ABSTRACT

DESIGN, DEVELOPMENT AND EVALUATION OF COLLARIO, A GROUP SUPPORT SYSTEM FOR COLLABORATIVE SCENARIO CREATION

by
Xiang Yao

In the fields of Emergency Management and Business Continuity Planning, scenarios are a widely used tool for planning, training and knowledge sharing purposes. The ability to create and discuss emergency scenarios in virtual teams can lead to many potential applications, such as discussing emergency scenarios by world-wide experts, conducting on-line exercises, and creating Communities of Practices. Existing scenario creation systems, like NxMsel provided by FEMA, allow distributed groups to create scenarios together. However, collaborative support in these systems is generally limited.

This dissertation explores an innovative solution to provide various types of collaboration support around a knowledge structure and uses this approach to build a collaborative scenario creation system called Collario (Collaborative Scenario). Following the Design Scenario paradigm, this research goes through four iterations to evolve Collario into a working prototype. Several evaluation methods, like system demonstration, protocol analysis and field study, have been employed to evaluate the design effects and get user feedback. The results show that Collario is useful to support creation and discussion of emergency scenarios in virtual teams and to share knowledge and experiences among geographically distributed emergency professionals and researchers. It is also found that Collario is not hard to learn and use.

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This dissertation is dedicated
to my lovely wife, Mengmeng Wang,
for making every day enjoyable and exciting;
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LIST OF SYMBOLS

EM	Emergency Management
FtF	Face-to-Face
GA	Group Awareness
GSS	Group Support Systems
IRB	Institutional Review Board
TTX	Table Top eXercise
VT	Virtual Team

CHAPTER 1

INTRODUCTION

1.1 Overview

The objective of this dissertation research is to design, implement, evaluate, and evolve a Web-based group support system (GSS) called Collario, (Collaborative Scenario), to support collaborative scenario creation in virtual teams (VT). This dissertation examines scenarios in the context of emergency management (EM), especially emergency preparedness planning and training.

In the design phase of this research, particularly explored are (1) a knowledge structure to organize and store components that make up a scenario and can be reused to create new ones, (2) knowledge structure-based collaboration support to allow users to work closely on composing and improving emergency scenarios, and (3) group awareness (GA) tools to help users keep track of the group activities.

This dissertation follows the design science paradigm in conducting the research, which identifies the problems from practice, designs and evolves the artifact through multiple iterations, and evaluates the artifact back in practice. The most important goal of this dissertation is to provide the Emergency Management community with an easily accessible and easy-to-use collaborative system to facilitate creation and discussion of emergency scenarios in Virtual Teams (VT). This dissertation also explores innovative GSS design methods to stimulate collaborative knowledge creation and collaboration.

1.2 Problem, Motivation, and Design

In the fields of Emergency Management (EM) and Business Continuity Planning, scenarios are a widely used tool for emergency preparedness planning, training and knowledge sharing purposes. Scenarios resort to story-telling to describe past or potential emergencies. The unique strength of scenarios is that they embed real-world uncertainties and complexities into plausible stories so that emergency plans can be made, reviewed, and practiced accordingly. This dissertation focuses on the scenarios' applications in training and knowledge sharing.

Responses to major emergencies such as a hurricane normally cover a wide range of task areas including, but not limited to, rescue, healthcare, law enforcement, fire fighting, HazMat (hazardous materials), communication, and public relations. To create and exercise complex emergency scenarios involves experts from a wide range of backgrounds. Collaboration is very important for the applications of emergency scenarios.

Currently, face-to-face (FtF) meetings are the most popular collaborative environment to conduct emergency preparedness exercises. FtF meetings have unparalleled strengths, e.g. rich information cues, instant feedback, less likely to be distracting (Daft & Lengel, 1986), and more mingling and relationship building opportunities. However, they are also associated with certain shortcomings. First, it costs time and money to attend FtF meetings. Second, some people might not be able to attend because of conflicting schedules. Third, because of physical constraints, FtF meetings can only be attended by a limited number of participants with a limited duration. Fourth, for large-scale meetings, logistic costs and efforts are not trivia.

Because of these reasons, it is not uncommon to see many emergency exercises only played at most once or twice a year.

To allow more EM workers to be involved in the training processes, various software applications have been developed. It is now possible for training participants to attend training programs virtually. Technologies such as WEB2.0, simulation and social networks have been explored to make training programs not only easily accessible, but also more enjoyable. Such applications are examples of new opportunities for technology-based emergency preparedness training programs.

Successful emergency exercises, FtF and technology-based alike, rely on high-quality scenarios, which are difficult to create. Although mathematical models are helpful to build scenarios for structured problems and predictable events, things happening in the front-line of emergency response can be much more chaotic and spontaneous. To create detailed scenarios for first-line emergency response necessitates collective intelligence from first responders. Software, such as FEMA MSEL Builder (https://hseep.dhs.gov), has been developed to facilitate creation of exercise scenarios. However, this research team has found that they are either PC-based or have only limited support for collaboration. None of them have a knowledge structure in the backend. These shortages might limit scenarios' potential applications for emergency preparedness training and knowledge sharing.

This dissertation explores an innovative solution to design a GSS that supports collaborative scenario creation and discussion. This solution includes (1) using a scenario knowledge structure to capture scenario knowledge components, (2) providing collaboration support to stimulate discussion and collaboration, and (3) developing Group

Awareness (GA) tools to help users better understand the team, its expertise, and its activities. This new design approach should allow distributed emergency experts to create and discuss complex emergency scenarios, and to share their knowledge more effectively.

1.3 Research Method

To develop the Collario collaborative scenario creation system, this dissertation follows the design science paradigm, and an iterative framework to initiate, design, implement, evaluate, and evolve the system. This approach is efficacious for developing innovative artifacts with user interactions as an important component. User requirements are normally vague at the beginning of projects. It is not uncommon for experienced users to not know exactly what they want or what functions new technologies can produce to them until they see a prototype. Prototypes demonstrating design ideas provide users an opportunity to take a sneak peek at the final product at an early time and stimulate them to think and give feedback. Since development of new artifacts needs to go through different Technology Readiness Levels (TRLs) during the life cycle of new artifact development, the design science paradigm is flexible with the selection of the evaluation methods,

Because prototype development and evaluation can be time-consuming and costly, the design science paradigm especially emphasizes the importance of careful selection of the problem(s). This dissertation follows this admonition by observing several FtF table top exercises to confirm the problem. It has been learned from these observations that scenario-based exercises are a widely used practice. However,

communication in the FtF meetings is unbalanced, as the majority of the participants won't be given many opportunities to express their opinions. Also, follow-up activities are limited. Such observations confirm the need for a new way to conduct table top exercises.

To develop a GSS supporting collaborative scenario creation, this dissertation went through four research iterations. The first iteration was to design and choose the most appropriate visualization to display scenario details, which was the basis for the whole system. This dissertation explored three approaches, an Event Log metaphor, a Bow-Tie diagram, and a Timeline graph. Concept-proving prototypes were created following these three approaches. Their strengths and weaknesses were analyzed and compared. After comparison, the Event Log metaphor was selected because of its familiarity to emergency workers, expandability, and ease to implement.

The second iteration was to implement the Scenario Event List to display scenario details using the Event Log metaphor approach. The component was evaluated using system demonstration and cognitive walkthrough. Two local emergency management professionals were invited for this round of evaluation. Potential values of such a system were confirmed. Feedback was taken for system improvement. The feedback was analyzed and integrated into the design.

The third iteration was to implement the collaborative workspace for scenario creation and discussion, based on the Scenario Event List. Several templates were created to obtain user inputs. Various types of Collaboration support were integrated with the Scenario Event List and various review templates. To get user opinions and feedback for the collaborative workspace, the two professionals attending the previous

evaluation, plus a FEMA Voluntary Group Liaison were invited for the second round of system demonstrations. More feedback was collected and analyzed. Adjustments to the system design followed.

Finally, the fourth iteration integrated Group Awareness (GA) support into the system. At this phase, the system was ready to support a real group to work on collaborative scenario creation tasks. Two evaluation methods were employed in this iteration: Protocol Analysis and Field Study. Protocol Analysis was conducted to identify potential usability flaws in the system. Five Ph.D. candidates in the Information Systems Department of New Jersey Institute of Technology (NJIT) were recruited as Protocol Analysis subjects. A field Study was aimed at evaluating the system's usefulness and usability in a naturalistic environment. One field study was completed with eleven undergraduate students majoring in Emergency Management. This field study obtained very good results. Many students mentioned their gratitude to the system designers for providing them the opportunity to try the system. The subjects also indicated their intentions to view and use the final product in the near future.

1.4 Contributions

This dissertation contributes to the EM and IS fields in multiple ways:

First, for the EM field, this research provides an innovative system, Collario, to support collaborative scenario creation and discussion in VTs. Preliminary evaluations showed that this system might lead to several useful applications for the EM community, e.g. creating exercise scenarios, conducting virtual table top exercises, and sharing knowledge among emergency responders.

