Scenario play workshops -
Co-design of emergency response scenarios for information technology design in collaboration with emergency response personnel

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ABSTRACT

We describe a co-design method for emergency response scenario creation, to support the evaluation of new information technologies. The aim of our use of the method were to achieve scenarios that could be used in experiments or training sessions with professional emergency response personnel. We have analyzed how the method facilitated the design of scenarios (events, resource demands, communication between players), and the description of constraints in a resource management matrix. Our research indicates that the resource management matrix could be an important complement to function-centric analysis methods such as Functional Resonance Analysis Method (FRAM). We also illustrate how the interplay between play and situation description allowed us to simultaneously design and validate the scenarios with respect to playability versus resource demands. We discuss how the resource matrix can be used to adjust the validated scenarios after the design sessions.

Keywords

Resilience, co-design, functional resonance analysis method, emergency response, dynamic planning

INTRODUCTION

In this paper we discuss a co-design method for achieving realistic scenarios to test decision support technology for emergency response personnel. We focus on situations that are resource-centric rather than mainly event-centric. For instance, planning of preparedness of ambulances, police, or recue services equipment and staff relate heavily to resources. A challenging situation cannot be defined merely in terms of events per se but are defined in terms of resource requirements versus available resources.

Scenario design has a long tradition within user-centered design (Arvola and Lundberg, 2007; Carroll, 2002; Dinka and Lundberg 2006; Muller, 2001). The scenarios are often built around events (Muller, 2001), and focus on how new technologies may improve on the management of those events (Arvola and Lundberg, 2007; Dinka and Lundberg 2006). Scenario design also has a tradition in the area of educational “serious games”. Those scenarios are sometimes centered around pathways. They start out with initial events, which subsequently follow different pathways depending on what actions are taken (Alinier, 2011). Scenario analysis (rather than scenario design) has also been used to analyze accidents and risks. For instance, scenarios can be analyzed using the Functional Resonance Analysis Method (Hollnagel, 2004; Lundblad, Speziali, Woltjer and Lundberg, 2008). As the name suggests, this method is function-centric.

The decision support technology that we need to evaluate through the scenarios we designed will support dynamic resource management in emergency response. This simply means that resources are not statically located at fire stations. Instead, they are used in non-critical emergency response work such as inspections, while still being available for emergency work. The problem is that the situation may become more complex: it can become harder to judge the current preparedness for emergency events. When units are split up, then for instance a smoke diving unit cannot be sent from just one location, but needs to be assembled "on site" from several locations. This situation is harder to get an overview of than if the resources had been on "stand-by" as complete units at fire stations. At the same time, the time for a "first responder" to reach the site can become shorter, when resources are more evenly distributed over the map in more locations. The designed scenarios will be integrated in simulation environment C3Fire. The C3Fire environment has been used in similar research projects (Johansson, Trnka, Granlund and Götmar, 2010; Smith, Granlund and Lindgren, 2010; Tremblay, Lafond, J.F, Rousseau. and Granlund, 2010). It is an environment that allows controlled studies of collaborative decision-making in dynamic environments (Granlund, 2003; Granlund and Granlund, 2011).

The specific co-design technique we report here is to combine situation description and gameplay to co-design a scenario step-by-step. First, an initial situation (for instance an alarm) is designed (where it takes place, what information the emergency response commander should receive). Then, the response is played out by the domain professionals– what resources would then be deployed, and "moved to the site". The domain professionals can then discuss this – and important constraints for the particular scenario can be identified, such as how many smoke diving units are required, and what resources are required to create a smoke diving unit. For more complex events, the scenario can be developed in steps, just like the game will be played out. A new situation description is created based on what resources were sent during "play". Then a new "play" session can start. This can be repeated until the scenario is complete. In this paper we describe and discuss how important constraints were identified during co-design, to become the basis for scenarios that could be played out by other emergency response personnel. We finally discuss how the scenario can be adjusted through the usage of a resource allocation grid, to make it more suitable for training or equipment testing purposes.

