Foresight Training as Part of Virtual-Reality-Based Exercises for the Emergency Services

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ABSTRACT

Due to the chaotic nature of accidents and crisis, emergency responses tend to unfold in a highly dynamic fashion. It is therefore of key importance that emergency service staff are continually trained on being mindful of risks and to spot early signs of things that could go wrong during an emergency response. This need is confirmed by an initial focus group interview with accident investigators who express a general need for training of flexible thinking and mindfulness. To meet this need, foresight training is being tried out in healthcare. Similar ideas, i.e. to base training on "what-if" discussions of typical risk scenarios, have been implemented in the mining industry, off-shore oil and gas companies, and in other high reliability organizations. We suggest a way for foresight training to be integrated into regular emergency response exercises as part of the after action review (when the emergency response exercise is debriefed). The material for foresight training could be based on events that were encountered in the preceding exercise as well as other typical risk situations, and subsequent discussions could, for example, be focused on the factors contributing to an elevated risk level and to what extent a negative development of events could be avoided through insightful actions. Hence, focus is on training to recognize typical risk factors and associate these with appropriate defensive actions.

Author Keywords

Foresight training, hazard awareness, emergency services, organizational resilience.

ACM Classification Keywords

H.5.3 Group and organization interfaces: Evaluation/ methodology.

INTRODUCTION

Real-life emergency responses to crisis are highly dynamic—sometimes even chaotic, and comprise a large number of factors that could interact in unpredictable ways, giving rise to unforeseeable situations during an emergency response. Rescue actions may not produce the expected outcome and risky situations may arise as the response operation unfolds. To minimize the risk for mishaps during an emergency response operation, it is important that the on-scene personnel can identify significant risk factors and can back off or call in reinforcement when the risk factors start to add up.

Mindfulness is a term commonly used to describe a careful, defensive style. An individual who is mindful recognizes early signs of potential danger so that he/she can back off, or in some other way counteract a dangerous development of events. For example, a nurse assisting with an operation, who realizes that there is a swab (small piece of cotton) missing, would be mindful if he/she asked the surgeon to pause the operation and look for the swab, in spite the fact that this is not mentioned in any safety procedure.

This kind of *individual mindfulness* in the emergency services (ES) seems on the face of it to potentially work against a strict chain of command. However, mindfulness is not so much a matter of disobedience as a question of dynamic, reciprocal communication across organizational levels. An on-scene commander needs feedback from the individual emergency responders in order to assess risk levels and make well-grounded decisions. If something is on the verge of going wrong, the commander needs to know about it.

Through real-time and after-action feedback given by emergency responders, individual mindfulness can in fact strengthen an organization, and make it more resilient, that is, less accident-prone and more efficient at recovery. *Collective mindfulness* refers to mindfulness on an organizational level. Collectively mindful organizations are continually on the lookout for new ways in which something could go wrong, in order to prepare for these [10, 11]. Reason suggests that individual and collective mindfulness lie at the basis of organizational *resilience*, that is, an organization's ability to avoid mishaps and accidents, and a strong ability to recover on those rare occasions when something still goes wrong [5, 6].

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At the very core of being mindful lies the ability to foresee bad things coming. This ability to foresee possible future mishaps can be learnt. *Foresight training* refers to a training program mainly targeted at front-line personnel, who is trained to recognize those personal, contextual, and task-related factors that could indicate a dangerous development of events. In addition, the trainees also learn to come up with alternative ways of action, and they learn to imagine how these alternative actions would affect the course of events.

Foresight training has previously been used in healthcare and in various high reliability organizations (HRO), such as nuclear power plants, and in the mining and chemical industries. There are a number of differences between HROs, which are presently offered this sort of training, and ES (the emergency services). HROs are committed to a broad range of activities, from risk management and accident mitigation to recovery after an accident, and HROs do normally not work under time pressure. ES, on the other hand, have to operate in chaotic accident scenes, and work under extreme time pressure, which means that decisions are often made on the basis of analogues and a holistic evaluation of the situation at hand, rather than through a complete analysis and comparison of all available options [8]. The aim of this article is to investigate how foresight training can be adapted to the special needs of ES.

