Information Technologies for Emergency Planning and Training

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ABSTRACT

Crucial to improving the management of emergency situations is the definition of suitable Emergency Plans and training of participants in the application of such plans. In order to design a good Emergency Plan, experts from different areas need to work collaboratively to identify all the events and the relationships among such events. The main purpose of this project is to study different information technology techniques that can be used in the elaboration of and training for Emergency Plans, based on the use of scenarios. The use of such techniques will support collaborative development of Emergency Plans, the use of rich formats that provide different perspectives on a plan, the exportation and sharing of plans in order to increase their evolution and improvement, the instruction of participants, as well as better interaction, participation and exchange of knowledge. Key aspects of the plans for this recently begun project are described in this paper.

Keywords

Emergency plans, advanced interaction, scenarios, document engineering, training

INTRODUCTION

In many cases it is not possible to anticipate the effects of an emergency situation, either because we cannot forecast low probability events, or because the effects are greater than expected. However, it is always possible to develop an appropriate emergency plan to improve our response to these situations. The existence of plans for specific emergency situations allows organizations to understand the context, the individuals and teams involved, the resources that should be used, the successful organization and coordination of the response, the protective measures and actions required to undertaken, and the procedures and sequence of actions needed in order to respond to possible emergencies. The obligation of organizations to develop an Emergency Plan is common in most countries. The Emergency Plan is a document that includes prevention standards and procedures to apply in emergencies, detailing all identified possible incidents that may occur.

Emergency response (with or without specific regulations) is a complex activity involving an undetermined number of people who are expected to follow the procedures outlined in the Emergency Plan. Therefore, it is vital that the developed plans are appropriate and well known to all those involved in using them. As indicated in (Waugh and Streib, 2006), the ability to collaborate effectively in real situations is enhanced by the planning and ongoing training of participants. Moreover, given the multidimensional nature of disasters (Oliver-Smith, 2002; Canós et al, 2005), the definition of plans is a highly collaborative process involving different types of experts and representatives of agencies concerned with their application. In addition, interoperability is a key issue to ensure coordination among various agencies involved in emergency situations. For example, one of the main weaknesses identified in the management of Hurricane Katrina in Louisiana was the lack of interoperability among the federal, state and local agencies (U.S. House, 2006).

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In this paper, we briefly describe the planned activities in a new project in Spain that began in January 2011, called TIPEx[1] . It is based on collaboration among three universities in Spain. The main purpose of this project is to study different information technology techniques, and their use in prototypes, in order to facilitate the definition of and training for the implementation of emergency plans, based on the use of realistic scenarios. We cannot ignore, however, that plans are never infallible nor do they cover all possible events (Waugh and Streib, 2006). The literature advocates supporting effective access to information to facilitate improvisation (Waugh and Streib, 2006, Carver and Turoff, 2007). Disasters are not events that occur at a single place and time but they are evolving processes (Oliver-Smith, 2002). This project approaches Emergency Plans as resource documents that evolve as they are used, either for training or real-case processes, to generate additional knowledge. This knowledge can then be used to improve our response to future emergency situations. Figure 1 shows the main concepts of the TIPEx proposal.

