SPURS: A framework towards Scenario Planning for Unexpected events, Response, and Startle using research, horror films, and video games

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ABSTRACT
Introduction: Decision makers face major challenges during crisis events as unexpected events may occur at any time. The startle reaction that may generate from these events can have a negative effect on subsequent decision-making. Therefore, it is important for personnel to train for the ability to quickly recognise and react quickly to unexpected cues, in order to regain control of the situation. Method: Using research, and learning lessons from horror films and video games, the SPURS framework provides design guidelines that can assist with the building and configuration of simulated training scenarios containing unexpected events and cues. Results and discussion: SPURS factors are chosen in order to illustrate how a simulated training scenario with unexpected events may work. As a consequence, successful training can be acquired where the trainee sees what needs to be done, quickly assesses resources, and implements timely decision-making in order to regain control of the crisis.

KEYWORDS
Learning and training; uncertainty management; planning and prediction; engineering.

INTRODUCTION
Crisis events are not pre-scripted and unexpected events can occur at any time. Therefore, decision makers face major challenges when faced with uncertainty, and time pressures (Tversky & Shafir, 2003). A potentially dangerous consequence of an unexpected event is the startle reaction, where emergency personnel may momentarily pause, unsure of what to do next, which can cause delay or failure of subsequent decision-making (Barnett, Wong, Westley, Adderley, Smith, 2011; 2012). Therefore it is important for personnel to train the ability to recognise and react quickly to cues generated by unexpected events, in order to regain control of the crisis. Simulations provide realistic training scenarios because they allow expected and unexpected cues to be manipulated, which ‘force’ the trainee to consider long-term projections under time pressure (Lafond, DuCharme, Gagnon & Tremblay, 2012). This paper introduces our Scenario Planning for Unexpected Events, Response and Startle (SPURS) framework, which can be used to inform the design of unexpected events arising as a consequence of information misperception (Level 1 Situation Awareness (SA)). As a consequence, it can be used to train decision making under pressure and uncertainty. As a basis, we draw from research investigating decision making, procedures vs. complexity, and information misperception (Level 1 SA), in addition to exploring how directors design unexpected events in horror films and video games.

Factors Affecting Decision Making
Unexpected events may startle personnel but also interrupt primary complex task performance because the additional cues generated by the event may lead to information cognitive overload (e.g. Altmann & Trafton, 2004). Other factors that negatively affect the accuracy and quality of decision making are time pressure (e.g. Payne, Bettman, Johnson & Luce, 1995), and confidence about decisions (Smith, Mitchell & Beach, 1982). Cognitive readiness is “the mental preparation an individual must establish and sustain to perform effectively in the complex and unpredictable environment …” (Fautua & Schatz, 2012, p. 277), which requires a high level of intelligence, affect control, and social skills in order to be able to adapt to the changing environment, recognise patterns (ibid.), and develop intuitive decision making skills (Yancy, 2006). Once acquired, emergency personnel can successfully perceive Level 1 SA factors, understand their meaning (comprehension – Level 2 SA), and predict future events and consequences (projection – Level 3 SA) (Endsley, 1988, 1995).
Procedures, Complexity, and Cognitive Processing

Procedures require little to no decision-making (Klein, 2009) as only a low level of attention is needed to complete the task (Shiffrin & Schneider, 1977). Similarly, the SRK (Skill, Rule, Knowledge, Rasmussen, 1983) model suggests three types of decision making – ‘Stick and Rudder’, where skill governs decisions and behaviour are automatically and subconsciously processed and require little to no effort. Rule-based decisions are made using IF/THEN statements, which may require some analysis beforehand, whereas knowledge-based decisions are more likely to be implemented in unusual situations where mental models are formed in order to ascertain the best course of action, and under time pressure, thereby increasing the likelihood of making errors. The training of complex tasks involves separating procedures into smaller events to ease the learning process. However, even simple procedures have unexpected changes and personnel must quickly adapt in order to regain control by switching to controlled cognitive processing (e.g. creating mental models) based on what is already known. However, experiencing these events may momentarily pause controlled cognitive processing, and cause a delay or failure to make decisions (see Barnett et al., 2011, 2012; Haus et al., 2012), particularly when important information was obscured, missing, or unavailable.

Information Misperception (Level 1 SA)

Emergency personnel may scan their environment in order to maintain a high level of SA, and to react quickly to unexpected cues (Sneddon, Mears & Flin, 2006). However, crisis events are stressful, which may reduce the effectiveness of information distribution systems (Hermann, 1963) by omitting information, delaying decision making (Miller, 1960), or incorrectly fill information gaps (e.g. Suedfeld, 1971). Failure to understand the environment caused a series of serious incidents on an offshore oil-rig, with 66.7% of them being related to Level 1 SA information misperception (Sneddon et al., 2006). Similarly, but with regards to unexpected events, recent research (Barnett et al., 2011, 2012) found that personnel experienced startle reactions caused by information misperception, where information conflicted with existing cues, changed meaning over a short period of time, or important information was missing.