Second, for the IS field, this research suggests an innovative solution to design of GSS, which includes three major parts: (1) designing a knowledge structure representing the problem domain, (2) designing collaboration support based on the knowledge structure, and (3) designing Group Awareness (GA) support based on the same structure. Because the data models and user interfaces to provide collaboration support and GA support are independent from the domain knowledge structure, it is possible to encapsulate the collaboration support and the GA support in reusable libraries. Ultimately, this might lead to automatic GSS generators, which allow users to define knowledge structures for their domains and then generate domain-specific GSS with collaboration support and GA support.

Third, for the IS field, this research also provides an example of design science research. Hevner et al. (2004) pointed out that for IS research, the design science paradigm is as important as the behavioral science paradigm. However, because of its complexity and uncertainty, not much design science research has been seen in IS Ph.D. dissertations. This research shows that to conduct design science research for developing a GSS is not an easy task. However, it is also rewarding. It is gratifying when the users think that the new system is helpful for them.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews literature in two areas: (1) scenario and scenario application, and (2) Group Support Systems (GSS). These reviews lay the foundation to design the collaborative scenario creation system.

2.1 Scenario and Scenario Application

Scenarios have a long history of applications. This section explains what they are, what they can be used for, and how to create them.

2.1.1 Definition of Scenario

On-Line Merriam-Webster dictionary provides three definitions for Scenario. The third definition was chosen by Coates (2000) to reveal the futurist's point of view:

Scenario is "A sequence of events especially when imagined; especially: an account or synopsis of a possible course of action or events." (On-line Merriam-Webster dictionary, http://www.m-w.com)

This futurist's view of scenario was also used by other researchers (Godet and Roubelat, 1996; Coates, 2000). However, this view might limit potential applications of scenarios because scenarios can also be used to describe happenings retrospectively. To avoid this limitation, this dissertation defines scenario as "A sequence of succinct events to portray actual or imaginary occurrences or courses of action."

2.1.2 Scenario Applications

In the EM field, scenarios are mainly used for three purposes: planning, training, and knowledge sharing.

First, scenarios have long been used as a planning tool by both the military and businesses. The unique strength of scenarios is that they can embed real life complexities and uncertainties into coherent, plausible, and systematic stories, so that planners can assess the problems and make decisions more effectively. Kahn (1960) used scenarios as a tool to explore potential complexities of a nuclear war. In the business world, Royal Dutch/Shell has been using scenarios for strategic planning successfully for over four decades (Kahn, 1976; Cornelius et al., 2005).

Second, scenarios can also be used for training and educational purposes (Turoff et al., 2006). They have been used for a full spectrum of scenario-based training programs ranging from small-scale Table-Top eXercises (TTXs) to large-scale field drills with smoke and bandages to make the scenes seem real. High-quality emergency scenarios can establish an Experience-Based Learning (EBL) (Kolb, 1984) environment for the trainees to practice their situation assessment and decision making skills to deal with emergencies without being physically present in the hazardous environments.

A social environment is the key for scenario-based exercises. Social learning theories (Vygotsky 1978; Kolb, 1984; Lave & Wenger, 1991) suggest that learning occurs as a result of the interactions between the environment and the learner. Vygotsky (1978)'s Social Development Theory emphasizes the importance of social interactions in the internalization process. Kolb (1984)'s Experiential Learning Theory (ELT) reveals that learning process includes circular steps of experiencing, reflection,

conceptualization, and experimentation. Finally, Lave and Wenger's (1991) Situated Learning Theory (SLT) reveals how novices or newcomers become more experienced and part of the group by a process they called Legitimate Peripheral Participation (LPP). Scenario-based exercises simulate the necessary social environment in which learning from the environment happens. The application of scenarios in learning and training is the focus of this dissertation.

Last but not least, scenarios can also be used as knowledge sharing and knowledge management tools. According to Nonaka and Takeuchi (1995), knowledge can be divided into two categories: explicit knowledge and tacit knowledge. Explicit knowledge is codified knowledge that can be found from different recording media. Tacit knowledge is unrecorded knowledge that only exists with knowledge holders as personal experiences. Tacit knowledge is not recorded either because it is difficult to describe, like how to swim or ride a bicycle, or because the knowledge holders have not had a chance to record them. For knowledge management, how to exchange and share tacit knowledge is the most difficult part (Nonaka and Takeuchi, 1995).

To explain the process of knowledge creation, Nonaka and Takeuchi (1995) proposed the SECI model, which posits that new knowledge is created through dynamic interactions between tacit and explicit knowledge. SECI stands for the four modes of knowledge interaction: Socialization, Externalization, Combination, and Internalization.

- Socialization is the mode in which tacit knowledge is exchanged among collaborators through communication or shared experience.
- Externalization is the mode in which tacit knowledge and personal experiences are translated into explicit knowledge.
- Combination is the mode to build connections between different explicit knowledge.
- Internalization is the mode to absorb the explicit knowledge to become part of personal knowledge base.

Figure 2.1 illustrates the SECI model.

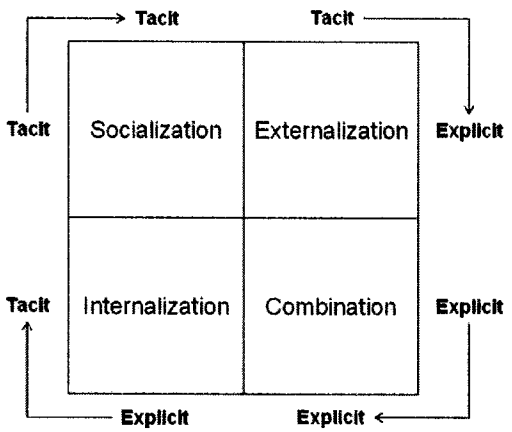

Figure 2.1 The SECI model to illustrate the knowledge creation processes.

Source: Nonaka, I., and Takeuchi, H. (1995), "The knowledge creating company: how Japanese companies create the dynamic innovation" New York, Oxford University Press.

Creating and sharing scenarios can facilitate all four processes in the SECI model. Translating personal experiences into scenarios is the process to externalize tacit knowledge. Exchanging scenarios as a representation of personal experiences is the combination process. Reading others' scenarios and absorbing their experiences is the internalization process. Finally, exchanging opinions based on each other's scenarios is the socialization process.

2.1.3 Scenario Creation

Quality plays an import role for all the three potential applications of scenarios. For planning and training purposes, the quality of the scenarios is directly related to the quality of the outcomes. For the knowledge sharing purpose, the quality of scenarios is related to the usefulness of the knowledge base. The importance of high-quality exercise scenarios is perfectly captured by a FEMA expert's comment the author interviewed: "The most difficult part (for using scenarios for training purposes) is to have high-quality scenarios. Once we have them, the remaining things would be much easier." Because of this reason, it is important to understand how to assess scenario quality and how to create high-quality scenarios.

From the literature, six criteria have been identified to assess scenario quality. They are Plausibility, Comprehensiveness, Novelty, Coherency, Consistency, and Timeliness (Godet & Roubelat, 1996; Mietzner & Reger, 2005; Quarantelli, 2006).

1. **Plausibility**: Foundation of the scenario is sound.
2. **Comprehensiveness**: Important issues have been thoroughly covered in the scenario.
3. **Novelty**: The scenario includes ingenious ideas for identifying threats and/or counter-measurements.
4. **Coherency**: Different parts of the scenarios are logically connected.
5. **Consistency**: The wording and style is unified throughout the scenario.
6. **Timeliness**: The scenario deals with up-to-date situations and concerns.

The literature also provides insights on how to create high-quality scenario from two perspectives, the process perspective and the content perspective. From the process perspective, Coates (2000) suggested a four-step process:

- **Step 1**: Identify and define the universe of concern.
- **Step 2**: Define the variables that will be important to define the future.
- **Step 3**: Identify the themes of scenarios.
- **Step 4**: Create and document the scenarios.

The fourth step was further divided into several sub-steps:

- **Step 4.1**: Write the scenario.
- **Step 4.2**: The team comes together to read, review, and evaluate the scenario.
- **Step 4.3**: One optional step is to have one person to go through all of the agreed parts of the scenario and give them a uniform style.

From the content perspective, the literature suggests that as many as seventeen concepts are related with scenarios (Gordon, 1994; Quarantelli, 1997; Coates, 2000; McConnoll & Davies 2006). They are Scenario, Theme, Constraint, Event, Notification, Situation, Potential Outcome, Parameter, Prerequisite, Resource, Resources Type, Alternatives Resource, Trigger, Assumption, Objective, Time, and Location. These concepts are summarized in the following list:

1. **Scenario**: A scenario is a series of events and situations to describe a possible or actual happening.
2. **Theme**: Theme is to describe the profile of a scenario. Theme also provides a way to group scenarios.
3. **Constraint**: Constraint stands for the limitations (material, human resources, finance, etc.) placed upon a scenario to be created.
4. **Event**: An event is a natural or man-made activity, which might change the states of a system.
5. **Notification**: A notification is an abstract of an event.
6. **Situation**: A situation is a snapshot of system states and/or environment conditions. A situation can be described using a set of variables.