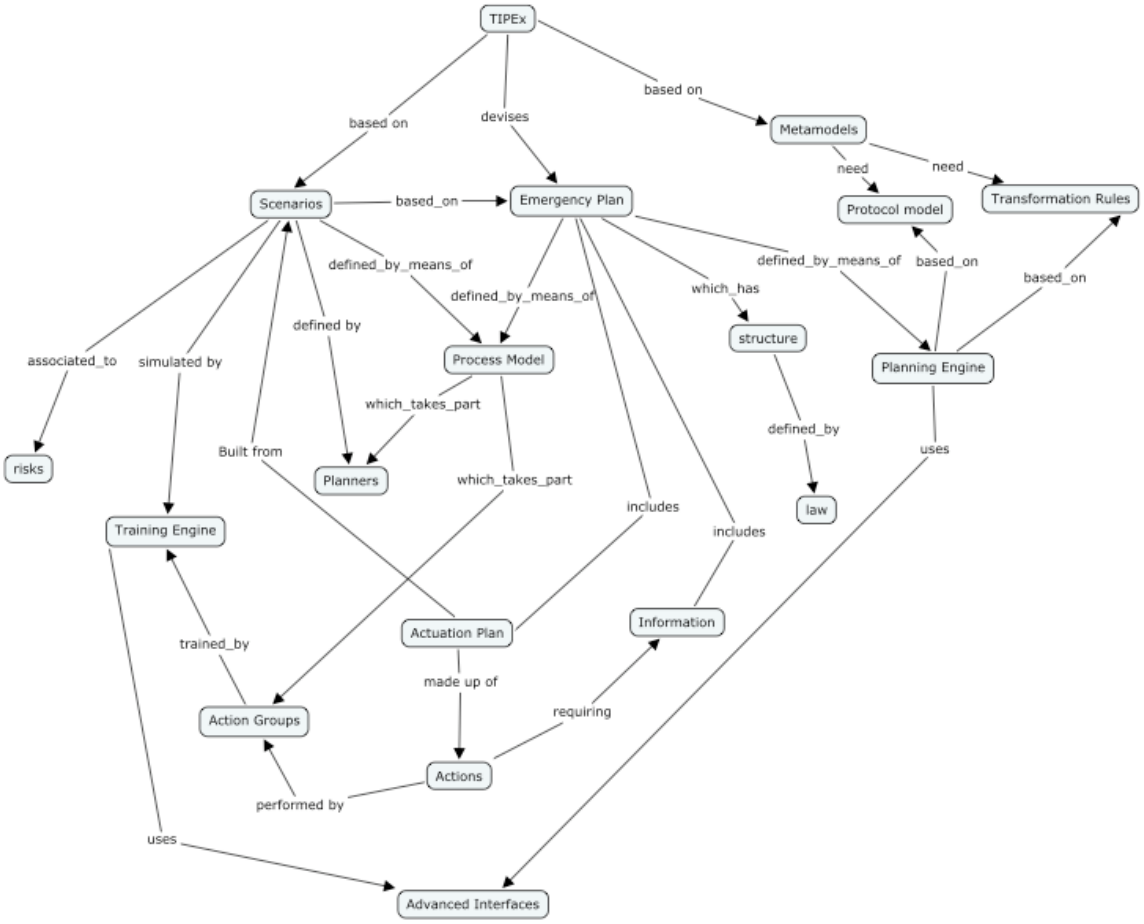

Figure 1. Concept map of TIPEx project

The following sections briefly describe the key research areas that are related to this project, including the use of scenarios in emergency planning, issues of training for emergency situations, the planned integration of advanced interaction techniques, and document engineering for Emergency Plan development.

SCENARIOS FOR EMERGENCY PLANNING

In an Emergency Plan, scenarios are developed based on significant events that have occurred in the past, that need to be updated to take current conditions into account, or on possible occurrences that have no precursors (Bañuls and Turoff, 2010). At this point we are studying with the practitioners different realistic scenarios in order to know and understand the different factors, which are involved in the definition of the plan and how different actors participate in it. Our examples of scenarios include: an air crash in Barajas Airport affecting nuclear substances in the airport depot; clearance of the second soccer stadium in Madrid (Vicente Calderón);

[1] Spanish acronym for Information Technologies for Planning and Training for Emergency Situations.

planning of evacuation routes for a small town (44000 residents) and a "dirty bomb." One of the most important contributions of scenario planning to the management of emergencies often comes from the process itself: the identification of partners, their capacities and resources, the development of a teamwork relationship, and the ability to reach an agreement on the issues, priorities and responsibilities. These benefits are generally recognized in the use of prospective techniques that focus on processes in the field of foresight and collaborative planning (Martin, 1995). For that reason, scenario planning requires a shared and coordinated collaboration with all involved in this process, under common objectives for a specified time span. This requirement makes it essential that the scenarios used in the planning process are interoperable and multi-perspective in order to allow for collaborative design of organization members belonging to different environments/contexts.

