Towards Situational Disability-aware Universally Designed Information Support Systems for Enhanced Situational Awareness

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ABSTRACT

This paper takes on the challenge of designing situational awareness information systems that take into account not only the prevalence of so-called demons of situational awareness, but also situational disabilities that will typically occur in a disaster situation, both in the control room and in the field among the general public as well as first responders. It further outlines how a situational awareness information system process model can be adapted and used as a basis for designing situational awareness information support systems that address these issues with the help of Universal Design principles.

Keywords

Situational Awareness, Situational Disabilities, Universal Design, Decision Making, Process Model.

INTRODUCTION

Making the right decisions are the essence of why situational awareness (SA) is important for everyone -- emergency responders and citizens -- in a disaster. In such a situation, situational awareness can mean the difference between life and death. However, there is still very little understanding of the fact that disabilities can actually occur to anyone in different environments and slow down the process of developing SA, and especially when we rely on digital tools to actually establish or support SA. In fact, in practice, for a variety of emergency management stakeholders, digital tools for augmenting their SA is essential to identify and interpret observations, predict further development, and communicate the essence of observations to other stakeholders. However, a disaster situation can severely affect our abilities to interact with technology. Time pressure, information overload, fear, shaking ground, smoke, noise, and other effects of the disaster can trigger conditions known as *situational disabilities* (Gjøsæter, Radianti, & Chen, 2019). In brief, situational disabilities are temporary impairments, e.g. of senses and cognitive abilities, caused by the situation. In addition, there are a lot of factors, the so-called SA demons (Endsley & Jones, 2016) that can hinder or delay the SA establishment. Indeed, it is in any situation essential that digital tools are designed to function adequately for all potential users, regardless of their abilities and disabilities, and in particular for tools for enhancing situational awareness, it is also very important that the tools can be handled adequately despite the potential impact of the situation on the users' physical and mental state and the condition of their senses during the disaster.

Universal design principles can be used to ensure that as many potential users as possible are able to use the technology, and research indicates (Gjøsæter et al., 2019) that techniques and design principles that work for permanent disabilities, will also benefit people with situational disabilities. However, Universal Design is still not ubiquitous in digital tools and information systems for situational awareness (Gjøsæter & Radianti, 2018; Gjøsæter, Radianti, & Chen, 2018; Radianti, Gjøsæter, & Chen, 2017).

Information systems for situational awareness, commonly called operational picture (OP) and common operational picture (COP) systems, tend to be strongly map-oriented, as is natural since spatial information is essential for situational awareness (Luokkala & Virrantaus, 2014). However, Luokkala and Virrantaus (2014) propose a process model for Situational Awareness systems that takes into account the decision making process and the need for a narrative component in order to interpret the situational picture and predict further development more efficiently. This process model is presented on an abstract level and allows for a variety of technology choices, designs and implementations. In this paper we will propose how we can adapt the Luokkala et.al.'s process model into a situational disabilities-aware process model for the development of Information systems for Situational Awareness.

The research question investigated in this paper is as follows: *What requirements and development process will facilitate the development of an information support system for situational awareness that takes into account situational disabilities and the Demons of Situational Awareness and mitigates them with a Universal Design approach?*

The rest of the paper is organised as follows. Section 2 covers the background knowledge and literature for this work, including a summary of the most important elements of the theoretical framework from Luokkala and Virrantaus (2014) and an overview of relevant parts of their process model for Information Systems for Situational Awareness. Section 3 covers methodology and Section 4 results and discussion covers requirements and design principles to take into account for adapting the process model to accommodate situational disabilities and using universal design to mitigate these. The paper concludes with Sections 5 that contain concluding remarks and future work.

THEORETICAL BACKGROUND

The first part of this section covers situational awareness, followed by an overview of the "Demons of Situational Awareness" that highlights some of the challenges in designing situational awareness information systems. Then, we cover Recognition Primed Decision Theory which is a major building block of the theoretical framework on which Luokkala and Virrantaus (2014) base their process model for information systems for situational awareness. Finally, we cover the principles of Universal Design and accessibility and describe the issue of situational disabilities as they may occur in a disaster situation, and the possibility to use a universal design approach to mitigate them.