NEED FOR FORESIGHT TRAINING

A general need for some sort of foresight training for emergency management was indicated in a recently conducted workshop with accident investigators. The investigators were asked to come up with ideas on how they would want to work with practical applications of resilience engineering and safety culture. The eleven participants came from varying safety-critical areas, such as patient safety, nuclear safety, maritime safety, occupational safety and road safety. They were asked to "think outside the box" and envision their future work with safety, i.e. not focus on hindrances such as money, resources, politics, but rather try to identify how they would like to work in order to achieve safer systems.

During the workshop the investigators were divided into four different groups and asked to discuss and envision the best options for the future. All groups discussed training as a necessity for increased resilience. This topic included training in simulated environments as well as discussion groups. These were some of the benefits identified:

- Simulating not only complex but also every-day situations will help to create a more secure working environment as personnel become increasingly comfortable talking about minor incidents and failures that occur in their working environment. This is important as most of the incidents and accidents occur here.
- Training will increases awareness of possible risk in the every-day working environment. This may also increase the amount of reported adverse events.
- Identify risks by discussing real or fictive events with persons from different levels of the organization will create a "collective knowledge". The organization has a lot of experience that is "unused" and should be fed back into the organization.
- Training environments will improve the competence and skills needed when something happens. It is essential to know how to prioritize and how to act in a state of emergency.
- Simulating possible events can help creativity, for instance to improve current procedures or try out new technology.

An illustrative case of lack of foresight

As an illustration of what can happen when risk factors are ignored, a rescue operation went from bad to worse on 30th of May 2002 when nine climbers fell into a crevasse on Mount Hood, near Oregon, USA. Helicopters were sent to the rescue. Mountains this high are known to be dangerous for aircraft as the air is thin at these altitudes, which entails reduced intake of oxygen to the engines which in turn makes the aircraft more cumbersome (slower) to maneuver, requiring more planning ahead from the pilot. Also, thin air will reduce the lift under the wings or rotors. On top of this, sudden wind surges can aggravate the problem of weak lift and bad maneuverability. This particular day was windy, with suddenly changing wind surges. In the midst of the rescue operation, one of the rescue helicopters "… crashed while attempting to airlift one of the critically injured climbers. The chopper lost lift, dipped to the Southwest, impacted nose first into the mountain and rolled eight times down into the mountain's crater. The accident injured the five crewmembers on board at the time — one seriously …" (see Figure 1) [1].

The US Air Force Accident Investigation Board (AIB) concluded after its investigation that "… the crew used inaccurate performance planning data, and therefore lacked the [engine and lifting] power required to accomplish the mission. The pilot immediately recognized the slowing of his main rotor RPM [rotation per minute], which was most likely caused by the loss of favorable headwinds. These headwinds had very probably initially compensated for the crew's inaccurate performance data…" [3] (see also [2] for a live video footage of the rescue operation).

Although the pilot was aware of the strong winds and of the risks associated with thin air, "rescue fever" might have pressed him to ignore these signs of potential danger. This case demonstrates the importance of acknowledging risk factors, especially when these add up. In other words, it is important to think "what if", and to always be prepared for the worst, that is, to have foresight.

Figure 1. Rescue helicopter crash on Mount Hood (photo from http://www.katu.com/features/seeit/3871892.html).

EXISTING FORESIGHT TRAINING METHODS

According to a systemic view, ES personnel, supported by road infrastructure, vehicles, tools and technical equipment, can be regarded as an aggregate socio-technical system that should be studied as a whole. As this system functions in a holistic way, accidents are caused by the system as a whole. Various parts of the system will perform unevenly, due to weather conditions, stress, fatigue, temperature changes, etc. The performance of system components thus varies incessantly. When the variation of several components converges in a bad way, it can lead to an accident [7]. According to this systemic view, variability (including human variability) is inherently bad.