7. **Potential Outcome**: A potential outcome is a possible situation resulting from an event.
8. **Variable**: A variable defines a dimension of interest to describe a situation.
9. **Prerequisite**: Prerequisite defines pre-conditions for the realization of an event. Prerequisites can be resources (material, human resources, finance, etc.), as well as other conditions defined by variables.
10. **Resource**: Resource is certain roles, equipment, or financial resources needed to carry out an event.
11. **Resource Type**: Resource type is to organize similar resources.
12. **Alternative Resource**: Alternative resources are replacements of a resource. They are useful when some resources are running short.
13. **Trigger**: A trigger is a special prerequisite, which will automatically set off some events when the conditions are met.
14. **Assumption**: Assumptions are the implicit beliefs that are taken into consideration together with explicit objective or subjective evidence to generate conclusions. Without understanding of the assumptions, it will be difficult to understand how the conclusions are reached.
15. **Objective**: Objectives define the purposes of a scenario under creation. Objectives limit the events and situations to be considered.
16. **Time**: Time defines when an event happens in a scenario.
17. **Location**: Location defines where an event happens in a scenario.

To create high-quality emergency scenarios, Turoff et al. (2006) emphasized the importance of dynamic interactions between the attack and defense events. From a Hegelian's point of view, a defense wouldn't be a good defense without considering attacks. It is true vice versa.

Turoff et al. (2006) also envisioned that scenarios can be played by both human and computer agents taking the offense or the defense roles, if the scenarios include quantitative estimates (probabilities, losses, etc.) for both the offense events and the defense events. Combination of the roles (offense vs. defense) and the agents (human vs. computer) leads to the four types of applications in Table 2.1:

Table 2.1 Four Potential Applications of Scenarios

	Human Offense	**Computer Offense**
Human Defense	Plan Improvement by experts	Training for learners
Computer Defense	Stress testing of plan details by experts	Simulation for sensitivity and risk assessment based upon probabilistic factors

Source: Turoff, M., Chumer, M., Hiltz, S. R., Hendela, A., Konopka, J., and Yao, X. (2006). "Gaming emergency preparedness." HICSS-39, Kauai, Hawaii.

2.2 Group Support Systems

The previous section is mainly concerned with the application domain. This section changes the focus to the design requirements for group support systems (GSS).

2.2.1 Introduction

A group support system was defined by Nunamaker et al. (1996, p.419) as: "a computer-based environment to support concerted and coordinated effort for joint problem solving and task completion."

GSS is one of the many group communication technologies such as Email, Instant Messaging (IM), Bulletin Board Systems (BBS), and Wiki, among which GSS provides the highest level of support to coordinate teamwork. Nunamaker et al. (1991) attributed GSS's contributions to team collaboration to four GSS features: process support, process structure, task support, and task structure.

- **Process Support**: Process support is new communication channels provided by a GSS.
- **Process Structure**: Process structure is the communication protocols enforced by a GSS to direct communication.
- **Task Support**: Task support is task-specific information channels to gather task-related information from other sources.

- **Task Structure**: Task structure is task-specific information processing capabilities to accomplish a task.

Because task-specific support and structure can be provided in GSS, this makes GSS more powerful than other group communication technologies to solve complex problems in team settings. For this reason, GSS was chosen in this research as the solution to solve the collaborative scenario creation problem.

2.2.2 Productivity Implications: Productivity Gains and Losses

An important issue about GSS is group productivity and GSS's effects upon group productivity. Steiner (1972) provided a conceptual formula for group productivity:

$$\text{Actual Productivity} = \text{Potential Productivity} + \text{Process Gains} - \text{Process Losses} \tag{2.1}$$

According to Steiner, potential productivity is pre-determined by team composition and is relatively stable no matter what technologies or processes are used. However, potential productivity might not be the same as actual productivity, because of process gains and process losses. Nunamaker et al. (1991) surveyed GSS's potential impacts on group process gains and losses. Table 2.2 summarizes Nunamaker's findings.

Table 2.2 Potential Process Gains and Losses Related with GSS

	Process Gains	**Process Losses**
Increase	Synergy Learning Stimulation More Information More Precise Communication More Objective Evaluation Effects Depend Upon Specific Technique Used	Free Riding Information Overload Flaming Slower Feedback Fewer Information Cues Incomplete Use of Information
Decrease	More Information	Attention Blocking Failure to Remember Conformance Pressure Evaluation Apprehension Free Riding Air Time Fragmentation Attention Blocking Concentration Blocking Socializing Domination Information Overload Incomplete Use of Information Incomplete Task Analysis Coordination Problems Effects Depend Upon Specific Technique Used

Source: Nunamaker, J. F., Dennis, A. R., Valacich, J. S., Vogel, D. R., and George, J. F. (1991). "Electronic meeting systems to support group work." Communication of the ACM. 34(7): 40-61.

2.2.3 Design Requirements

The literature provides GSS design requirements from various perspectives. Table 2.3 summarizes the perspectives and the design requirements relevant to this research.

Table 2.3 GSS Requirements: A Summary

Perspective	GSS Design Requirements, Models, and Theories	Key Points
Individual Cognition	TEAM (The Economics of Attention Management)	Limited cognitive resources need to be allocated among competing tasks of communication, information processing, and deliberation.
Group Cognition	Group Awareness (GA)	GA is a mental state of the group to align individual actions to the group goals. GA can be in different forms (e.g. location, action, intentions, etc.)
Group Communication	Communication Protocols	Communication protocols dictate how a group communicates.
	Levels of Collaboration	Five collaboration levels have been identified (competing, informing, coordinating, cooperating, and collaborating)
Group Problem Solving	Problem Solving Models	Group problem solving consists of divergent and convergent processes.
Social Support	Role Management	Several roles are necessary for GSS in general.
Technology Acceptance	Technology Acceptance Models	Three factors: perceived usefulness, perceived ease of use, and social influence, mainly determine if a new technology will be accepted or not.

2.2.3.1 TEAM (The Economics of Attention Management) Model. The Economics of Attention Management (TEAM) model is a cognitive model for collaborative problem solving (Briggs, 1994). The TEAM model posits that humans have only limited cognitive resources of attention, which must be allocated among competing cognitive processes like Communication, Information Accessing, and Deliberation for group problem solving. Communication includes the interactions among the team members to share information, form shared understanding, develop agreement, and coordinate activities. Information Accessing involves activities to get necessary information either from the archive of the discussions or from external resources. Deliberation is the process by which individuals analyze, manipulate, and integrate the information, and translate their ideas into languages. An implication of the TEAM model for GSS design is that GSS should facilitate all three processes with minimal demands on cognitive resources.

2.2.3.2 Group Awareness (GA). The enhancement of group productivity can also be achieved through improving GA in virtual teams (Dourish & Bellotti, 1992; Mendoza-Chapa, 2000; Lowry et al., 2004; Neale et al., 2004). Researchers have found GA is critical for effective virtual teams (Mendoza-Chapa et al., 2000; Lowry et al., 2004; Neale et al., 2004). GA is defined as "a mental state of the users generated by their mutual interactions and by their interactions within the workspace. Thanks to this mental state, a user can capture a common knowledge which allows him to decide about his own actions in order to reach the group goal." (Mendoza-Chapa et al., 2000, p.114). Without knowing other people's activities and the statuses of the group goals, it would be difficult for any individual to position his/her own efforts (Dourish & Bellotti, 1992). GA

information should be supplied by group support systems, either explicitly e.g. through annotation structure (Dourish & Bellotti, 1992), or implicitly, e.g., through role settings (Dourish & Bellotti, 1992).

Gutwin and Greenberg (1996) found that GA was an integrated state of awareness about different elements such as locations, presences, activity levels, actions/changes, objects, intentions, extents, abilities, sphere of influence, and expectations. Table 2.4 summarizes these elements and their definitions provided by Gutwin and Greenberg (1996).

Table 2.4 Group Awareness Elements

Element	Explanation
Locations	Where are they working?
Presences	Who is participating in the activity?
Activity Levels	How active are they in the workspace?
Actions	What are they doing? What are their current activities and tasks?
Changes	What changes are they making, and where?
Intentions	What will they do next? Where will they be?
Objects	What objects are they using?
Extents	What can they see? How far can they reach?
Abilities	What can they do?
Sphere of Influence	Where can they make changes?
Expectations	What do they need me to do next?

Source: Gutwin, C. and Greenberg, S. (1996). "A usability study of awareness widgets in a shared workspace groupware system." Proceedings of the Conference on Computer-Supported Cooperative Work (CSCW'96), Boston, pp.258-267.

2.2.3.3 Communication Protocol. GSS provides communication support by implementing communication protocols, structures or rules to direct the patterns of communication (Linstone & Turoff, 1975; Hiltz & Turoff, 1985; Nunamaker et al., 1991). Communication protocols are the controls on what a team member may do with respect to creating a new communication which, in the case of collaborative scenario creation, may be a new item, a contribution to a missing piece of an old item, or the creation of an alternative to a current element of an item. It also includes how conflicts are resolved when there is more than one alternative to an item.