METHOD

This paper reports results from a series of ten scenario design workshops that were conducted during fall 2011. Each workshop had a duration of three hours on the average. A central workshop activity was co-design of scenarios. In our workshops, we used a co-design method as outlined in the introduction of this paper, where two emergency response professionals (RES1 and RES2) co-designed the scenarios together with two facilitators / designers (MOD1, MOD2). RES1, MOD1, and MOD2 are the authors of this paper. We designed several scenarios using the same method. However, to highlight details, in this paper we have selected one scenario design session (from workshop 4), for an in-depth presentation and discussion. We base the scenario work on an "initial state" that was designed during workshops 1 and 2. During the workshops, the participants used a magnetic map placed on a whiteboard, station images placed on the side of the map, and magnetic icons depicting vehicles and personnel, as well as events. After the workshops, we analyzed the scenarios and created the grid shown later in this paper. The resource matrix (Figure 1) focuses on the scenario

ANALYSIS

Our analysis consists of two parts. The first part illustrates how events and resource requirements, as well as information exchanges and decision points can be designed, and the playability of the scenario can be validated through scenario play. The second part is an analysis of resources and constraints through a resource matrix. We then discuss how that can be used to tweak the scenario in different ways.

Scenario design

During scenario design, the scenario stops to define events (circumstances, such as a fire), and "goes live" to play out how the event is managed. It stops again when the players decide that it is time to define a new event (new circumstances, such as how a fire has developed). When the scenario is "live" the workshop moderators (when necessary) probe the participants about how they would act in the situation. The stations and places (e.g. B20) referred to in the scenario correspond to the stations and places in Figure 1.

Defining event "1.0 fire in wooden building" and an information exchange

The scenario starts by defining an initial *RES1 defines the alarm call as an apartment fire. RES1 then thinks aloud about the height of the house, and decides that it should be three floors high, demanding a ladder vehicle.* This starting point defines an information exchange (the alarm call) as well as frames the initiating event.

Defining initial resources required for specific events

The scenario goes live. *RES1 starts out by sending a ladder vehicle to the site of the fire*. However, in doing so RES1 also defines a constraint for the scenario. The requirement of a ladder vehicle (with a higher ladder than are available on regular fire engines) constitutes a first element of an "alarm plan", which should always be used during an event classified as an apartment fire in a high building (until more details are known).

Highlighting decision points regarding resource deployment

RES1 then gathers a fire engine a ladder vehicle, four fire fighters and a commanding officer from station 20. RES2 then asks whether this would be enough to man the different units. RES1 then concludes that the ladder vehicle could actually not be manned, and instead sends it from station 21. RES1 sends a fire engine, a ladder vehicle, and everyone from station 21 (four fire fighters including one unit commander). RES1 then ponders what is then missing, and decides to send two first responders from External education B20. RES2 questions whether that would be realistic. RES1 then instead sends the more remote "Information A21". This illustrates an important point, that people will have to make a decision during this scenario about whether the nearest resources should be sent, or the ones with the lower priority further away.

Defining the full resource needs of the first part of the scenario and for specific capabilities

RES1 concludes that there then are 2 fire rescue vehicles with 5 fire fighters in each (enables smoke diving), but RES2 counters that there are no people in the ladder vehicle. RES1 then moves two persons to the ladder vehicle. This results in one complete smoke diving unit, and one fire rescue vehicle with three people. The scenario defines resources that can be re-used in other scenarios. Firstly, a smoke diving unit requires five people: one unit commander, four regular fire fighters, and one fire rescue vehicle Second, the ladder vehicle requires two fire fighters. Having played the situation out, the full resource requirements for the start of the scenario are also defined: The scenario for an apartment fire in high building requires one smoke diving unit, one ladder unit, and one site commander.

Defining event "1.1 fully developed fire in wooden building" and information exchange in the scenario

The play then temporarily halts, to discuss what will happen next. *It is decided that an arrival report will occur, describing the situation from the point of view of a fire fighter having arrived to the fire. RES1 then decides that the situation should be "a fully developed apartment fire". The arrival report is then defined as: "Object: 3 floor wooden building. Damage: Fully developed apartment fire, 3rd floor. Risk: "Fire reaches the attic". Goal: Put out the fire.".* This defines the event per se, but also an important information exchange for the scenario, the arrival report.