Situational Awareness

SA is essential in an emergency situation, not only for first responders and decision-makers, but also for the general public affected by the emergency. In the literature, SA is developed on an individual level as well as on a team level to comprehend a crisis situation. There are numerous definitions of SA derived from different application areas such as military, air traffic control, large-systems operations, psychology. Thus, SA has been defined in a multitude of ways, mainly centres around three concepts: "the information processing framework", "the reflective quality" and "an embedded work view" (Stanton, Chambers, & Piggott, 2001). For example, Nofi (2000) defines it as "the results of a dynamic process of perceiving and comprehending events in one's environment may change and permitting predictions as to what the outcomes will be in terms of performing one's mission. In effect, it is a development of a dynamic mental model of one's environment". Smith and Hancock (1995) for instance, suggest SA as "the invariant in the agent-environment system that generates the momentary knowledge and behaviour required to attain the goals specified by an arbiter of performance in the environment"

However, the most frequently cited definition of SA is the one proposed by Endsley (1995) who suggests a three-level model of SA. It is referred to 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". These three SA concepts i.e. perception, comprehension and projection have been referred to as Level 1, 2 and 3 SA respectively. On level 1, the actors only perceive the various elements of the environment as separate entities. On level 2, they make sense of the different elements and their connections and understand what it means to the big picture. On level 3, they are able to predict the further development of the system based on your current observations.

When emergency management stakeholders and response teams cooperate in responding to an emergency, team SA would be as important as the individual SA. However, the coordination would be crucial as each team member may have a specific set of SA elements depending on each member's responsibility in the team (Endsley, 1995).

Demons of Situational Awareness

Stanton et al. (2001) point out typical errors in different levels of SA. For example, Data is not available, data is hard to detect or discriminate, failure to observe or monitor data and misperception of data are issues commonly occurring in the Level 1 SA. While lack of, or incomplete mental model, use of incorrect mental model and over-reliance on default values are error types that happen in the Level 2 SA. In level 3 SA, the errors occur both due to lack of or incomplete mental model and over-projection of current trends. From the lens of psychology, the underlying mechanisms of these reduced SA are perception, attention, memory and decision making that play a role in causing errors. Errors due to *Perceptual* issues occur when a person misread or misheard the information. Errors caused by *attention* issue happens when a person is distracted, not attentive to the tasks, or fail to monitor situations. Errors due to memory issues occur when a person has poor retrieval, could not recall, or is confused concerning the information. Errors due to *decision making* happens when a person develops poor interpretation, poor understanding, poor judgment, poor reasoning, or poor planning (Durso, Truitt, Hackworth, Crutchfield, & Manning, 1998).

Various failures of individual situational awareness can lead to degraded team SA (Kaber & Endsley, 1998; Stanton et al., 2001) such as failure to detect critical cues regarding the state of a system; or failure to interpret the meaning of information. Factors that can affect SA and some of these have been referred to as *Demons of Situational Awareness*. Eight categories of SA demons have been identified and each presents its own set of challenges to maintaining SA (Endsley & Jones, 2016).

- D-1: *An attentional tunnelling* occurs when a person has a strong focus on a single or specific task or easily affected by attentional narrowing, and leaves other important parameters that can improve SA or avoid failure. Thus, any emergency supporting systems need to be capable to support multitasking across multiple goals and decisions.
- D-2: *A requisite memory trap* occurs when a person has to deal with too many subtasks and forgets one of them. A human tends to have limitations to hold short term memory and information and therefore any emergency supporting systems should not rely on short term memory that is easily disrupted.
- D-3: *A data overload issue* occurs when the volume and rate of change of information to be taken into account in a situation is faster than a person's ability to keep up with it.
- D-4: *A misplaced salience* can be a problem if the interface of the system is designed to maximize the perception and attention of the user on a specific device, while the salience should be placed on other devices. For example, the overuse of prominent visual features such as bright colors and flashing lights overwhelm and misdirect a person's' attention.
- D-5: *A complexity creep* when a person encounters a problem and involving so many complex systems and cause difficulties for this person to develop accurate situation comprehension and projection and is not able to infer any useful conclusion to solve it.
- D-6: *An errant mental model* occurs when a person misinterprets the current situation due to inappropriate inferences from observations.
- D-7: *An out-of-the-loop syndrome* occurs when an automatic system performs a complex task and suddenly gives the control back to a human, who was in the low awareness of the states of the systems, not following the task and is therefore unable to handle the situation.
- D-8: *A workload, fatigue and other stressor* are another obvious SA demon that causes decreased capability of a person. These factors reduce already limited working memory, disrupt information acquisition, and influence the reduced performance of this person.