However, human flexibility can also be an asset. In real-life socio-technical systems, emergency procedures might not cover all situations, technical equipment may not function as intended, and so on, which means that human flexibility, creating workarounds, might be the actual stuff that keeps a system functioning in the first place [10]. According to this view, human flexibility, creativity and foresight should not be restricted, but should instead be capitalized on.

What risk factors to look for

Existing methods for foresight training focus on the recognition of risk factors which can be identified according to the *three bucket model* [9]. The three bucket model is used as a simplified tool for subjective assessment of high-risk situations. When the three buckets are close to being full of "brown stuff", the situation at hand is highly risky (i.e. the — might hit the fan), and it would be well advised to take a step back from the situation. The three buckets refer to three types of factors that can affect risk level. The first bucket contains factors related to the individual, for example, self-assessed levels of fatigue, recent negative life events (e.g. divorce), whether feeling sick, and how well subjectively perceived competencies meet the requirements of the given task. The second bucket relates to contextual factors, such as availability of necessary equipment, time pressure, imminent or recent shift handover, etc. The third bucket collects factors related to the task at hand, for example, the complexity of the task, and whether one has reached an error-prone portion of the task (where there is a lack of cues as how to proceed), or if one is close to the end of the task (when most errors are made). The combined contents of the three buckets can give a rough indication if one should go ahead, proceed with caution, or back out.

Foresight training in healthcare

Boakes [4] described an example of foresight training in nursing care using scenario-based discussions. A series of scenarios are verbally described or showed on video to a group of nurses. The scenarios are meant to serve as a starting point for a discussion among the nurses of what contributed to the events and what could have been done differently. The scenarios that were used were developed with the help of active professionals. Four focused group discussions with healthcare professionals (nurses) yielded four types of scenarios:

Reflection on action—The first type of scenarios contains paper-based descriptions of a patient incident. These descriptions are aimed to facilitate discussion of possible contributing factors and how foresight would have made a difference.

Storytelling—The second type of scenarios comprises paper-based stories that are designed to trigger the trainees' own experiences of how they stepped in to prevent an incident.

Spot the difference—The third group of scenarios include video-sequences showing two versions of an event. In version A the risk-level increases for each action taken. Version B begins in with the same initial situation, but here different actions are made, and the risk for subsequent incident is mitigated for each action.

Garden path—Finally, the fourth category of scenarios are such that they unfold in an unexpected way. The video presentation is stopped at certain key points and a discussion is initiated about what has happened so far, which factors are at play, and what could be done at this stage to prevent bad from going worse.

The scenarios were pilot-tested on ten voluntary teams of professionals. Feedback from these evaluations indicates that foresight training might benefit not only front-line personnel but also team leaders. Making the transition from healthcare to emergency management, these results seem to suggest that foresight training could benefit emergency responders and on-scene commanders working directly on the front line, as well as command post staff.

INTEGRATION OF FORESIGHT TRAINING INTO EMERGENCY RESPONSE EXERCISES

Foresight and preparedness requires constant vigilance, however, the mishaps that could offer a training opportunity

and an opportunity to gain experience occur seldom. It is therefore important to offer alternative means for foresight training.

A highly suitable way to train high-risk situations during an emergency response operation is through simulated mishaps and unforeseen complications using a virtual reality (VR) environment, where the trainee can be immersed by being involved in a dynamic interaction with the simulated environment and other real-life actors. One great advantage of simulated training environments is that high-risk events can be practiced without exposing the personnel to real danger. In addition, all details of the training session can be recorded—and analyzed after the exercise. Although simulator-based training normally covers a wide range of situations and learning goals, in this article we place particular emphasis on foresight training, the learning goal being a more mindful personnel and a more resilient organization.

As mentioned previously, there are clear differences between the HROs presently utilizing foresight training and the conditions under which ES have to operate. Among other things, accident scenes are chaotic and there is often no time to evaluate and compare all options. Instead, decision making is forced into a quicker mode, where the present situation is evaluated in a holistic way on the basis of previously encountered similar situations. Actions that worked well in the previous situation are attempted in the present situation, what is called *recognition primed decision* (RPD) [8].

