Envisioning Collaboration at a Distance for the Evacuation of Walking Wounded

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ABSTRACT

The "walking wounded" is a category of disaster victims that can help themselves in finding their way to safety. The problem we address here is how first responders, walking wounded, and other rescue personnel can coordinate their joint activities more efficiently in order to accomplish the evacuation as quickly as possible. We focus our design on the "coordination loops" in the disaster response organization, both vertically across levels of authority, and horizontally among responders in the same echelon. In our envisioned scenario of a chemical accident we identify the most important interactions through which activities are coordinated that are crucial for a successful evacuation. We propose three different "coordination devices" that can be used by the walking wounded, the rescuers in the fields, and the people in the command center. We believe our approach, explicitly designing support systems for coordination first, will lead to important improvements in the daily practice of disaster response.

Keywords

Collaboration, coordination, disaster response, evacuation, design for coordination, walking wounded

INTRODUCTION

There is a category of victims of an incident that can largely help themselves, the so-called "walking wounded", that provides a rich set of coordination challenges for crisis response and management. In order to evacuate them properly, coordination is needed among a large group of people. For example, after a chemical spill the walking wounded might have to be decontaminated and though they can walk away from the "hot zone", they still have to be guided to the proper location. Our goal is to design coordination support systems that assist a disaster response organization in coordinating the process of evacuation of the walking wounded in the most effective manner possible.

One of the major lessons learned from disasters in the past, (and even simulated responses), is that communications are often the first to fail (Kean and Hamilton, 2004; Lisagor, 2002; Mikawa, 2006). Following Klein et al (2004) we adhere to some basic requirements for a successful collaboration; first of all the people that are coordinating their joint actions need to agree to work towards a collective goal ("basic compact"). In the case of collaboration between rescuers and victims, it is usually clear that everyone wants to save as many lives as possible. Secondly, the (joint) actions should be mutually predictable in the sense that coordinating partners know what the other one is going to do, and when their task is done. The action should be mutually (re)directable so that if one partner observes something is going into the wrong direction, action can be taken to get the other partner back on track. Finally, "common ground" is the shared picture of the situation that is in constant need of testing, updating, adapting, and repairing.

The process of coordination where common ground is checked and repaired, actions are observed and (re)directed is called a "coordination loop" (Voshell et al., 2007). One can have separate horizontal loops, such as law enforcement and fire fighting that are isolated via their scope and actions. A series of loops are often working together in an incident (and even more when this scales up to a disaster) on independent isolated loops. Vertical loops are any communication that modifies a plan across these horizontal levels to update information, new plans, or new hazards.

This work, and related current research, have begun to use different classes of the walking wounded scenarios to test the resilience of new information, communications, and robotic technology in multiple domains.

METHOD

We take a human-centered approach towards the design of support systems for members of disaster response organizations, but we take it one step further. We explicitly design for coordination; we identify the joint actions and the coordination loops that are necessary to achieve common goals, and consequently design systems that support the coordination (Woods and Hollnagel, 2006).

In this paper we envision a scenario in which walking wounded need to be evacuated. A chemical incident was chosen based on previous interactions with the Chemical/Biological Incident Response Force (CBIRF) in the USA (CBIRF, 2007), as well as incident command and response groups in the Netherlands. The scenario helps us to identify the actors involved, and in telling the story we discover the situations that they get involved in (Carroll, 1999; Rosson and Carroll, 2002). This helps us to pinpoint the coordination loops, and to envision the functionalities of our novel coordination devices. It is scenario-based design in the sense of formulating a story that is as realistic and generic as possible, and discovering the weaknesses in the coordination that our support systems can alleviate.

ENVISIONED SCENARIO

It was a sunny warm spring Sunday, 11 AM, 1st of May, in a small village 10 km east of Tilburg, the Netherlands. A train transporting hazardous chemical materials was derailed after it collided with a herd of cattle. There was a chemical spill, and the train driver was badly injured. There was nobody around since people had been up late celebrating Queen's day the previous night. The spill happened to be a flammable liquid, and the sparks from the collision between the train wheel and the rail actually lit up a fire. Not far away from the accident site, there was a woodchip mill that could easily burn down.