Delphi is a structured communication technique whose use is mainly to support a group of experts working to reach agreement during group decision making. The Delphi can be computerized (Linstone & Turoff, 1975).

Annotation structures (Weng & Gennari, 2004), another example of communication structure, have been applied in various collaborative writing systems such as Quilt (Fish et al., 1988), SASSE (Baecker et al., 1993), GroupWriter (Adkins et al., 1999), and Collaboratus (Lowry et al., 2002). Through the annotation structure, collaborators can exchange information regarding a specific portion of a document and track writing progresses, as well as responsibilities associated with their social roles.

2.2.3.4 Levels of Collaboration. Prior research found that communication occurred in different levels (Denise, 1999; Neale et al., 2004). Neale et al. (2004) identified five levels of communication based on working coupling: Light-Weight Interaction, Information Sharing, Coordination, Collaboration, and Cooperation.

Similarly, Denise (1999) classified group communication into three levels: Coordination, Cooperation, and Collaboration, according to the nature of interaction. In

Denise's classification, Coordination aimed to make all parts get necessary information when it is needed. Cooperation aimed at creating harmony among the parts. Quite different from both coordination and cooperation, collaboration embraced differences and attempted to have synergy from the dissents.

Based on Denise (1999) and Neale et al.'s (2004) work, this dissertation also proposes to divide communication into five levels of collaboration. Competing is identified as a separate level to address the situations when sharing information is not in a group's interest. Informing is identified as a separate level to refer to the situations when one-way information flow is the dominant way of communicating. The five collaboration levels are: competing, informing, coordinating, cooperating, and collaborating.

- **Competing**: Each member has no trust or commitment to exchange accurate information in the team.
- **Informing**: Each member continues to act independently of the others. However, they are informed of what each other is doing.
- **Coordinating**: Each member knows the order of the activities, so they can orchestrate individual efforts to achieve common team goals.
- **Cooperating**: Each member agrees on what the tasks are and how to divide the tasks among the members.
- **Collaborating**: Each member mutually works on the task. Differences are encouraged for the best of the whole team.

In the author's view, different collaboration levels require different GSS features. For example, in the level of competing, whatever a GSS provides doesn't matter too much, because there won't be much useful communication anyway. In the level of informing, one-way communication channel would suffice. In the level of coordinating, there must be a way for members to know what to do when and where. In the level of

cooperating, consensus establishing tools such as voting and ranking tools would be useful. Finally, in the level of collaborating, functions that allow users to reveal and take advantage of the differences would be helpful.

2.2.3.5 Problem Solving Models and GSS Design. Problem solving models contribute to the design of GSS in that they help designers understand what activities are needed for a group of people to solve problems together. Two classic problem solving models have been reviewed. One is Simon's (1972) Four-Stage Model. The other is VanGundy's (1987) General Problem Solving Model.

Simon's (1972) Four-Stage Model divides problem solving processes into four stages: Intelligence, Design, Choice, and Implementation.

Intelligence: The intelligence phase is the first phase in Simon's model. This phase includes activities to identify and define the problems, such as listening to people; environmental scanning, querying internal and external data bases; brainstorming for gaps between current and future conditions; and performing an analysis of Strengths, Weakness, Opportunities, and Threats (SWOT) (Forman and Selly, 2002).

Design: The design phase is to conceive alternative solutions for the problems. Activities included in this phase include brainstorming, reviewing the literature, building models and prototypes, and conducting exploratory studies (Forman and Selly, 2002).

Choice: The choice phase is to select the best solution(s) among the alternatives. Sometimes, this phase is also referred to as "decision making." Easy decisions can be made intuitive by comparing pros and cons of the alternatives. Making complex decisions necessitating consideration of a lot of factors can be difficult. Rational decision makers attempt to find the solution(s) that maximizes utility. However, rationality is

often bounded, due to constraints like available information, limited cognitive resources, limited amount of time, etc. (Simon, 1991). Computer programs can ease some constraints in some cases and improve human's capability of decision making. Cross-Impact Method (CIM) is one example of using computer programs to reveal complex relationship between uncertain future events and can be used for Emergency Preparedness (Gordon, 1994). In recent years, Analytical Hierarchy Process (AHP) has gained increasingly popularity (Forman and Selly, 2002). To use AHP, decision makers need to first decompose the decision problem into a hierarchy of more easily understood sub-problems, relate them to the overall decision, and then evaluate the elements in pairs. Such a structured approach is very suitable for computer programs to support.

Implementation: The implementation phase is to carry out the solution and evaluate its effectiveness.

VanGundy (1988) extended Simon's Four-Stage Model and established a General Problem-Solving Model (GPSM). GPSM uses three stages to represent the problem solving process: problem analysis and redefinition, idea generation, and idea evaluation. The first stage, problem analysis and redefinition, is a convergent process to narrow the problem into manageable units. The second stage, idea generation, is a divergent process to seek more information to reduce uncertainties, and to create candidate solutions for solving the problem and the sub-problems. The last stage, idea evaluation, is another convergent process to select the best solution from the candidates. Figure 2.2 illustrates GPSM's divergent and convergent processes.

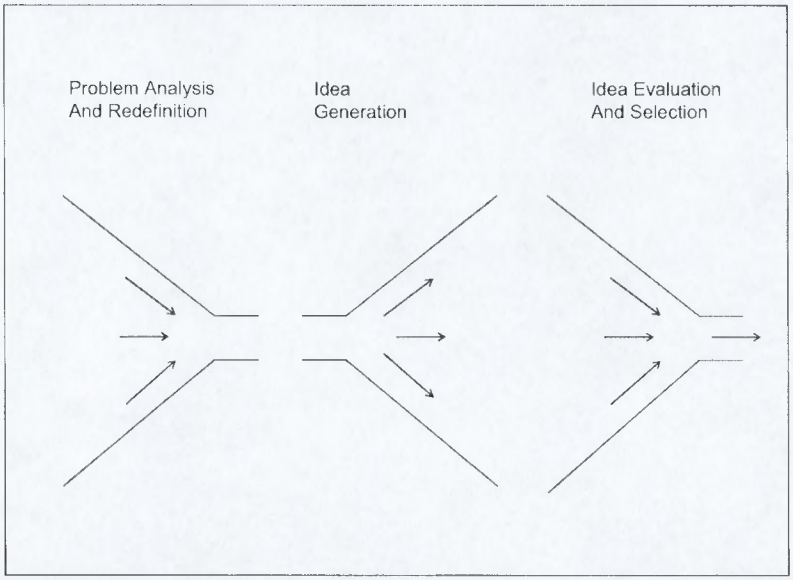

Figure 2.2 VanGundy's General Problem Solving Model (GPSM).

Source: VanGundy, A. B. (1988). Techniques of Structured Problem Solving. Van Nostrand Reinhold, New York, NY.

These two models have a lot of implications for GSS design and research. For example, electronic brainstorming systems (EBS) have long been created and evaluated for idea generation (Nunamaker et al., 1991; Valacich et al., 1994; Lowry et al. 2002; Lowry et al., 2004). Valacich et al. (1994) reported on three experiments to compare idea generation performance between EBS-supported groups and equally-sized nominal groups in various group sizes. Valacich et al. (1994) found consistent results suggesting that large group supported with EBS outperformed equally-sized nominal groups in idea generation tasks. Further, Valacich et al. (1994) conducted four experiments to explain why EBS-supported groups outperformed nominal groups. They found elimination of production blocking in EBS-supported groups accounted for a significant portion of the production enhancement.

Before Valacich et al. (1994) conducted the experiments described above, Nunamaker et al. (1991) had conceptually analyzed why GSS could improve group performance and found three GSS features (anonymity, parallelism, and group memory), were the most important reasons. Anonymity means that true identities of the contributors can be hidden. This might be helpful when discussing controversial and sensitive issues. Parallelism means that ideas can be generated simultaneously. This helps to break the production block which commonly occurring in FtF meetings. Finally, group memory means that the discussions are recorded and retrievable. This can be important for follow-ups activities.

For modern GSS, the idea generation function is normally integrated with other functions to support more sophisticated group activities. For example, Lowry et al. (2002) introduced a web-based Collaborative Writing (CW) system called Collaboratus, in which idea generation is a module. In addition, Collaboratus provided other modules such as the GroupOutlier module to develop hierarchical outlines to help generate and organize ideas, the GroupCommenter module for team members to give comments, the GroupCategorizer module to categorize generated ideas, and the GroupVoter module to help users to make decisions.

While the strength of GSS in supporting divergent processes has been verified by many experiments, its weakness in supporting convergent processes has also been identified (Kerr and Murthy, 2004). Although consensus building tools such as voting tools (Cheng & Deek, 2007), and structured communication techniques such as Delphi (Linstone and Turoff, 1975), have been invented to help a group of people to reach agreement, convergent processes required to solve real-world problems can be much

more complicated than what these tools can support. More sophisticated decision support frameworks such as AHP (Analytical Hierarchical Process) (Forman and Selly, 2002) have been proposed to deal with complex problems, and been implemented in some group problem solving and decision making systems. For example, Telelogic DOORS, a web-based collaborative system for requirement definition and management, utilizes AHP to compare benefits of different solutions (http://www.telelogic.com). Telelogic grew rapidly over the last several years and in April, 2008 it was acquired by IBM. However, according to Task-Technology Fit (TTF) theory, different tasks might need different technologies to have best performance (Zigurs & Buckland, 1998). How to provide effective convergent support is still a question for GSS research.