The question is how foresight training can be integrated with this context. The goals of foresight training can be boiled down to 1. Correct risk assessment 2. Creativity when generating alternative actions and 3. To imagine the outcome of these alternative actions. Goal number 3, to imagine the outcome of actions, is already practiced as part of RPD. Goal number 2 is *not* practiced in RPD, as new alternatives for action are normally not generated until the current option has been rejected as being unfeasible. This single-alternative mode works fine as long as risk levels are low to moderate. When risk levels start to soar, the single-option style becomes suboptimal.

To have an added value, foresight training for ES should focus on training goals 1 and 2: Correct risk assessment and to *always* be creative when it comes to preventing a potentially dangerous development of events. One caveat is that correct risk assessment is often neglected during an emergency response, due to time constraints.

If a simplified scheme for risk assessment were learned, and highly practiced, time constraints would seize to be an issue. As correct risk assessment is a prerequisite for the other training goals, goal number 1 should be of primary concern in foresight training for ES. One way to practice risk assessment and the detection of indicative signs of imminent danger is by being subjected to unexpected, but realistic development of events. These should preferably reflect a course of events that have occurred during real-life responses.

To obtain realistic and useful scenarios, these could be based on interviews and/or focus group discussions with emergency service personnel. These scenarios are meant to cover high-risk situations that could emerge in the course of an emergency response. Some of the scenarios should describe situations that actually went from bad to worse.

These scenarios could be included as injects into the VR-training environment, adding an element of surprise to the training exercise. The trainees' actions during the foresight inject could then be discussed during the after-action review (debriefing) that normally follows an emergency response exercise. After the discussions, the foresight injects could be rerun with the same group of trainees in order to allow them to try out alternative actions.

Following the foresight training method used in healthcare, we suggest four phases of foresight training:

The concept of contributing factors—This first phase is meant to introduce the three bucket model. Scenarios describing an incident should inspire a discussion of possible contributing factors. Could the incident have been avoided if these factors would have been recognized in time? The scenarios should contain elements corresponding to bucket 1, 2 and 3 in Reason's three bucket model, in other words personal, contextual and task-related factors that could affect risk levels.

Personal experiences of successful risk mitigation—In the second phase of foresight training, the scenarios could contain unfolding events that have occurred during the emergency response exercise—preferably minor "close calls" that were appropriately handled during the exercise. The point here is to actualize the theoretical concepts introduced during the first phase, by triggering the trainees' personal memories of similar events, where an imminent danger was successfully mitigated. In this phase, trainees will realize that it is often possible to handle a high-risk situation by taking preventive measures.

Spot the difference—In the third phase, scenarios could comprise injects that could have unfolded in one of two ways. In development A, risk-level increases at each step, in development B, risk-levels decrease as a result of preventive measures. In this phase, trainees will hopefully become aware of the potential power that every individual has to affect a course of events through cautious thinking and preventive actions.

How will this end?—This concluding phase of the suggested foresight training for ES could contain scenarios based on especially tricky events that unfold in a way that is difficult to foresee. Content should, if possible, be based on actual events (like the helicopter rescue described earlier). The purpose of this final phase is to exercise what has been learnt. A recording of the trainees' actions during the inject will be replayed during the after-action review. After a

discussion of which factors are presently at play, what might happen and what could be done to prevent it, the VR-simulation can be rerun, in order to allow the trainees to try out alternative actions.

CONCLUDING REMARKS

Training, as outlined here, could be offered to all categories of personnel in ES: the emergency responders, the team leaders and the on-scene commander, as well as the command post staff. Details of the training could be adapted to organizational level, but will have the same main goals: to help develop a more risk perceptive and less fatalistic, more flexible way of action during an emergency response.

We would also like to note that foresight training for ES can have a beneficial effect not only at the individual, but also at the organizational level (even if only front-line personnel are trained). The mindset that is practiced through foresight training is associated with an increased feeling of power to change the way things are. Provided that front-line personnel is encouraged by management to be mindful, they will take an increased responsibility for safety work in the organization, creating a more reciprocal information flow across the organizational levels. In this way all personnel will feel responsible and will actively partake in achieving organizational resilience.

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