While the analysis of these situational awareness demons helps to understand what could happen to people in a stressful situation, the discussions of these SA demons have mostly been limited to operators in control rooms, derived from the safety domain. However, the SA itself has been well augmented into the emergency management setting which typically deals with inter- and intra-organizational emergency management stakeholders and their interactions with affected citizens (Harrald & Jefferson, 2007; Seppänen, Mäkelä, Luokkala, & Virrantaus, 2013; Steen-Tveit & Radianti, 2019; Steen-Tveit, Radianti, & Munkvold, 2020). These works emphasize the barriers and improvement of SA and Team SA, while this work looks at the psychological mechanism that can contribute to reduced SA.

In Gjøsæter et al. (2019), the authors argue that in disaster situations, the SA is also acutely needed for responders in the field as well as the general public (who needs to understand their situation and make informed decisions, and to receive life-saving information from the authorities and to report events of interest). Thus, information delays, errors, misunderstandings, biases and mistakes that hinder SA could also occur in the crisis management setting. The core of establishing SA is to enable a person to develop shared SA and eventually making decisions. Scholars working in the safety area often use psychological theories to explain SA and decision making and rarely touch upon the issues of lack of universally design of supporting tools as a possible explanation of an incident, and the possible occurrence of situational disability when a user uses technologies to develop SA and making decisions. Gjøsæter et al. (2019) suggest augmenting the Demons of SA (Endsley & Jones, 2016) with a supplementary set of demons covering various *situational disabilities* that may occur in the field as well as in the control room.

For these reasons, we include two additional concepts i.e. Recognition Primed Decision (RPD) as a relevant theory to explain a person's decision-making mechanism under pressure, and situational disabilities that can impair someone's judgment on a disaster situation as well as their senses and motorics. Based on these additional concepts, we argue how universal design can contribute to minimize SA demons.

Recognition Primed Decision Theory

Recognition-Primed Decision (RPD) is based on two-minds theory (Klein, 1993). The two minds theory assumes humans possess both *an old mind*, which resembles the cognitive systems of higher non-human animals (*System 1*), and a new mind which is uniquely developed in humans (*System 2*) (Evans, 2014). On one hand, *System 1* includes the following features: unconscious mind, reflexive, low effort, fast, non-verbal, evolutionarily old, parallel, tacit knowledge and contextualized. On the other hand, *System 2* encompasses the following properties: conscious mind, reflective, intentional, high effort, slow, evolutionarily new, linked to language, sequential, explicit knowledge and abstract (Luokkala & Virrantaus, 2014). Furthermore, the authors indicate that the human brain tends to choose effortless and energy-efficient options and therefore *System 1* often supersedes *System 2* and makes almost every human decision as the latter is slow and requires high efforts.

Therefore, there are two ways for humans to know and make decisions. The so-called *System 1* illustrates how intuitive pattern recognition is supplemented by a logic-based conscious simulation (*System 2*) that checks the actions to avoid decisions based on unwanted biases. Luokkala and Virrantaus (2014) adopted the theory to explain a mental process that leads to SA, as shown in Figure 1. Using the concept in this figure, they accentuate the importance of adding narrative approach which can be an efficient way to organise cues into plausible patterns, a way for actors to recognise patterns that they have previously encountered or heard about from their peers, and also a way for experts to produce memorable patterns for assisting in future decision making (Oliver, Snowden, Schreyögg, & Koch, 2005; Torell, 2005). We reuse Figure 1 in the following to detect and understand the underlying mechanisms of a person that leads to poor SA and decision making, and this can be used as a framework and process model for designing situational disability-aware universally designed systems to improve SA.