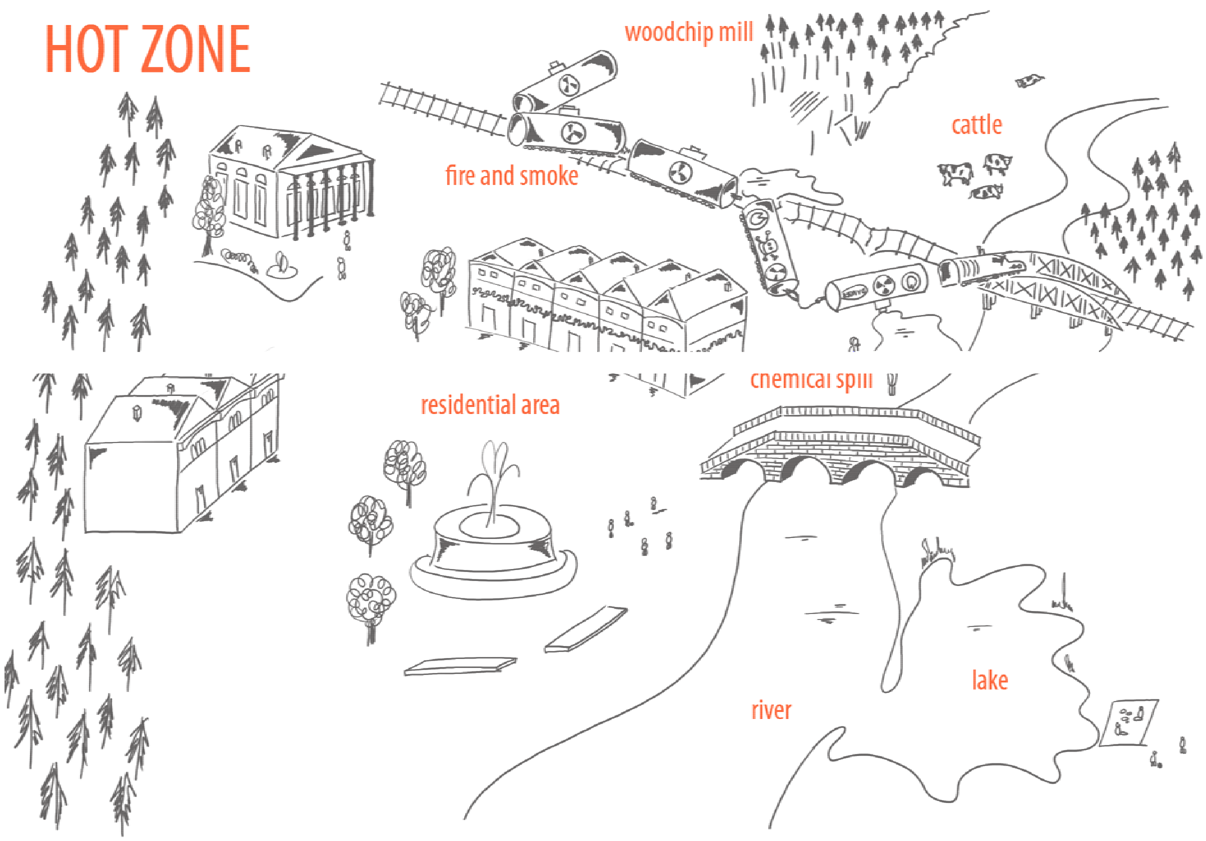

Figure 2. Hot Zone at 11.45 AM where the first responders are trying to assess the incident of train derailment.

The accident area was also not very far away from a residential area, about 1 km away, and very close to a recreation lake. Around thirty minutes after the accident, a photographer who had just arrived, saw the resulting mess and called the emergency number. By that time, the spill had already contaminated the surrounding air, river and lake.