2.2.3.6 Social Support. In addition to the four types of support GSS contribute to the improvement of group productivity, some researchers (Hiltz, 1983; Turoff, 1991) believed that GSS are not only communication or task systems, but also social computing systems. Therefore, it is necessary for GSS to provide social support. One basic requirement for social support is to provide different privileges to different people according to their social roles (Turoff, 1991). A role covers a group of users with similar needs and rights thus can be treated as a whole, instead of individually. Turoff (1991) identified the following fundamental roles for a GSS:

- **Author:** Someone who can create new objects and modify, delete, or accept changes to an object created by him/her, but cannot modify, delete, or accept changes to objects created by others.
- **Commenter:** Someone who can give comments or ask questions about an existing authored item.
- **Proposer**: Someone who can propose specific changes or alternative wordings to an existing element of an authored item.
- **Modifier:** Someone who can modify, delete, or accept changes to any object.
- **Observer:** Someone who can view all the objects, but cannot add, modify, delete, or accept changes to any object.
- **Contributor**: Someone who can fill in missing fields in someone else's authored item.

As the team gets larger approaching, say approaching 100 or more, then other types of roles can be conceptualized (Turoff, 1991; Turoff et al., 2002).

- **Organizer:** Someone who can move items around and make new clusters of material
- **Summarizer**: Someone who can summarize the current status of the effort for the benefit of the others.
- **Indexer**: Someone who can create meaningful index terms to use with the particular application.

Privileges define the permitted operations and can be assigned to roles. With roles and privileges, GSS doesn't need to deal with each individual user directly. This greatly reduces system complexity to manage user privileges. Such an approach is widely used for role management. For example, this approach is a standard way to manage roles and privileges in Database Management Systems (DBMS) (Ramakrishnan and Gehrke, 2002).

2.2.3.7 Technology Acceptance. The ultimate goal of design science research is to develop new technologies that users want to use. Thus, it is useful to understand the driving factors for users to accept or reject a new technology. Three technology acceptance models are reviewed here: the original Technology Acceptance Model (TAM) (Davis, 1989), the TAM2 model (Venkatesh & Davis, 2000), and the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003).

The original TAM model was first proposed by Davis in 1989. Based on Theory of Reasoned Action (TRA), this model posits that perceived usefulness (U) and perceived ease of use (EOU) are determinants for behavior intention (BI), which in turn determines actual usage of an information system (Davis, 1989). Validity of the TAM model has been proved by numerous experiments afterwards (Davis, 1989; Adams et al., 1992; Venkatesh and Davis, 2000; Lederer et al., 2000).

TAM2 is one of the many derivative models based on the original TAM model by adding determinants and/or moderators to the three original constructs: U, EOU, and BI (Venkatesh and Davis, 2000). Venkatesh and Davis (2000) conducted experiments to examine four different systems at four organizations (N=156) using longitudinal measurements. The results strongly supported the TAM2 model, accounting for 40-60% variances in U and 34-52% variances in BI. The TAM2 model reveals that both social influence processes (subjective norm, voluntariness, and image), and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) influence user acceptance.

Over the years, there has been a trend for researchers to take the original TAM or various TAM-derived models as the base and to add new variables freely (Venkatesh et

al., 2003). According to Venkatesh et al. (2003), this practice has both positive and negative impacts. On the positive side, this approach gave researchers more flexibility. On the negative side, this approach also made it more difficult to compare research using similar but different models. It would be much easier for a researcher to refer to a unified model, instead of choosing among hundreds of similar models. This idea motivated Venkatesh and colleagues to propose the UTAUT model. UTAUT integrated eight relevant research models for technology acceptance. It used three constructs: Performance Expectancy, Effort Expectancy, and Social Influence, instead of two: U and EOU in TAM, as determinants of BI. Gender, age, experience, and voluntariness of use are considered to be moderators adjusting the effects of all the determinants. Empirical studies showed that UTAUT outperformed all the other eight models, accounting for much higher portion of variance of information technology usage (Venkatesh et al., 2003).

One useful implication that can be taken from these models to help the design of information systems is that usability is as important as functionality in shaping users' intention to use a new technology. For GSS to be accepted by potential users, system usability has to be carefully considered.

Regarding information systems usability, Norman (1989) gave many insightful discussions, e.g., in terms of user interaction design, simple is virtue, since a simple technology makes it much easier for users to learn and use. Affordance is also a preferable user interaction feature, and using metaphors familiar to users is an effective way to achieve affordance.

As the World Wide Web gained in popularity, researchers also started to study usability issues inside the WWW realm. One of the best summaries about how to improve WWW usability came from Levi and Conrad (2003), who provided the following nine heuristics to enhance usability of WWW prototypes:

- Speak the users' language.
- Be consistent.
- Minimize the users' memory load.
- Build flexible and efficient systems.
- Design aesthetic and minimalist systems.
- Use chunking.
- Provide progressive level of details.
- Give navigational feedback.
- Don't lie to the user.

2.3 Summary

To design a group support system for a complex problem domain is a difficult task. This chapter reviews various literature to establish the foundation for designing a collaborative scenario creation system. These reviews can also be used to explain the design choices. However, they might not be complete.

CHAPTER 3

DESIGN OF COLLARIO

3.1 Background and Motivations

The previous chapter discusses how scenarios can be used for various planning and training purposes. It also explains that to utilize scenarios for these purposes, the most challenging part is to create high-quality scenarios, which requires plausibility, comprehensiveness, novelty, coherency, consistency, and timeliness. Once scenarios have been created, they can be integrated with various planning and exercising systems or programs. For example, they can easily be fed into exercise systems, such as DisasterLan (http://www.buffalocomputergraphics.com/dlan_intro.html) to conduct scenario-based exercises (NYSDPC, 2005).

To help exercise creators to build exercise scenarios or MSEL (Master Scenario Event List), several systems have been developed. However, to the best of the author's knowledge, these systems are either PC-based, like Exercise Builder 2008 (http://www.orau.gov/emi/exercisebuilder) provided by ORISE's (Oak Ridge Institute for Science and Education), or short of collaborative support, like FEMA's Web-Based MSEL Builder (FEMA). Consequently, as of now, if exercise creators want to discuss MSEL with other people, they need to meet in person, call by phone, or rely on external communication channels such as E-Mail systems. This limitation might hinder collaboration among a group of experts needing to create complex emergency scenarios together.

With the advent of Web 2.0, the Internet provides a universally accessible platform for people to share information and collaborate on joint tasks. Web 2.0 technologies have given birth to many successful social computing and social network applications, with wiki (http://www.wikipedia.org), blog (http://www.blog.com), and twitter (http://www.twitter.com), and Drupal, an on-line Content Management System (http://www.drupal.com) as just a few of the most prominent examples. Although these applications are very popular and allow users to collaboratively create and edit contents, none of these applications provide a way for users to define task structures. This is fine for simple tasks. However, for a complex task such as creating emergency scenarios where task structures are important to make teamwork productive, this is insufficient. A group support system (GSS) able to provide process structure, process support, task structure, and task support is believed to be a more proper solution.

From the beginning, the collaborative scenario creation system has been envisioned as being able to achieve the following three major goals:

1. To aid distributed groups to work together to develop complex scenarios.
2. To allow members to share their ideas and to help improve the contributions of others
3. To develop a database of components for scenarios so it becomes easier to evolve and improve existing scenarios.

This dissertation has multiple goals. In the short term, the goal is to develop a GSS to support collaborative scenario creation using Web 2.0 technologies. In the long term, it is hoped that the methods used to develop this collaborative system can lead to the design of a GSS generator, which allows users to define task structures and then create GSS automatically based on user-defined task structures.

This dissertation focuses on the short-term goal, for which the main problem is to find an effective solution to design a GSS to support collaborative scenario creation. The solution proposed by this dissertation consists of five parts: (1) designing a knowledge structure representing scenarios, (2) implementing an Event Log metaphor to display scenarios, (3) using templates to collect and display information, (4) providing collaboration support, and (5) facilitating Group Awareness (GA). The remaining sections of this chapter introduce the design details of all these five parts.

3.2 Scenario Knowledge Structure

The scenario knowledge structure is the backbone of the Collario system. The scenario definition and review templates are based on it. The scenario event list retrieves scenario detail information based on it. Collaboration support and Group Awareness support also rely on it. Because of this, the scenario knowledge structure is introduced first.

Knowledge structure is similar to task structure as discussed by Nunamaker et al. (1991). This dissertation uses "knowledge structure" instead of "task structure" because Collario views scenario creation not only as an isolated task, but also as an opportunity to share knowledge and build up a knowledge base that can be reused in the future to create other scenarios. For this, knowledge structure serves the purpose better.