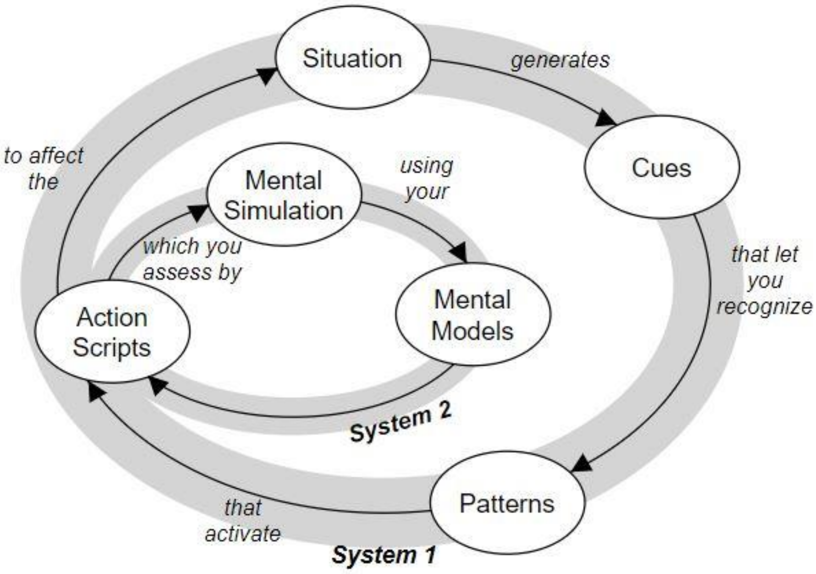

Figure 1. Recognition-Primed Decision model from Luokkala and Virrantaus (2014)

Universal Design and Situational Disabilities

Universal Design is defined in "The Principles of Universal Design" by Connell et al. (1997) as: "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." The following 7 principles of Universal Design highlights the importance of features such as flexibility, simplicity, and perceptibility; features that are also particularly relevant for any technology to be used in a crisis situation:

- UD-1: *Equitable use* - The design is useful and marketable to people with diverse abilities.

- UD-2: *Flexibility in use* - The design accommodates a wide range of individual preferences and abilities.
- UD-3: *Simple and intuitive use* - Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- UD-4: *Perceptible information* - The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- UD-5: Tolerance of error - The design minimizes hazards and the adverse consequences of accidental or unintended actions
- UD-6: *Low physical effort* - The design can be used efficiently and comfortably with a minimum of fatigue.
- UD-7: *Size and space for approach and use* - Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture or mobility.

A prerequisite for the Universal Design of ICT is *accessibility*. In particular, the World-Wide-Web has a well-established set of guidelines for accessibility of webpages, defined by WAI/W3C in The Web Content Accessibility Guidelines (WCAG). WCAG 2.1 (Kirkpatrick, O'Connor, & Cooper, 2018) defines 4 top principles supported by in total of 13 guidelines, as well as testable success criteria and techniques for implementation for each guideline. The guidelines are as follows:

- WCAG-1: *Perceivable* - Information and user interface components must be presentable to users in ways they can perceive.
- WCAG-2: *Operable* - User interface components and navigation must be operable.
- WCAG-3: *Understandable* - Information and the operation of user interface must be understandable.
- WCAG-4: *Robust* - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

The principles of universal design as well as the WCAG principles and guidelines can be applied to any ICT artifact and interactive systems, in order to ensure that they are usable by as many potential users as possible. It is clear that the principles of Universal Design of ICT can play a particularly valuable role in Emergency Management (Gjøsæter et al., 2018; Radianti et al., 2017). Also in the control room, universal design can play a significant role in supporting situational awareness (Gjøsæter & Radianti, 2018).