Since it was a holiday, there were not that many emergency responders on duty. The Alpha team was the first team sent to the incident. Their task was to get an early assessment of the incident, determining the extent of the hazard, identifying the chemical agent involved, completing a direct survey, marking and recording the contaminated area, and taking samples of biological material. The team quickly came up with some recommendations for controlling movement of personnel and equipment around the contaminated area.

“Beep” System

The emergency team has a system called “Beep”. It integrates diverse sensors and communication systems that are connected wirelessly. It basically consists of a tagging device that can be used for navigation (W), a central overview system for the command center (C), and a device for the mobile rescuer agent for locating victims and marking up a map of the disaster area (R).

1

First-responder [first report]: *“It’s pretty bad here, one badly injured, two major spills, and the last two carriages are on fire, a major explosion may occur. The smoke might be poisonous, and it is going south to the residential area. On the north of the railway there is a woodchip mill which might catch fire. All visible contaminated areas on the ground are now identified and marked”*

Command-center: *“Got all the marks. There is an even bigger residential area behind the north forest. What about the river?”*

First-responder: *“The spill is reaching it faster than we thought”*

Command-center: *“Ok, keep me posted”*

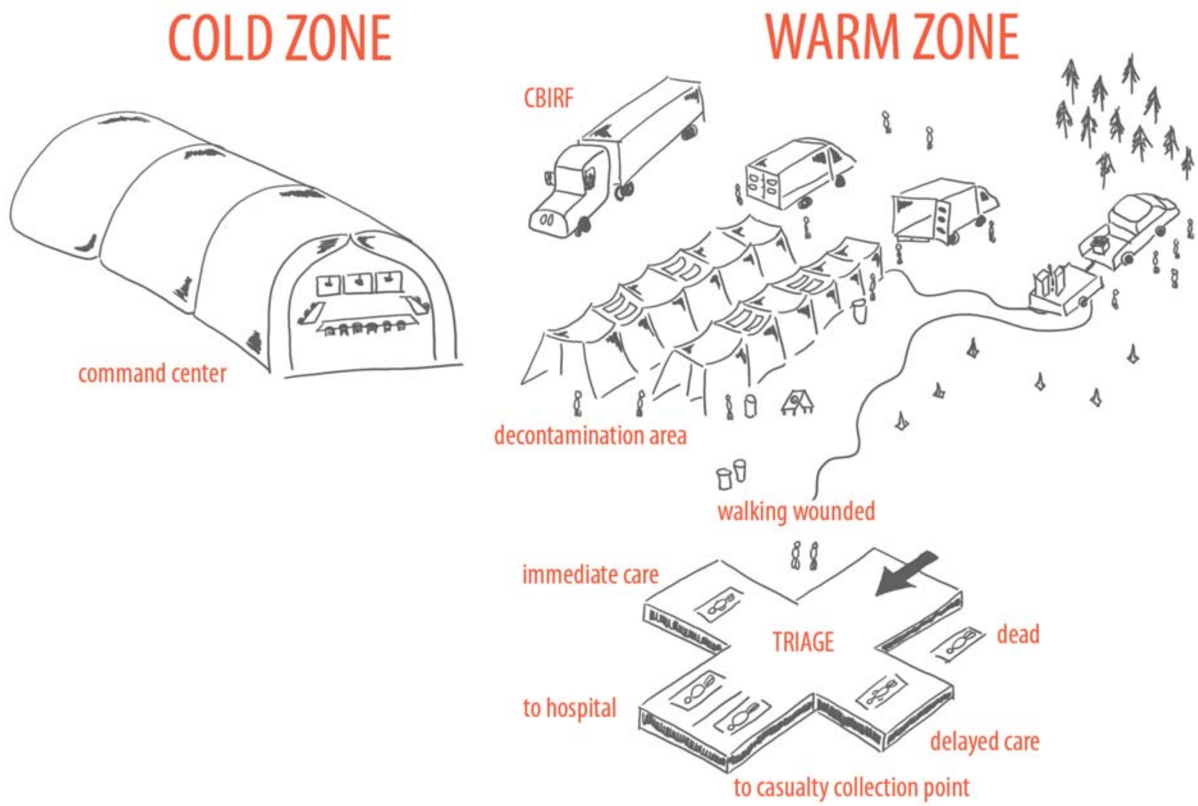

Figure 3. The decontamination area was set up in the Warm Zone, while the command center operations are placed in the Cold Zone as the scope of the disaster becomes clearer.

The decontamination area is a dynamic area that could be moved from one place to the other, depending on the current scope of the incident. For example, the decontamination area needs to be moved since the wind changed its direction. This uncertainty creates a constantly changing, and to a large degree, unpredictable, Warm Zone.

2

First-responder 1: *"Did they change the decon area again?"*

First-responder 2: *"Yeah, the wind is changing its tail, smoke is straight to the decon area"*

Most of the people contaminated by the spill were capable of walking. But unfortunately there were not many rescuers at the scene and these victims needed to be taken care of and guided to the decontamination are in the Warm Zone.

Device W: the Tagging Device

The tagging device W is a simple GPS device with an embedded screen. It functions as an electronic triage-tagging device with a "compass needle" for guiding the victims to the decontamination area. This device is designed to be very easy to use, since the victims are under stress, and there is no time to train them on anything.