This section first introduces the elements included in the knowledge structure and then models them using Entity-Relationship (E-R) modeling. It also briefly introduces Relational Algebra, a formal mathematical representation to describe query operations against Database Management Systems (DBMS). Relational Algebra is used later on to

explain how to apply the scenario knowledge structure in the design of other components of the Collario system.

3.2.1 Selection of Scenario Elements

Identifying the elements for a problem domain is the first step to create domain-specific knowledge structure. Section 2.1.3 identifies as many as seventeen elements for scenario creation. They are Scenario, Theme, Constraint, Event, Notification, Situation, Potential Outcome, Parameter, Prerequisite, Resource, Resources Type, Alternatives Resource, Trigger, Assumption, Objective, Time, and Location.

However, for this dissertation research, implementation of all theses scenario elements will not be done before it has been proven that this is a feasible and effective solution. A way to verify effectiveness of this design approach is to start with prototypes embodying the design gist but in a smaller and simpler scale and evaluate the prototypes to see how effective they are. This strategy reflects the essence of the Spiral Models (Sommerville, 2006) and the Design Science paradigm (Hevner et al., 2004), both of which have been reviewed in Chapter 2.

Also, the selected elements need to be complex enough to meet the three visions introduced earlier in supporting collaborative scenario creation (to aid distributed groups to create scenario collaboratively, to allow members to share knowledge and help others to improve their contributions and to develop a database which can be reused to create new scenarios). To balance these two sides of the requirements, three essential scenario elements: Scenario, Event, and Resource, were finally chosen to represent the scenario knowledge structure.

3.2.2 Modeling the Scenario Knowledge Structure

Since Relational Database Management System (RDBMS) provides a convenient yet robust way to store and manage data, this study uses RDBMS to implement the scenario knowledge structure. Since Entity-Relationship (ER) modeling is a companion data modeling method to represent data that need to be stored in RDBMS (Sumathi and Esakkirajan, 2007), this study use ER modeling to represent scenario knowledge structure.

ER modeling was first proposed by Peter Chen to represent relational data models using entities, relationships, and attributes, which can then be visualized using graphical diagrams, or called ER diagrams (Chen, 1976; Sumathi and Esakkirajan, 2007):

- **Entity**: An entity is an object that exists and is distinguishable from other objects.
- **Relationship**: A relationship is an association of entities where the association includes one entity from each participating entity type whereas relationship type is a meaningful association between entity types.
- **Attributes**: Attributes are properties of entity or relationship types.

Relationship glues entities together. Broadly, there are three types of relationships: one-to-one relation, one-to-many relation, and many-to-many relation (Sumathi & Esakkirajan, 2007).

- **One-to-One Relationship**: The relationship that associates one entity to another entity is called one-to-one relationship.
- **One-to-Many Relationship**: The relationship that associates one entity to more than one entity is called one-to-many relationship.
- **Many-to-Many Relationship**: The relationship that associates more than one entity in one entity type to more than one entity in another entity type is called a many-to-many relationship.

Convenient ER modeling software such as ERWin and Visio are available to draw ER diagrams and translate ER models into logical and physical database designs. ERWin is a data modeling product provided by Computer Associates (CA) and Visio is provided by Microsoft. However, there might be minor differences in how these tools visualize the entities, relationships, and attributes. Figure 3.1 is drawn using Visio to represent the latest scenario knowledge structure.

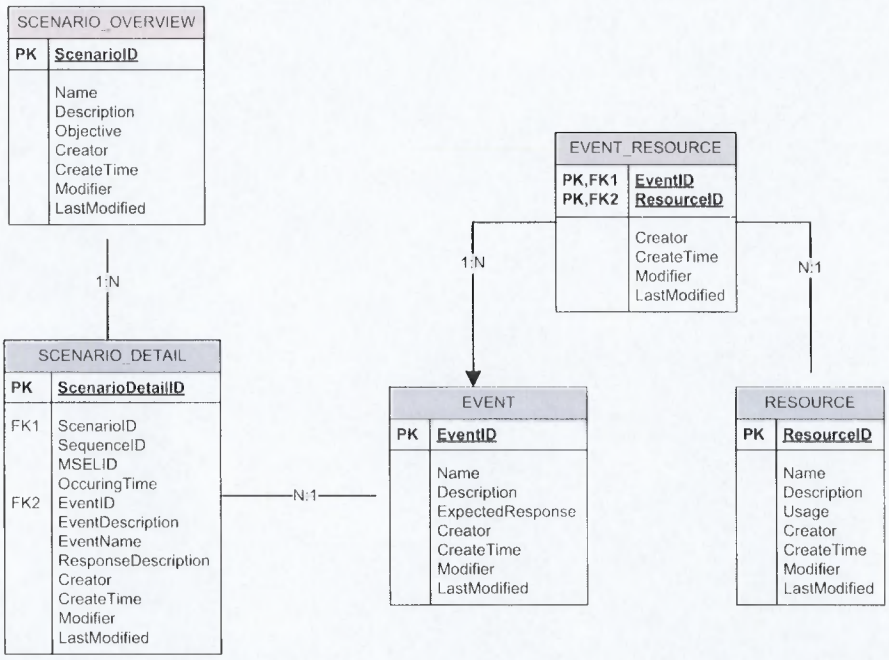

Figure 3.1 The ER Model representing the latest scenario knowledge structure.

From this diagram, it can be seen that the scenario element is modeled using two entities: SCENARIO_OVERVIEW, which stores the summary information about a scenario such as description and objective, and SCENARIO_DETAIL, which stores the detailed information about a scenario such as situation reports and response actions. Using two entities instead of one to represent the scenario element is the result of normalization, a requirement of relational data model to eliminate data redundancy and to guarantee data integrity. SCENARIO_DETAIL and SCENARIO_OVERVIEW have a

one-to-many relationship between them, which means a scenario can have multiple scenario detail items, but a particular scenario detail item belongs to only one scenario.

A stand-alone event is modeled with the EVENT entity. A stand-alone resource is modeled with the RESOURCE entity. "Stand-Alone" means that events and resources of those two entity types are not tied to a particular scenario, but visible to and able to be reused by any scenario. An intermediate entity, EVENT_RESOURCE, is introduced to model the many-to-many relationship between the EVENT entity and the RESOURCE entity, which means that a stand-alone event can use multiple stand-alone resources and a stand-alone resource can be used by multiple stand-alone events. In this way, existing resources can be reused to define many events.

Finally, the EVENT entity and the SCENARIO_DETAIL entity have a one-to-many relationship, which means that a scenario detail item can refer to a stand-alone event, while a stand-alone event can be referred to by many scenario detail items.

For the properties of the entities, please refer to Appendix A.

3.2.3 Accessing the Scenario Knowledge Structure

Relational Database Management Systems (RDBMS) not only allow users to store, update and delete data using Data Manipulation Language (DML), but also allow them to retrieve data using Structured Query Language (SQL). The DML ADD statement adds new records. UPDATE clause is used to update existing records, and DELETE clause to delete unneeded records. A SQL statement uses more complicated SELECT clause to retrieve data fulfilling the conditions defined in the WHERE clause.

Within RDBMS, SQL selection statements can be parsed and transferred into relational algebra operations (Ramakrishnan and Gehrke, 2002). RDBMS can then

execute the relational algebra operations to return query results. There are six primitive relational algebra operations: Selection, Projection, Cartesian Product, Union, Difference, and Rename. In addition, relational algebra also defines several join operations such as Natural Join (or Equal Join), and Outer Joins. These operations are summarized in Table 3.1. In the following sections, these operations will be used to show how to utilize the scenario knowledge structure to design the Collario system.

Table 3.1 Summary of Relational Algebra Operations

Operations	Representation	Explanation
Selection	$\sigma(\varphi)$ (R)	Return the tuples from relation R that fulfill the condition represented by φ, which contains atoms allowed in the normal selection and the logical operations $\wedge$ (and), $\vee$ (or), and $\neg$ (not).
Projection	$\pi_{a_1,\ldots,a_n}$(R)	Return all the tuples of relation R restricted to the set $\{a_1, a_2\ldots, a_n\}$.
Cartesian Product	$R \times S$	Cartesian product of two relations R and S returns all combinations of tuples of R and S. Cartesian product can be formally defined as $R \times S = \{r \cup s \mid r \in R, s \in S\}$
Union	$R \cup S$	Union of two relations R and S returns tuples of both relations. To apply the union operation, R and S must be union compatible, which means that R and S must agree in number and type of attributes.
Difference	R – S	Difference of two relations R and S returns tuples of R that are not in S. To apply the difference operation, R and S must also be union compatible.
Natural Join	$R \bowtie S$	Natural join of two relations R and S returns the set of all combinations of tuples of R and S that are equal on the common attribute names.
Left Outer Join	$R \ltimes S$	Left outer join of two relations R and S returns Natural Join of R and S, as well as tuples in R (left side of the operation) without any matching tuples in S.
Right Outer Join	$R \rtimes S$	Right outer join of two relations R and S returns Natural Join of R and S, as well as tuples in S (right side of the operation) without any matching tuples in R.