Defining the final resource needs of the scenario after the information exchange

The scenario then goes "live". *RES2 decides to send the "external education B20" to get the ladder vehicle from station 20 (leaving their first response vehicle at the station). RES2 also sends the commanding unit from station 21 and a fire rescue vehicle from station 23.* This defines what resources are sufficient to deal with the fire and validates that also this step can be played out with the "game plan".

Validating the scenario through scenario play

Playing the scenario also validates that the required units can actually be deployed – the scenario "works" with the resources and their geographic positions that were the starting point of the scenario. The validation ensures that there is at least one workable solution to the scenario.

Analysis – modeling constraints

As described above, the scenarios define resources and capabilities, events, communication, decision points, and resource needs. After the workshop, we entered the workshop data into the matrix in Figure 1.

In Figure 1, the left part defines resource needs and capabilities. Resources are listed to the left (starting with "first response vehicle"). Capabilities are listed from the top (starting with "first response). Following the "fire rescue" (smoke diving) capability downwards shows that it requires a fire engine, one unit commander, and four fire fighters. One of them needs to be a smoke diving commander (although this was not used in this specific scenario). The empty box above the smoke diving commander box reminds that there is also a "wildcard" competence, one that can be used either as smoke diving commander or as ladder vehicle driver.

The middle part of figure 1 depicts the resources at different stations, in the columns. Going to the area to the right, we first find an initial state of non-emergency activities, such as information, together with the resources used in the columns. Going to the far right, we see the two events from the scenario in red type. First, the initial event of the fire call, and then the event after having received a situation update.