It also has an emergency button. The walking wounded can notify the command center if they need urgent assistance. The device can tell the walking wounded about position changes of the decontamination area, how far it is from the current position, and estimated time of arrival to the decontamination area. A walking wounded can wear this device by hanging it around their neck, and clipping it to their clothes.

After checking the status of a walking wounded, a first responder gave him the device W. The first responder explained how to use the device for navigation to the safe area. He also explained that the decontamination area could be relocated so that the walking wounded could anticipate this type of change.

3

First-responder: *"You have been triaged, now you should walk to the decontamination area. The arrow shows you where to go and the yellow blinking circle depicts the decontamination area. Please help other people on the way, if they need any assistance."*

Walking-wounded: *"Ok. But what if I can not walk anymore"*

First-responder: *"Wait for other people carrying the same type of device. But don't wait too long. If you do not see anybody, just press the red button"*

Walking-wounded: *"Got it, thank you"*

The walking wounded thus walked to the decontamination area by himself. Some of them form a walking wounded column, and assist each other.

The Command Center (C) and the Rescuer Device (R)

The command center C can track the position and condition of the walking wounded. The operator will inform a standby rescuer if a walking wounded needs urgent assistance. He will send the appropriate data to the rescuer's device (R), so the rescuer can locate the victim. The command center can also indicate the location of the new decontamination area when it is moved to a new place. All the information gathered such as blockades, and number of walking wounded individuals, can be used to prepare the decontamination area accordingly. This information is synchronized in real time, making it a powerful evacuation system. The rescuer device (R) is similar to the device of the walking wounded, but it can also highlight the person who needs assistance. It is also used as a mapping device to mark the assessed area.

A walking wounded was unable to continue and there was no one around, so he pressed the emergency button. The command center received this emergency signal and responded to the walking wounded that the signal was received and help was on the way.

4

Command-center: *"CC calling A1, individual walking-wounded needs help"*

First-responder: *"A1 response, position?"*

Command-center: *"It's on your device now, blinking red dot"*

First-responder: *"Ok"*

The first-responder found the walking wounded and assessed the situation. It turned out that the victim could walk with a little help, so he was teamed up with a fellow victim and was quickly on his way.

The evacuation process was done more efficiently with the assistance of the "Beep" systems, especially because the decontamination personnel could anticipate the number of walking wounded that were in their way.