Source: Ramakrishnan, R., and Gehrke, J. (2002). "Database Management Systems", McGraw-Hill, New York, NY

3.3 Presentation of Scenario

Chapter two reviewed GSS design requirements from several perspectives. From the perspective of individual cognition (Section 2.2.3.1), humans only possess limited cognitive resources. When working in a team, these limited cognitive resources need to be allocated among cognitively competing processes of communication, information accessing, and deliberation (Briggs, 1994). This is the TEAM (The Economics of Attention Management) model. Based on this model, if GSS can present information in an optimal way so that users can find information more easily, it will reduce cognitive requirements on information accessing, resulting in more available resources for the other two tasks: communication and deliberation.

A complex emergency scenario might consist of dozens or even hundreds of events. In addition to the potential large amount of scenario information, there may be discussions about the scenario. Users can easily be overwhelmed if scenario information is not organized and presented optimally.

Chapter two also provides a literature review about usability and User Interaction (UI) design (Section 2.2.3.7), which shows that affordance is an effective approach to designing user interfaces, and that using metaphors familiar to users is an effective way to achieve affordance (Norman, 1989). In the field of Emergency Management, event logs are familiar to EM workers. Exercise administrators are using event log-like tables to create exercise scenarios. Table 3.2 shows the header of an Excel table used by an exercise administrator to prepare for a table top exercise:

Table 3.2 Scenario Event List Implementing an Event Log Metaphor

Time	MSEL#	Message Summary	Expected Responses	Actual Responses
...	...	...	...	...

In the table that was used by the exercise administrator to plan for the exercise, the "Time" column contained occurring times. The "MSEL#" column contained sequential numbers representing the scenario events. The "Message Summary" column contained descriptions of the scenario events. The "Expected Responses" column contained the responses suggested by the exercise administrator. The "Actual Responses" column was empty during the planning phase and used by the exercise administrator to make notes during the exercise.

In a collaborative environment, scenario details can be created by anybody at any time. Information about creators and creating times thus are important for the team to track down who has done what and when, and should be presented to the users. In addition, it is also important for the users to discuss the scenario details. To integrate such information/functions, the event log display needs to be expanded accordingly. Table 3.3 shows the adjusted event log structure used by Collario to display scenario details.

Table 3.3 Event Log Structure Used in Collario

Time	MSEL#	Scenario Event	Creator / Create Time	Comments
...	...	...	...	...

In this table, there is no column for expected responses to save screen space for scenario events, which were the focus of the scenario creation task in the field study to evaluate Collario. However, it is obvious that such a column can be easily added to the display, because it has been modeled in the knowledge structure and included in the corresponding definition and review templates (next section). The screenshot in Figure 3.2 illustrates how the event log display has been implemented in Collario. The table in the middle is the event log display which shows the details of a scenario.

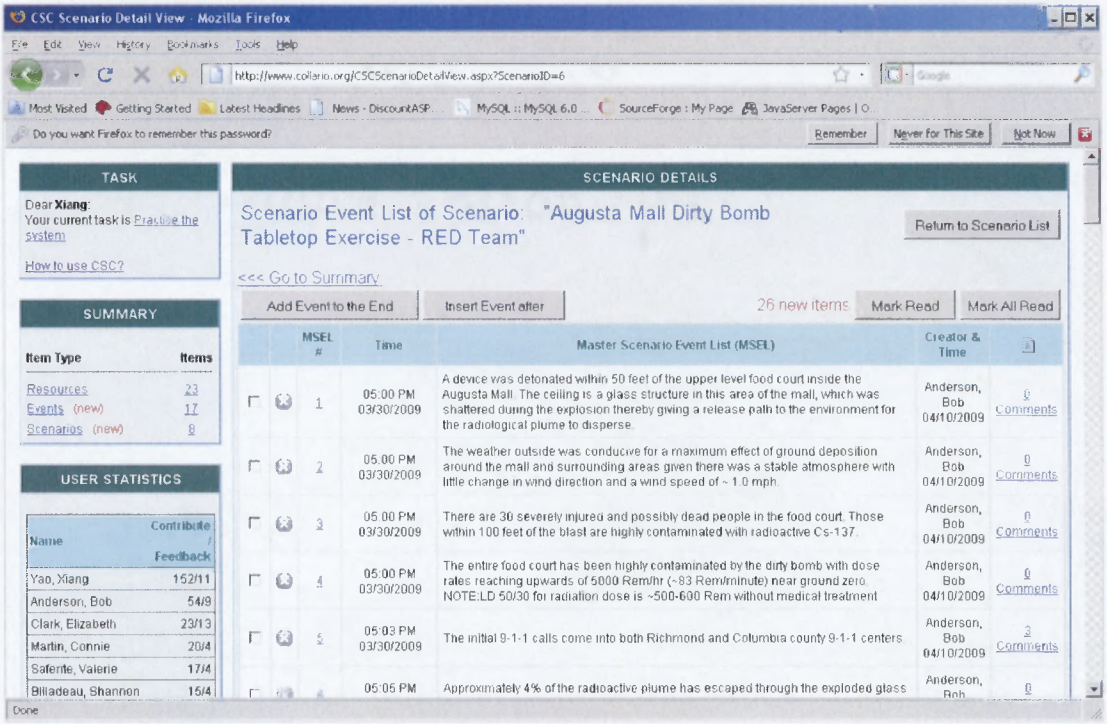

Figure 3.2 Screenshot of the scenario event list page.

3.4 Templates to Create and Review Scenario Elements

Templates are used in Collario to collect user inputs and to review/change the details. The templates map to the underneath scenario knowledge structure and follow some standard methods of design. This section introduces the templates to define and review the four types of scenario elements: scenario overview, scenario detail, event, and resource. Other templates for defining and reviewing feedback will be introduced in the next section.

The templates to define new elements for the above four element types contain text fields for users to input values for the corresponding data fields in the underneath tables. For example, the template for defining a new scenario (overview) is shown below. There is a clear one-to-one relationship between the UI fields and the fields in the SCENARIO_OVERVIEW table.

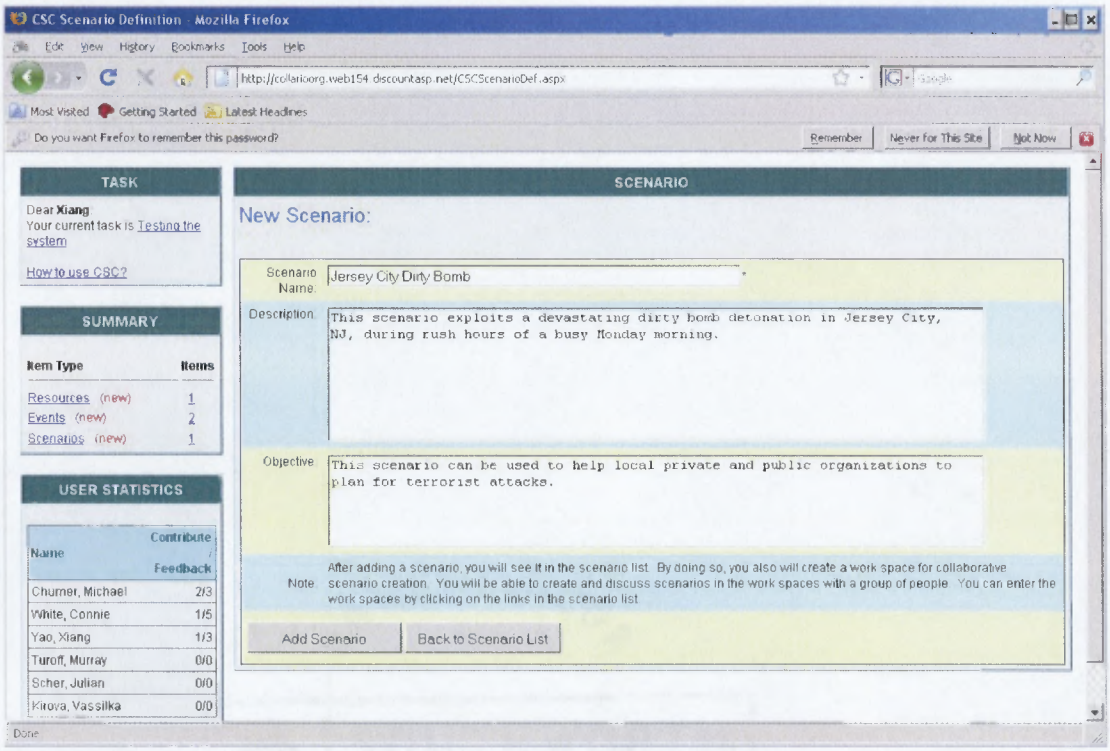

Figure 3.3 The template to define the summary of a new scenario.

The templates to review elements of the above four element types contain the text fields, and sets of buttons to change element values and to access collaborative functions. The screenshot in Figure 3.4 shows the review template for scenario overview elements. This is a companion template of the above definition template.