Scenarios for Emergency Plans are usually designed in terms of risk, vulnerability, impact and response to emergencies. These scenarios further aim to incorporate a variety of environmental situations, for example, disasters that occur at night or during the day. Despite the important role of scenarios in emergency response management, there is a lack of academic research on how to generate and analyze such a set of scenarios and how to integrate them in the development of Emergency Plans. In order to bridge this gap, we will propose a scenario-based model to identify the features of the events that happen in a crisis, the actors involved and the nature of Emergency Planning tasks in this project. According to the model, a scenario generation method will be proposed based on the fundamentals of cross-impact analysis to simulate support planning process scenarios and to detect interrelations between scenario elements and the critical event detection in an emergency.

TRAINING FOR EMERGENCY SITUATIONS

As indicated in (Waugh and Streib, 2006), emergency response capability is built from the bottom up, that is, it must arise from all those who are expected to put the plans into practice. This requires periodic training to enable employees to understand their responsibilities and to know what actions to perform, when they should be performed and how to perform them. Among the different types of training, simulation exercises are particularly popular because they support situated learning in which skills and knowledge are applied in realistic situations (Brown et al, 1989). Exercises can vary in their degree of realism, complexity and level of stress, but they all try to reproduce a scenario of a real emergency so that each participant simulates the actions carried out for the role they should play. The importance of simulation exercises lies in their ability to clarify the exact responsibilities of each participant's role and improve his/her performance in carrying out each task. Moreover, simulation exercises can be used to evaluate a plan, insofar as they can help in identifying weaknesses or possible improvements in policies and procedures. Thus, we plan to emphasize simulations as a training technique for the Spanish agencies to be involved in this project.

The use of virtual environments for conducting simulation exercises can provide numerous advantages. For example, one can easily obtain an exhaustive record of the actions performed by each role during the simulation. This register can be used both to implement a tool to assess the degree of alignment with the plan of actions for each participant, as well as to simplify the analysis and evaluation of the plan itself. Moreover, once an exercise is designed to represent a specific emergency in a particular context, it is easy to replicate it in other contexts. In addition, participants can take part from various locations, rather than having to travel to a common location. Thus, we plan to emphasize virtual simulations.

Various software tools support emergency staff training scenarios, providing a greater or lesser degree of immersion in virtual scenarios. ArtesisVirtual (Houtkamp and Bos, 2007), for example, allows for training and performance evaluation of the role of a fire chief in a home-type fire emergency. However, most of these products restrict training to one or more specific emergency situations and settings, while making reuse or training in other settings complicated and expensive. It is therefore important to design emergency services training software tools for both individual and collaborative Emergency Planning, which are highly configurable, easy to use, and capable of reproducing different scenarios. Similarly, to enhance the adoption of the designed tools, we should pay particular attention to interaction design issues that enable the use of simulators by personnel unfamiliar with the technology. During this project, we aim at exploring the usefulness of advanced interaction devices that have emerged in recent years like the ones introduced in the following section in order to get a tool as intuitive and easy to use as possible.

ADVANCED INTERACTION

The planning and training phase of emergency situations suggests the use of new technologies to boost natural multimodal interaction. These technologies use digital tools that employ direct manipulation that allows participants to act naturally. An example is design of evacuation plans by interacting with a digital map collaboratively. Support for different views should be provided, including annotation features (text, sound and

graphics). Several areas of research and innovative technologies that can be used to develop a multimodal natural interaction and that we plan to pursue include:

- Tangible interfaces (tangible bits or tangible interfaces) (Ishii and Ullmer, 1997), based on the fundamental idea of giving physical form to digital information so that you can manipulate the bits directly with your hands.
- Touch screens that allow the user to point and select objects on the screen using their fingers, and therefore are much more natural and direct than the mouse, and act both as input and output device.
- An Interaction without touching (touch-less) system through which body movements are tracked and converted into digital data before being used as commands. Gesture recognition is an application in the area of computer vision in which a set of image processing techniques and time series analysis are used to make the computer understand a gesture captured by a camera or Webcam. The UC3M group has developed its own mechanism for browsing through the iris of the eye by three-dimensional space to facilitate movement in emergencies (Malizia et al, 2009).
- Multimodal interaction, a paradigm in which users interact with a system by mixing modes of human interaction, such as voice or speech, gestures, eye movements, and various modes of input and output encompassed in previous paradigms. The most common multimodal systems combine visual presentation with voice commands. However, they may include other modalities such as posts based on stylus and haptic devices, and many more.

A system that is designed for multimodal and touch-less interaction will offer users the opportunity to design collaborative planning scenarios, and to interact naturally and effectively with different types of maps or information displayed simultaneously. Furthermore, the use of advanced technologies, such as touch screens, facilitates the development of advanced training environments to test and improve the implementation of plans developed in the preceding phase.

ENGINEERING EMERGENCY PLANS: DOCUMENT MODELS, META-MODELS AND TRANSFORMATIONS

The scenario-based planning processes must have as a final result a document integrating, not only the good practices defined via the scenarios, but also all the supporting information for the correct development of responses in actual emergency events. Such a complex document is, as mentioned above, the Emergency Plan, which integrates all the knowledge related to emergencies in an organization. Such knowledge comes from different sources, some specific to the organization, and others common to a set of similar organizations. Additionally, the same knowledge can be displayed in different formats suitable for the different capabilities of responders' devices.

We intend to provide emergency planners with methodological and tool support for the development of Emergency Plans. Specifically, we will apply Document Engineering techniques for the development of variable-content documents to the case of emergency plans, where variability arises in two aspects, namely the specific structure and content of a plan, and the expressiveness used to build it, ranging from plain text to rich-content hypermedia applications.

Document Engineering has not previously been used either in the field of emergency management or in the planning of emergency response, so the project is opening a new application field of Document Engineering techniques. We will develop variable content document (meta) models, and will define a process for the derivation of such documents from the scenarios captured in the early stages of the emergency planning process.

CONCLUSIONS

Many challenges remain open in the Emergency Management field. During the last decade, we have seen how IT research has focused on the definition of (service-oriented) architectures for distributed emergency management systems, the emergence of mobile devices as new ways to access information, and the use of Web 2.0 as the platform for the dissemination of emergency-related information. Now, it is time to focus on aspects related to the quality of the information delivered to the different actors involved in emergency response (Aedo et al, 2010). In this context, planning becomes a crucial activity within the emergency management lifecycle. The design and development of effective emergency plans will be the key to providing high quality information to the responders and to the victims of emergencies. And, in the search for better emergency plans, methodological and technical issues arise. The use of scenarios is the first step to understand the needs of

specific emergency situations that include teams, roles, situations, and actions. The knowledge captured by means of the scenarios can be formalized in emergency plans. In order to provide planners with tools to support the generation of such plans, document engineering techniques can be applied to generate plans compliant with both legal regulations and the domain-specific scenarios. Such plans will be accessible via different technological platforms ranging from plain text readers to the most advanced interaction mechanisms. Understanding the different contexts in which plans are accessed, the various kinds of users involved in their application, their abilities, skills and limitations, the different purposes they pursue and other contextual constraints will help in designing the most effective interaction platforms. Moreover, scenarios with advanced interaction mechanisms can be used to support situated and effective training of the involved teams, increasing their preparedness.

These are the goals of the TIPEx project that is expected to improve the definition of emergency plans and training. It is based on the concept of scenarios as key elements, and the reusability of existing plans and their extensibility, making use of advanced interfaces and document engineering.

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