Situational Disabilities (also known as *situational impairments* or *situational limitations*) occur in situations "*that limit a person's ability to hear, see, use their hands, concentrate, understand instructions, etc*." These issues can be increasingly prevalent in an emergency situation, for example, caused by stress and cognitive overload, fear, deafening or distracting noise, shaking ground, cold or wet hands, and smoke or dust in the eyes. We can divide Situational Disabilities into the following 8 categories from Gjøsæter et al. (2019), with examples of cause/effect where appropriate.

- Touch SD: Lack of sensitivity caused by cold/water/fear: Not detecting haptic feedback/vibration.
- Vision SD: Smoke/dust/no electricity.
- Hearing SD: Noise.
- Cognitive (understanding) SD: Stress, fear.
- Speaking SD: Language barrier, too much noise to be heard.
- Moving SD: Blocked, slowed or redirected movement.
- Dexterity SD: Lack of fine-motorics caused by cold/water/fear: Barrier for access to ICT-based SA tools.
- Cognitive (act) SD: Paralysed by fear/stress.

In Gjøsæter et al. (2019) a scenario-based approach augmented with personas is used to illustrate the occurrence of situational disabilities in emergency situations, and to show how environmental factors can trigger these situational disabilities. Personas representing typical characteristics and roles help to explore the scenarios to show how these situational disabilities can affect the situational awareness of different stakeholders, not only in the command and control centers but also first responders in the field as well as affected members of the public. This suggests that *Universal Design of ICT* can be a particularly useful approach for stakeholders in a disaster situation that depends on situational awareness (Gjøsæter et al., 2019).

METHODOLOGY

To answer the research question, we have examined relevant theoretical background, and in particular Luokkala and Virrantaus (2014)'s approach to situational awareness, as well as relevant principles of universal design and accessibility in order to gain an understanding of the needed features of such systems and their inherent risks regarding situational disabilities and demons of SA. A team of three experts has then proposed a set of mitigation requirements targeting the specific interaction modes and their risks, based on the principles of universal design. We briefly outline a simple user-centered development process for ensuring that the requirements as well as other user needs are met, based on best practices in the development of universally designed information systems.

RESULTS AND DISCUSSION

Recognizing SA Demons in RPD-based Decision Making

We argue that decision making is a peak of the SA that triggers a set of alternative actions. Using the model in Figure 1, the SA Demons are mapped into the diagram as seen in Figure 2 (a), indicated with yellow (*System 1*) and blue (*System 2*) rectangles:

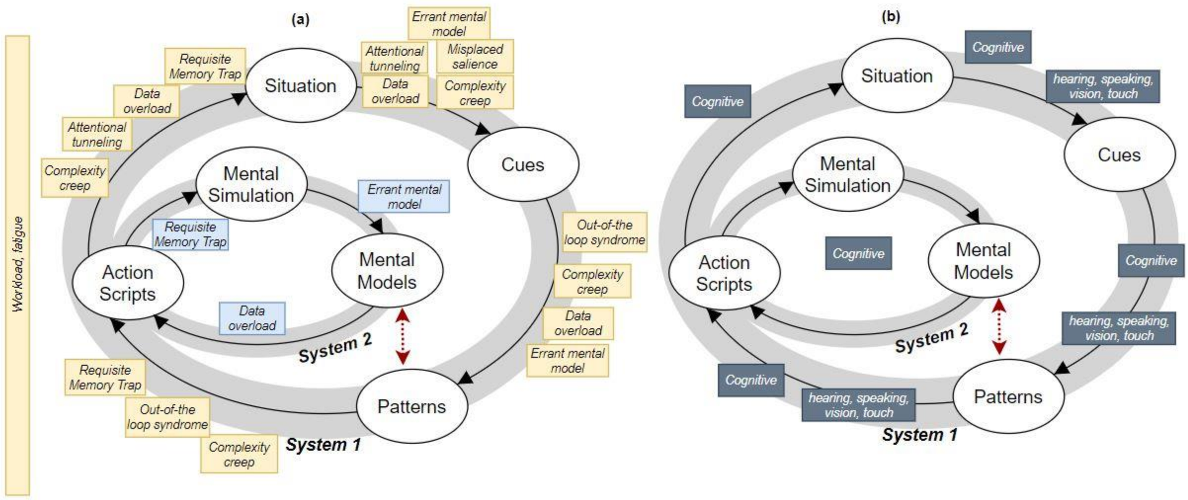

Figure 2. (a) Mapping potential SA Demons into the RPD model; (b) Mapping Situational Disabilities (SD)