INTRODUCTION TO SCENARIO DESIGN FOR UNEXPECTED EVENTS

The SPURS framework was developed in order to create unexpected events that could be injected randomly within a larger main scenario (e.g. a train crash). However, we first investigated startle research, and horror film and video game design in order to understand how to create and maintain uncertainty, and how to design scenarios where important information changes meaning.

Table 3. The SPURS design factors.

<table>
<thead>
<tr>
<th>Design Factor</th>
<th>A startle reaction can be created by including one or more of the following:</th>
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</table>
| 2 Real-world research | - Prioritize information – information should conflict with existing cues  
                           - Formulate handling strategy – information should change meaning over a period of time  
                           - Communicate information – Important information should be missing |
| 3 Environmental design | - Content must provide a degree of anticipation  
                           - Engagement must be prolonged so the trainee remains attentive  
                           - Problem solving should not be too difficult to avoid trainee frustration  
                           - Provide alternative possibilities to problem solving that can be evaluated  
                           - Both desirable and undesirable outcomes should be achieved |
| 4 Create vulnerability | - Invaluable information must be temporarily or permanently irretrievable (e.g. burned in a fire).  
                           - Scripting variations  
                           - Stage a series of false alarms |
| 5 Camera angles | Unexpected events should occur in  
                           - Wide-open spaces  
                           - Narrow confined spaces |
| 6 Proximity | - People or objects should intrude into the trainee’s personal space  
                           - Unexpected events should occur outside of the trainee’s peripheral vision  
                           - Incorporate unexpected events that are both distant, and close to the trainee’s location |
| 7 Obscurity and everyday objects | - Should change their meaning at some point  
                           - Trainee tools and everyday objects can behave in unexpected ways  
                           - Partially or fully block the view of items and/or locations |
| 8 Sound effects | - Implement sudden noises (bangs, shouts etc.) related to the present task, or just random |
| 9 Synchronization | - The above effects can be synchronized with each other to increase complexity |

Development of the SPURS Framework

The process consisted of three steps. First, using the CUUES interview methodology (Barnett et al., 2012) with emergency personnel provided us with training aims and initial design direction (Table 1, Section 1). Second, interview results revealed three factors relating to Level 1 SA (Table 1, Section 2). Third, we conducted a literature review that investigated the ways in which video game and horror film directors incorporate design factors relating to uncertainty, that as a consequence, produce audience startle reactions. The review provided us with a further seven design factors – environmental design (Section 3), creating vulnerability (4), camera angles (5), proximity (6), obscurity and everyday objects (7), sound effects (8), and synchronisation of these factors (9). The main points are summarised here.
Research suggests that the startle reaction varies as a function of level of anxiety. If an individual is highly anxious, their startle reaction will be more intense (Grillon, 2008). Therefore, it is important to create an *environmental design* that will generate and maintain anxiety by designing scenes that produce fear, false hope, uncertainty, and helplessness (e.g. Frome & Smuts, 2004). Recent research (Windels et al., 2012) explored gamers’ startle responses while playing horror video games. They suggested four recommendations for generating and maintaining uncertainty - *anticipation*, *engagement*, *scripting*, and *false alarms*, which in turn, should *create vulnerability*. Information misperception can be created in a number of ways. For example, by varying scripts, where either too much (overload) or too little (filling gaps) information is provided, by incorporating false alarms (e.g. a loud crash) before the real unexpected event begins, or by limiting the use of the in-game camera to look around. Restrictive *camera angles* have successfully induced stress in horror games such as *Resident Evil* (Konami, 1996; 1998; 1999), where gamers were forced to make a series of quick decisions when choosing escape routes through zombie infested alleyways (Figure 1).

![Figure 1.](http://uk.gamespot.com/resident-evil-3-nemesis/images/220763/)

Once uncertainty is created, unexpected events can be incorporated in various ways. For example, the *proximity* of an unexpected event may cause startle depending where it occurs in relation to the trainee’s location. Early research (Landis and Hunt, 1939) suggested that startle intensity varied as a function of proximity. If it occurred near or on the edge of peripheral vision then the likelihood of startle would be higher, compared to further away where the trainee could place the event into context. *Tom Clancy’s Splinter Cell* series (Ubisoft, 2002-2012) require stealth mode to progress but uses *sound effects* to add to the stress. Enemies may still spot the gamer and unexpectedly appear behind them firing bullets and shouting loudly to alert nearby colleagues. Research (Windels et al., 2012) using the horror game *Dead Space* (EA/Visceral Games, 2008-11), suggested that sudden noises produced startle in gamers (e.g. a roof vent falls to the floor), particularly when the location of the noise was unknown. Finally, the *obscuring of everyday objects* increases uncertainty and can be incorporated as information misperception. The horror game, *Silent Hill* (Konami, 1999), is a town covered in an omnipresent fog making gamer visibility limited, and increasing vulnerability. Berg, Norin Persson & Ögren (2006) found that they spent 31.5% of the time watching the edges of the fog at one-second intervals in order to determine the meaning and location of sudden noises. The fog limits the information the gamer can perceive (clues and threats), which forces them to use their imagination to replace what they cannot see (Girard, 2011).

