible SA' is more appropriate. This is achieved when different agents' SA connects to give the overall system the big picture. Achieving compatible SA involves acknowledging that individuals have different views on a situation and identifying who needs what information, when, and in what format. Incompatibilities can lead to suboptimal DSA where there are gaps in the SA required for effective performance.

What is the role of technology in optimising distributed situation awareness?

An interesting feature of DSA is that it explicitly considers the SA held by technological agents as well as that held by human agents. The idea that non-human agents could be situationally aware was controversial at first but has since become highly relevant given advances such as artificial intelligence. As such agents gather, interpret, and share information, they play a critical role in ensuring that a system can generate the DSA required for safe and efficient performance. Unfortunately, what we are seeing many areas is a failure to consider the important role that technological agents play in DSA.

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What is important to consider when designing and introducing advanced technologies?

With advanced technologies such as automation, we need to consider not only human agents' SA but also the SA held by automation and how it shares SA-related information with humans and other technologies and vice versa. We have seen many recent incidents in aviation and road transport for example whereby advanced automation has either not been aware of something it needed to be, or where automation has not communicated critical information to human agents. This is not because the automation failed, rather it is because designers have not fully considered what the automation needs to know or what SA-related information the automation needs to pass to human operators. As a result, we are seeing breakdowns in DSA which in turn can lead to catastrophe.

It is important then when designing advanced technologies to consider the SA requirements of both human and non-human agents. What does the advanced technology need to be aware of for the system to function effectively? Then designers need to ensure that the automation can gather and understand the information required to fulfil these SA requirements.

The sharing of information between human and non-human agents is also important to consider. We label this sharing of awareness as 'SA transactions' and have found many instances where these transactions are inadequate, erroneous, or do not occur at all, resulting in suboptimal DSA. For example, in a recent automated vehicle collision, the automation did not inform the vehicle operator of an obstacle that it had detected in the road ahead. So it is critical to consider what information needs to be exchanged, when, and how non-human agents will exchange SA-related information with human agents.

A final consideration is how to ensure that human agents understand what non-human agents are aware of. Without this, it can be difficult for human agents to understand why automation is behaving in a certain manner, or why it has taken a particular course of action.

What happens when systems 'lose' DSA?

As DSA degrades the risk of system failure is heightened. Recent high-profile examples of incidents involving DSA failure include the Air France 447 collision and the Arizona Uber-Volvo test vehicle collision. When investigating and responding to such incidents it is important to maintain a systems perspective. It can be tempting to seek to identify the individual agent who 'lost SA'. However, as the SA required for effective performance is not something that can be held by one individual alone, it cannot be lost by one individual alone. Hence, the most appropriate view to take is that systems lose SA and not the individuals working within them. Accident investigators should examine the overall system to determine why DSA failed, not who lost it. In our experiences, DSA failures most often involve failures in the exchange of SA-related information between human and non-human agents.

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