In the literature, the domination of *System 1* over *System 2* occurs, especially among novice decision-makers. While an expert decision-maker with a long career makes a decision using *System 1* and *System 2*. *System 1* is mostly automatic for an expert to observe cues, recognize patterns from situations, form initial impressions on how to react to the situation at hand, but is not necessarily without biases (Luokkala & Virrantaus, 2014). Several potential SA demons that could occur in different stages of decision making are mapped in the RPD model (Figure 2(a)). It is clear that *Workload, fatigue and other stressors* can affect the process in any state of the process, while other demons are more prevalent in specific parts of the process, like *Errant mental model* that primarily comes into play while interpreting *Cues* into *Patterns* in *System 1* or going from a *Mental Simulation* to forming a *Mental Model* in *System 2*. An expert can intuitively activate *System 1* and *System 2* almost simultaneously, where the latter will check the actions to avoid decisions based on unwanted biases, which in this figure is represented with a red arrow, linking patterns and mental models. Note that at the citizen level, many of them may be untrained, novice decision-makers (i.e. individuals who try to act to save themselves from disasters), thus the demons mapping are highly relevant. Assuming information technology and supports are used in improving SA and decision making, Figure 2(b) shows the potential situational disabilities that could occur in various stages: cognitive, voice, touch, hearing, and vision disabilities. Here it can be seen that *Cognitive SD* corresponds closely to the demon *Workload, fatigue and other stressors and affects all parts of the process, while the sense-related SDs come into play where there is an interaction with the environment or with technology.* We use these mappings for proposing requirements for technology support that can help removing the SA demons in the next section.

Requirements based on Universal Design Principles

We will take as a starting point a SA system in the form of a smart-phone app for first responders and command and control in the field, connected through a backend with information screens and communication tools for the remote command and control room.

The main interaction modes on the smart-phone app are input and output, requiring actions from four different categories while interacting with a SA system, typically performed in a loop that can be mapped to the RDP model as shown in Figure 3:

- I-1: information output, from sensors or messages from fellow responders or command & control (text, image, voice and haptic feedback, corresponding to cues in the RDP model.
- I-2: information merging and interpretation, supported by the user's System 1 pattern recognition.
- I-3: decision making support, nudging the decision from the user's System 1 towards System 2.
- I:4 information input (through touchscreen or voice control) as a digital action corresponding to the real-world action scripts in the RDP model. This information becomes part of the Shared Digital Information.