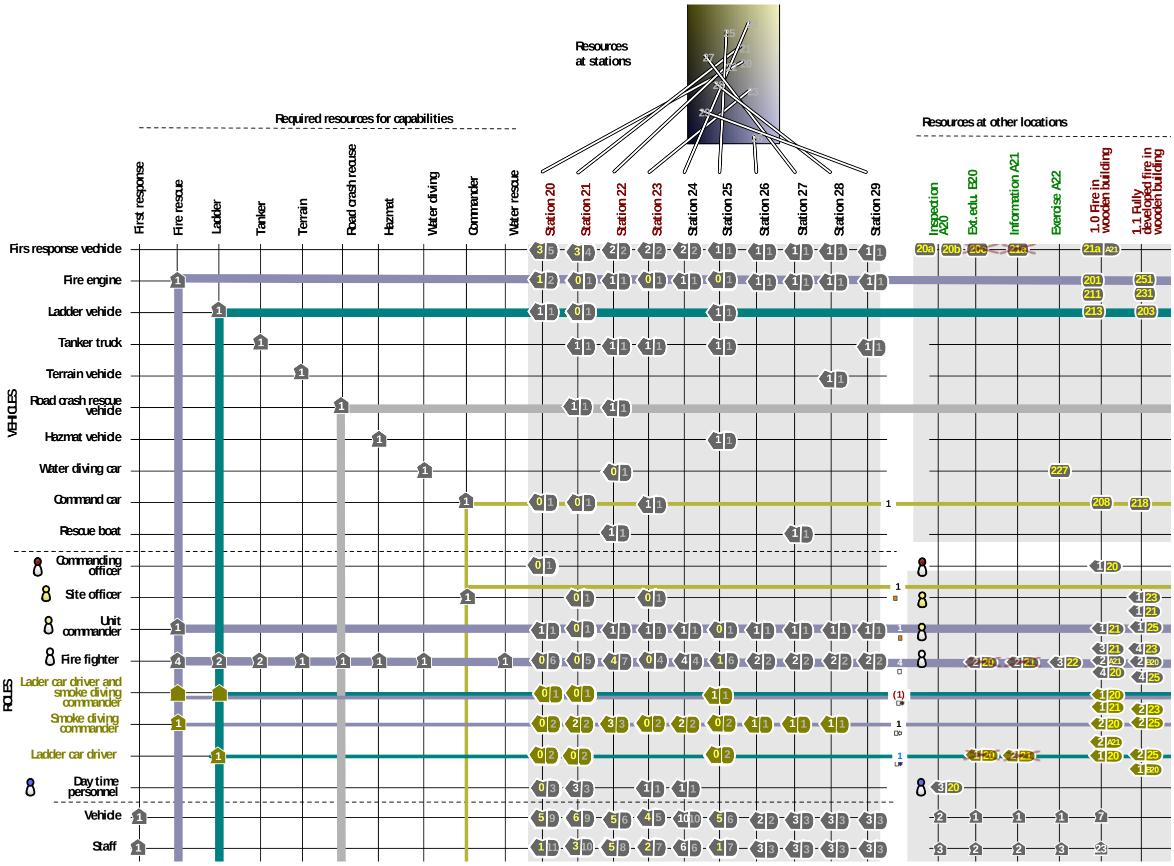

Figure 1 – Resource matrix: Allocation of resources and capabilities, resources at stations, resources at other locations. End state after event 1.1. Fully developed fire in wooden building.

Adding the information about what resources are needed to deploy units reveals the capacity of different stations and locations to deploy them (the middle and right parts of Figure 1). For instance, we can first look up what resources are required to create a smoke diving unit (second column from the left, Figure 1). Following the horizontal lines, we can see what amount of the required resources are available at different locations. For instance, the figure shows that 4 (yellow type) of 7 (grey type) fire fighters are at station 22 (of which three can be smoke diving commanders), together with their unit commander and their fire engine. This means that the smoke diving unit at this station is intact. We can also see that the same unit is not intact at station 21 (no fire engine, no fire fighters, no unit commander). It is possible to locate the resources from station 21 by following the line to the right. We then first see that two fire fighters were located at Information A21 as a starting point of the scenario. This means that to use the fire engine from station 21 at the outset, since there were three of five fire fighters were in the station, the staff there would have to be combined with staff from other locations to form a fire fighting crew for smoke diving. Following the two events, we also see that the crew from A21 were combined with the crew from station 21 at the site of the wooden building fire.

The matrix also reveals critical dependencies – for instance that resources may be sufficient to deploy several different kinds of units – but not at the same time, creating a demand for decisions about from what stations or combinations between stations and non-critical missions to deploy the units. For instance, we can see that at station 22, if the resources are actually used to deploy one complete smoke diving unit, then there will be no fire fighters left to drive the ladder vehicle. Looking at the horizontal line for the ladder vehicle we can see that it is a very limited resource available at only three locations. It is thus central for preparedness.

DISCUSSION AND CONCLUSIONS

In this paper we have described a method in detail that can be used to create emergency response scenarios, and model resource dependencies of the scenario in a grid (Figure 1). When the scenario has been entered into the grid, this starting point is already validated – it is possible to play it out considering resources – nothing is missing that will be needed during the scenario. However, it can be useful to use the grid to adjust the scenario. For instance, in our game it is vital that people get experience of working with units that are assembled on the event site rather than sent as a whole from specific locations. Therefore, using the grid, the resource allocation can be adjusted if needed. If resources for a capability such as smoke diving were all available from one station, this can be adjusted before the scenario is used. For instance, resources can be moved to a non-emergency activity such as an information activity. Then it will be necessary to combine resources from different locations to arrive at a capability. It is also possible to use the grid to design trade-offs. For instance, to preserve a high priority non-emergency activity near an emergency event versus to send it out. How the players value the importance between alarm and non-emergency activity can make the game play out differently by different players. Although this occurred during scenario design, it could have been designed in afterwards.

Our research indicates that the resource management matrix could be an important complement to function-centric analysis methods such as FRAM (Hollnagel, 2004) or to event centric analysis scenario co-design methods (e.g. Arvola & Lundberg, 2007; Dinka & Lundberg, 2006).

ACKNOWLEDGMENTS

We are indebted to the emergency response personnel who have participated in this study. This study was sponsored by the Swedish Civil Contingencies Agencies.

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