DISCUSSION

The vertical coordination loops were described in the conversation 1, 3, and 4 respectively, while the conversation 2 is an example of a horizontal coordination loop. In the first conversation, the command center, a higher level in the emergency response organization, got detailed information from the first-responder about what happened in the field. In the second conversation, peer-to-peer communication was supported, enabling communication among first-responders in the field. This communication led to observability among the first-responders, therefore they could maintain common ground and redirect local resources and roles effectively.

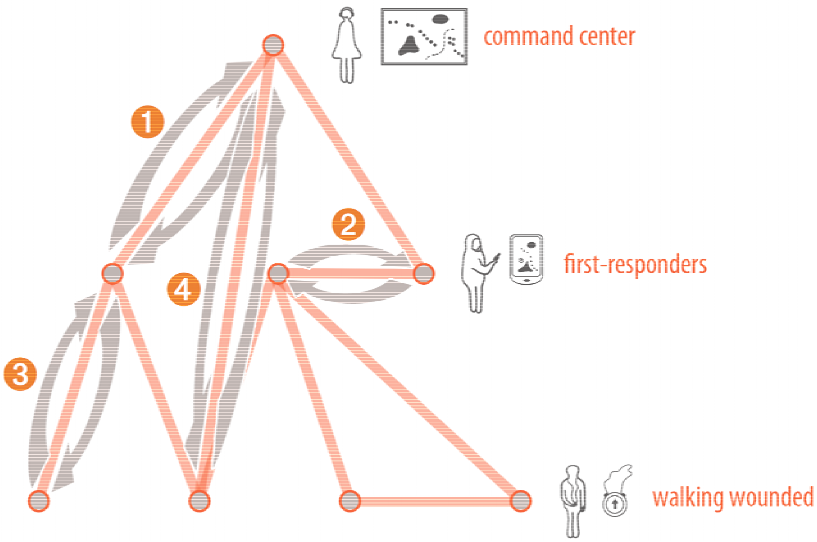

Figure 4. Coordination loops in the scenario.

In the third conversation the first-responder provided the walking wounded the clue that the decontamination area might be relocated. Because the walking wounded can find the decontamination area by himself, the first-responder was free to spend his time helping other victims. The real-time data gathered from the devices can also be used for organization awareness (Oomes, 2004), such as the numbers of victims, categories of victims, and the geo-spatial information of walking wounded. This information can be used to prepare the necessary resources accordingly. What is really unique about this coordination process is that we are attempting to utilize the adaptability of the civilians in the response. They are adaptive and often own technology that has the potential to update their own local conditions faster than responders. Coordination loops allow us to both describe how such information (with potential for coordination) influences them - and also a way to emphasize and envision how such capabilities might better be incorporated into larger crisis response. Synchronization was assumed effortlessly done across the system. When the command center received information update, such as the change of location of the decontamination area, it was sent simultaneously to all devices in the organization (C, R and W).

In the fourth conversation 4, a walking wounded triggered an emergency signal. The command center that received this signal forwarded this information to the first-responder in order to find and to assist the walking wounded who had difficulties.

The "Beep" system can be summarized as follow:

BEEP			
Device	W	R	C
Purpose	Electronic triage and simple navigational device	Assistance overview and marking device in the field	Monitoring interface
Features	An individual device equipped with GPS that has	An individual device equipped with GPS that has the	Big screen with capabilities of sending and receiving

	the capabilities of sending and receiving some data from the command center.	capabilities of sending and receiving some data from the command center. This device has a bigger screen than device W.	data from device W and R.
User	The walking wounded	The first-responders	The command center operators

Table 1. Beep system summary

One of the advantages is the possibility to support anticipation, which means being able to know when to include new resources, being able to help them prepare- or even prepare to prepare in anticipation, which is a key to resilient response.

CONCLUSION

We proposed a system through a scenario-based approach that serves as a prototype tool for discovery. A scenario-based approach helps us identify the actors involved, problems, envisioned artifacts of use built to support coordination, situations and needs.

Future research:

- Scenario evaluation (testing and refining the concept)
- Prototyping and testing (iteration processes of user-centered design)

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