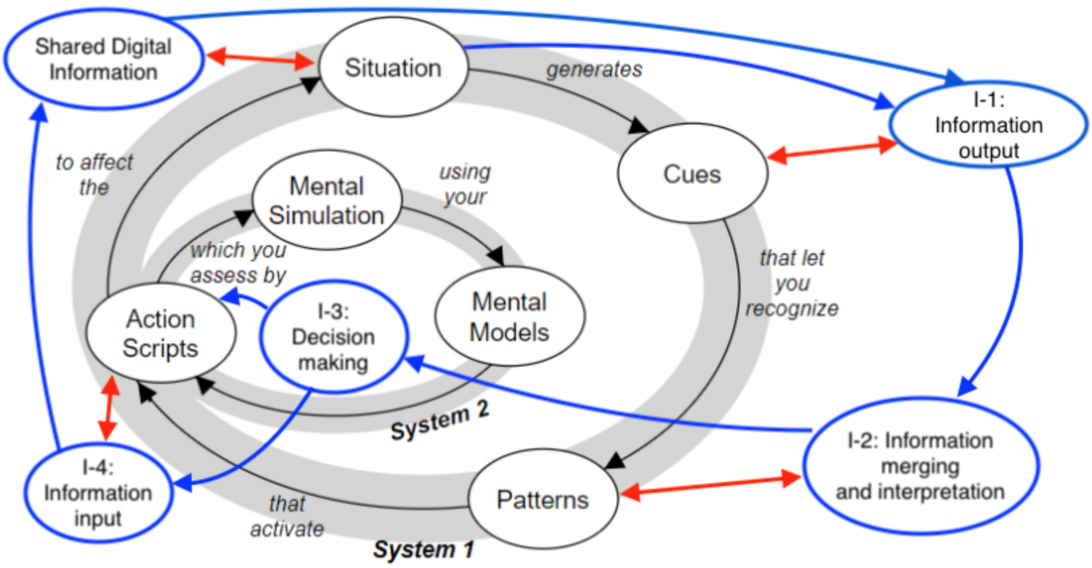

Figure 3. Situational Awareness Information Support app as an RDP support system

For each of these interaction modes, different situational disabilities (SD) and demons of SA come into play. In order to mitigate these, requirements are suggested as outlined in Table 1. The requirements are derived from the different interaction modes and their corresponding relevant guidelines to counter the different SD and SD-demons that apply to them. In particular, simplicity and flexibility have been emphasised since these are essential aspects of Universal Design.

Each requirement in the table applies to one or more interaction modes and are backed by Universal Design and Accessibility principles to mitigate a set of situational disabilities and Demons of SA. For example, requirement R1 is intended to achieve clarity of communication with a clear, consistent and simple ontology of terms as detailed in and relates to interaction modes I-1 Information output (how the system presents information), I-2 Information merging and interpretation (making the information easier for the user to interpret) and I-4 information input (how the user uses the system to communicate new information, using a customised limited vocabulary or corresponding symbols as defined in the ontology). This requirement helps to enforce the Universal Design principles UD-1 Equitable use (facilitating use by users with diverse abilities and in diverse situations), UD-3 Simple and intuitive use (reducing the cognitive load of the user when receiving, interpreting and entering information), UD-5 Tolerance of error (using a limited controlled vocabulary mitigates miscommunication and misunderstandings, and simplifies voice recognition), UD-6 Low effort (having a simple vocabulary of terms available makes it easier to understand messages and easier to enter new messages through e.g. voice commands, symbols or shortcuts); and WCAG Principle 3 - Understandable (similarly to UD-3, this Principle is about simplicity of cognition). All of these relate to making the interaction easy, simple and error tolerant. This is particularly important for people affected by cognitive SDs (simplifying cognition and communication processes) and Situation Awareness Demons D1 Attentional tunnelling (keeping the information and interaction simple to fit inside the tunnel of attention), D5 complexity creep (through simplification of complex information), D3 Data overload (lowering cognitive load of processing large amounts of information), D2 Requisite memory trap (simplifying the communication to avoid exceeding the short term memory capacity), and D6 Errant mental models (simplifying the communication to avoid misinterpretation).

Table 1. Universal Design Principles to Override SA Demons and Situational Disabilities