To increase complexity these factors can be *synchronized* and/or randomized to an extent, in order to provide training for different levels of expertise. The horror film, *Alien* (Scott, 1979), contained a startle scene where the crew are searching for the alien but when opening a suspect locker, instead find their trapped angry cat (Figure 2). By synchronizing three effects - close-up visuals (proximity), sudden shouts, and the screech of the cat (sudden noises), and the low-angle camera shots (restricted view), Scott produced intense startle reactions from audiences.

When designing unexpected events using SPURS, it is not necessary to incorporate every single design factor at the same time, but instead, choose factors appropriate for specific training requirements. The following section provides an example of this.
EXAMPLE SCENARIO DESIGN USING SPURS
Assuming a main scenario is in place, unexpected events can be injected beforehand on a timed basis, or as training progresses. Initial training may consist of simple procedures, which require automatic processing. The instructor may then increase complexity by injecting a SPURS-based unexpected event, which requires the trainee to switch from automatic to controlled cognitive processing. The following example illustrates a SPURS-based unexpected event, which was injected into a main scenario designed to train decision making in the event of a train crash with a civilian vehicle. The factors used to plan the scenario are in brackets.

Training scenario
The trainee arrives on the scene and is required to perform a familiar procedural task and collect evidence surrounding the crash (procedural, automatic processing). Part of the train suddenly shifts and crashes to the ground (unexpected event 1; sudden noise; false alarm; uncertainty), and startles the trainee, who, after recovery, nears the burning vehicle where two fire fighters are extinguishing the fire. Suddenly, the vehicle explodes because the vehicle contained two hidden gas canisters (unexpected event 2; sudden noise; high anxiety; obscurity). The fire fighters are thrown backwards as a result of the explosion and the trainee relays the events to the on-scene commander (prioritise communication; communicate information; resist pressure). A panicked colleague suddenly starts shouting from immediately behind the trainee (unexpected event 3; proximity; sudden noise).

Figure 3. A timeline of the procedural and unexpected events

Training Aim: Take control of the situation by,
1. Resisting pressure from the first unexpected event in order to take control of the second and third.
2. Implementing decision making and communicating the events to the commander in a timely manner.

Outcomes:
Desirable: Completing the training aims.
Undesirable: The trainee is startled by the events, and is unable to implement timely decision making.

Synchronization
The event factors can be synchronized and randomized to a point (Table 2). For example, the explosion occurs in a wide-open area but could also be confined to a restrictive space.

Table 4. Examples of synchronizing and randomizing the design factors.

<table>
<thead>
<tr>
<th>Synchronize all or some factors</th>
<th>Difficulty level</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Novice</td>
</tr>
<tr>
<td>Trainee proximity</td>
<td>Far away from explosion</td>
</tr>
<tr>
<td>Environment</td>
<td>Open area</td>
</tr>
<tr>
<td>Trainee proximity + environment</td>
<td>Far away + open area</td>
</tr>
<tr>
<td>Sudden noise (explosion)</td>
<td>Far</td>
</tr>
<tr>
<td>Sudden noise (shouting located behind trainee)</td>
<td>Far away shouting</td>
</tr>
<tr>
<td>Proximity + Environment + Explosion + Shouting</td>
<td>Far</td>
</tr>
</tbody>
</table>

DISCUSSION
This paper introduced a framework, SPURS, which can be used to create uncertainty and design unexpected events in simulated training scenarios. The factors are not exhaustive and can be adapted for further scenarios that train for task interruption (e.g., Gillie & Broadbent, 1989), inattentional and change blindness, and sensory information overload. Research suggests humans experience a wide visual array of stimuli, and are often unable
to detect fully visible objects, or obvious unexpected changes to the environment (Simons & Chabris, 1999). Additionally, when two or more ‘noises’ compete, attention permits selective listening of relevant events whilst disregarding non-relevant information, because it cannot process all sensory input simultaneously. Therefore, incorporating dichotic listening tasks may be important for training the understanding and recall of important information.

Simulations permit trainees to learn about the nature of, and actively engage with unexpected events. Therefore, simulations should replicate real-life in order to develop the level of intuition required for effective decision making (Rousseau, 2003). Increasing event complexity permits training towards the acquisition of higher levels of expertise and complex cognitive skills such as developing mental models. Successful training can be acquired where the trainee sees what needs to be done, quickly assesses resources, and implements timely decision-making in order to regain control of the crisis.

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