Universal Design Requirements	Interaction mode	UD/WCAG Principles	Address which SA Demons and SDs?
• R1 Clear ontology of terms • For text, symbols and voice command • Covering vocabulary for responder domain events, spatial/time information and decisions	I-1 Information output I-2 Information merging and interpretation I-4 Information input	UD-1 Equitable use UD-3 Simple and intuitive use UD-5 Tolerance of error UD-6 Low (physical) effort WCAG-3 Understandable	SDs (cognitive) D1 Attentional tunnelling D5 Complexity Creep D3 Data overload D2 Requisite memory trap D6 Errant mental models
• R2 Flexibility of input modes. • Voice • Symbols • Information fragment input • Information fragment merging	I-4 Information input	UD-1 Equitable use UD-2 Flexibility in use UD-4 Perceptible information UD-5 Tolerance of error UD-6 Low (physical) effort WCAG-1 Perceivable WCAG-2 Operable	SDs (hearing, speaking, vision, touch) D5 Complexity Creep D3 Data overload D1 Attentional tunnelling
• R3 Simplicity of input modes. • Big buttons clearly with text and intuitive symbols hierarchically organised	I-4 Information input	UD-1 Equitable use UD-3 Simple and intuitive use UD-4 Perceptible information UD-5 Tolerance of error UD-6 Low (physical) effort WCAG-1 Perceivable WCAG-2 Operable WCAG-3 Understandable	SDs (cognitive) D8 Workload, fatigue and other stressors D5 Complexity Creep D3 Data overload D2 Requisite memory trap
• R4 Flexibility of output modes. • Voice, text or picture (map)	I-1 Information output	UD-1 Equitable use UD-2, Flexibility in use UD-4 Perceptible information UD-5 Tolerance of error UD-6 Low (physical) effort WCAG-1 Perceivable WCAG-2 Operable	SDs (hearing, speaking, vision, touch) D3 Data overload D1 Attentional tunnelling
• R5 Simplicity of output modes. • Sufficient contrast in pictures • Simplicity and intuitivity of language and semiotics • Focus on the most important elements to avoid information overload	I-1 Information output	UD-1 Equitable use UD-3 Simple and intuitive use UD-4 Perceptible information UD-5 Tolerance of error UD-6 Low (physical) effort WCAG-1 Perceivable WCAG-2 Operable WCAG-3 Understandable	SDs (cognitive) D8 Workload, fatigue and other stressors D6 Errant mental models D5 Complexity Creep D3 Data overload D4 Misplaced salience D1 Attentional tunnelling

• Modest use of strong effects (colours, alarms)			
• R6 Interpretation and decision-making support • Semi-automated information merging • Symbol clustering • Context-awareness	I-2 Information merging and interpretation, I-3 Decision making	UD-1 Equitable use, UD-2 Flexibility in use, UD-3 Simple and intuitive use, UD-4 Perceptible information, UD-5 Tolerance of error, UD-6 Low (physical) effort WCAG-1 Perceivable WCAG-2 Operable WCAG-3 Understandable	SDs (cognitive) D8 Workload, fatigue, and other stressors D5 Complexity Creep D6 Errant mental models D3 Data overload D7 Out of the Loop syndrome
• R7 Flexible system-agnostic standards-adherent implementation	I-1 Information output, I-2 Information merging and interpretation, I-3: decision making, I-4 Information input	UD-1 Equitable use, UD-2 Flexibility in use, WCAG-4 Robust	SDs (cognitive) D8 Workload, fatigue, and other stressors

The requirements listed above are all high-level requirements. For successful development of an information system for Situational Awareness, there are of course an abundance of local specifics regarding organisational structure, training, tasks and risks to take into account, and it is, therefore, hard to give very specific recommendations for detailed design and implementation. However, these high-level requirements can be used to elicit detailed and specific requirements for design and development of individual information systems. Based on established best practices (Røssvoll & Fuglerud, 2013), we would suggest a user-centred iterative design process involving a focus group representing all relevant groups of stakeholders that will use the app, as well as experts in emergency communication and universal design of ICT, for requirements elicitation, feature selection, requirements conformance testing, user testing and realistic field testing.

CONCLUSION AND FUTURE WORK

In this paper, we have adapted Luokkala and Virrantaus (2014)'s process model into a process model for universally designed information support systems for situational awareness, and proposed a set of design principles and derived requirements to mitigate the effects of the Demons of SA as well as situational disabilities.

The requirements and design principles will be able to support implementation of a SA information support system. However, to increase the flexibility, we are deemphasizing the narrative elements in Luokkala and Virrantaus (2014)'s process model and leaving them as optional. They may be implemented as information fragments, but they may also be left out altogether if a more traditional SA system is wanted.

When studying the Demons of Situational Awareness and the Situational Disabilities that typically occur in a disaster situation with the principles of Universal Design and WCAG, it is increasingly clear that these principles can provide invaluable input to the requirements for information support systems for situational awareness in order to make them more robust against these threats.

Prototype implementation as well as validation with stakeholders are the next steps. Further research on situational disabilities and their impact on situational awareness, as well as the ability of the universal design approach to mitigate these also needs to be carried out and validated. Expanding on the implementation process suggestions with a complete development process for universal design of ICT in Emergency Management is also planned.

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