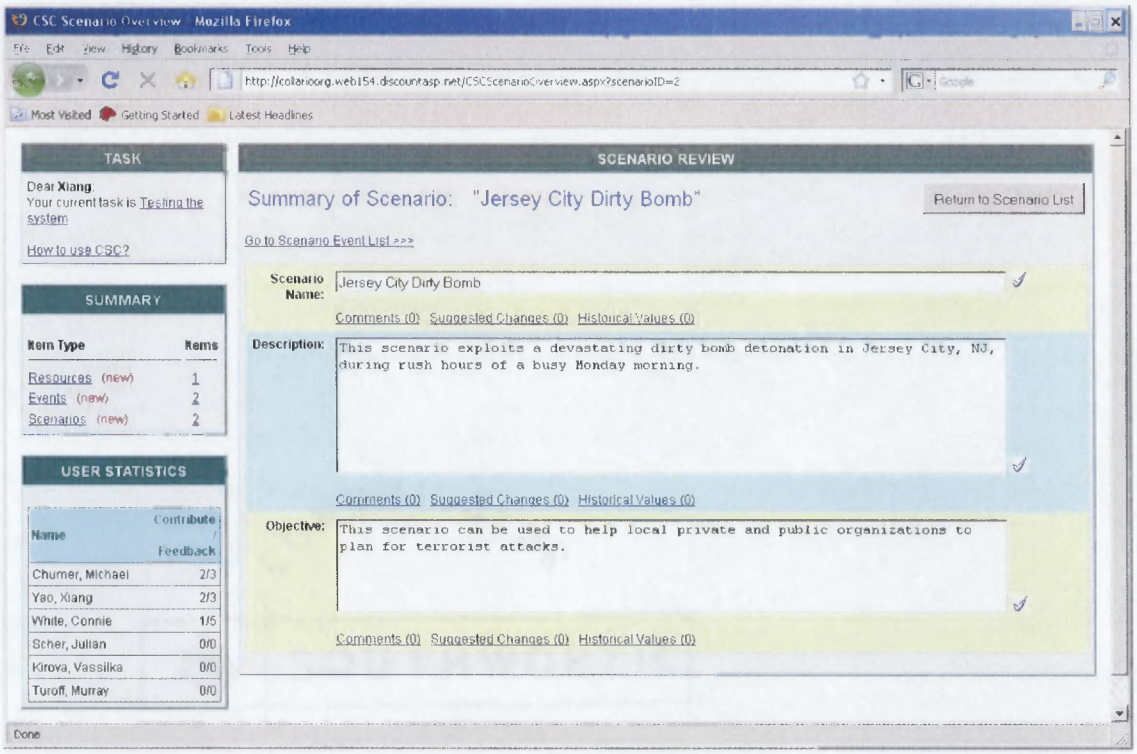

Figure 3.4 The template to review the summary of a scenario.

The only difference between the definition and the review templates of the scenario overview element type is the four buttons added to each data field. In the review template, for each data field, there is an update image button to the right, and three link button underneath. Clicking the update image button will update the value of the corresponding data field. Clicking the link buttons will enter templates for collaborative support such as giving/viewing feedback and viewing/restoring historical values. As

mentioned earlier, templates for the collaborative support will be introduced in the next section.

Because the definition and the review templates are created using a standard method, there is no need to show all the templates of the different scenario element types. Table 3.4 lists the data fields covered by the templates for the four scenario element types. The actual templates can be figured out easily by following the above design method.

Table 3.4 Templates for the Four Scenario Element Types and Their Data Fields

Template Type	Mapping Table	Fields in the Template (Table Fields within Parentheses)
Scenario Overview	SCENARIO_OVERVIEW	Scenario Name (ScenarioName), Description (ScenarioDesc), Objective (Objective)
Scenario Detail	SCENARIO_DETAIL	Occurring Time (OccurringTime), Description (EventDesc), Expected Responses (Response)
Stand-alone Event	EVENT	Event Name (EventName) Description (EventDesc) Expected Results/Responses (Response)
Stand-alone Resource	RESOURCE	Resource Name (ResourceName) Description (ResourceDesc) Usage (Usage)

3.5 Collaboration Support

The ability to provide convenient collaboration support is one of the unique features of Collario. Table 3.5 summarizes the collaboration support provided by the Collario system.

Table 3.5 Summary of Collario's Collaboration Support

	Collaboration Support	Details
1	Give comments to a record	Users are able to comment on scenario elements (scenario overview, scenario detail, event, resource) as a whole.
2	Give comments to a data field	In addition to giving comments to a scenario element as a whole, users are able to give comments to data fields inside a scenario element.
3	Suggest values to a data field	Users are able to suggest values for data fields.
4	Accept suggested values for a data field	Users with the appropriate privileges are able to accept suggested values.
5	View historical field values	Users can view historical values of a data field.
6	Restore historical field values	Users with the appropriate privileges are able to restore a historical value for a data field.
7	Fill-in an empty data field	If a data field is empty, others are able to fill in contents.
8	Change a data field	Users with the appropriate privileges can make changes to a data field.
9	Reuse stand-alone elements	This function allows users to reuse stand-alone events to define new scenario detail instances, or to reuse stand-alone resources to define new scenario or stand-alone events.

To provide the collaboration support, it is necessary to design a data model to store and manipulate the collaboration data, and to design templates to access the collaboration data. The remaining parts of this section first introduce the collaboration data model and then the collaboration templates.

3.5.1 Collaboration Data Model

The collaboration data model abstracts the entities used to provide collaboration support, as well as their properties and relationship. From the above Table 3.5, it is clear that two types of feedback, comments and suggestions, are needed. Further on, feedback needs to be given in both the record level and the data field level. Historical values of the data fields in the scenario elements also need to be stored. A convenient way to store the information is to use a FEEDBACK entity to store all the feedback and a HISTORY_RECORD entity to store all the historical values. To locate feedback and historical values for a particular data field or record, some mapping mechanism is needed. An easy approach is to assign each table a unique table id, each data field a unique field id and each record a record id. The combination of the table id and the record id will uniquely locate a record in a particular table. The combination of the table id, the record id, and the field id will uniquely locate a data field in a particular record. The table ids and the field ids can then be stored in dictionary tables (ENTITY and ENTITY_FIELD) for easy reference and maintenance. Since all the scenario element tables have a single integer field as the primary key, these numbers can be used as record ids. Based on such analysis, Figure 3.5 illustrates the collaboration data model.

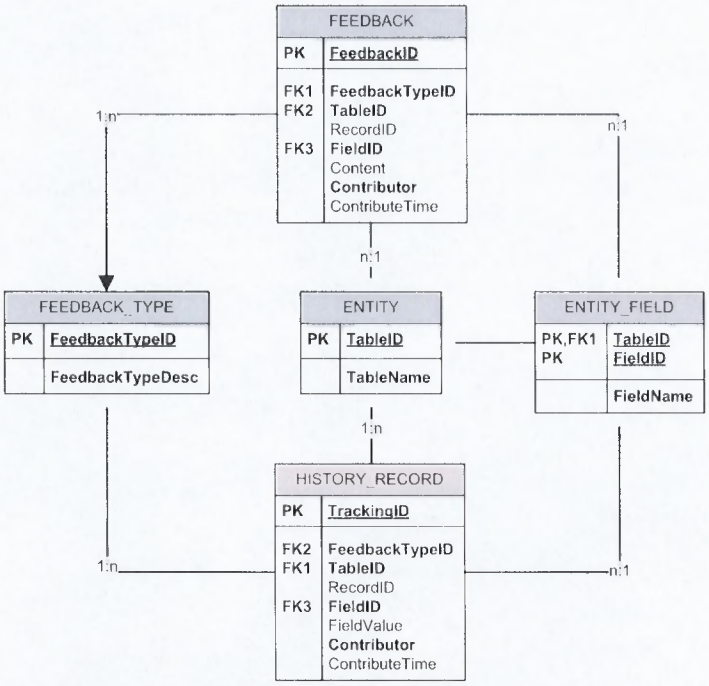

Figure 3.5 The ER diagram to model collaboration data.

Detailed descriptions of the entity properties and the pre-defined records of the dictionary tables (FEEDBACK_TYPE, ENTITY, and ENTITY_FIELD) can be found in Appendix A.

3.5.2 Record-Level Comments

Collario allows users to compose comments for all the records of the four scenario element types (scenario overview, scenario detail, event, and resource). The contents of the record-level comments are stored in the same FEEDBACK table using special field identifiers. The pre-populated dictionary table of ENTITY_FIELD assigns a special field identifier (FieldID) for each scenario element type to represent the whole record. Details about the pre-defined records for the ENTITY_FIELD table can be found in Appendix A.2. The relational algebra operations to fetch record-level comments will be explained in the next sub-section, together with the field-level comments.

Entrances to the record-level comments are through the four element lists to display all the elements of the four scenario element types. The Event-Log display introduced in Section 3.3 is the scenario detail list to display all the scenario detail elements. The screenshot in Figure 3.6 shows the scenario overview list:

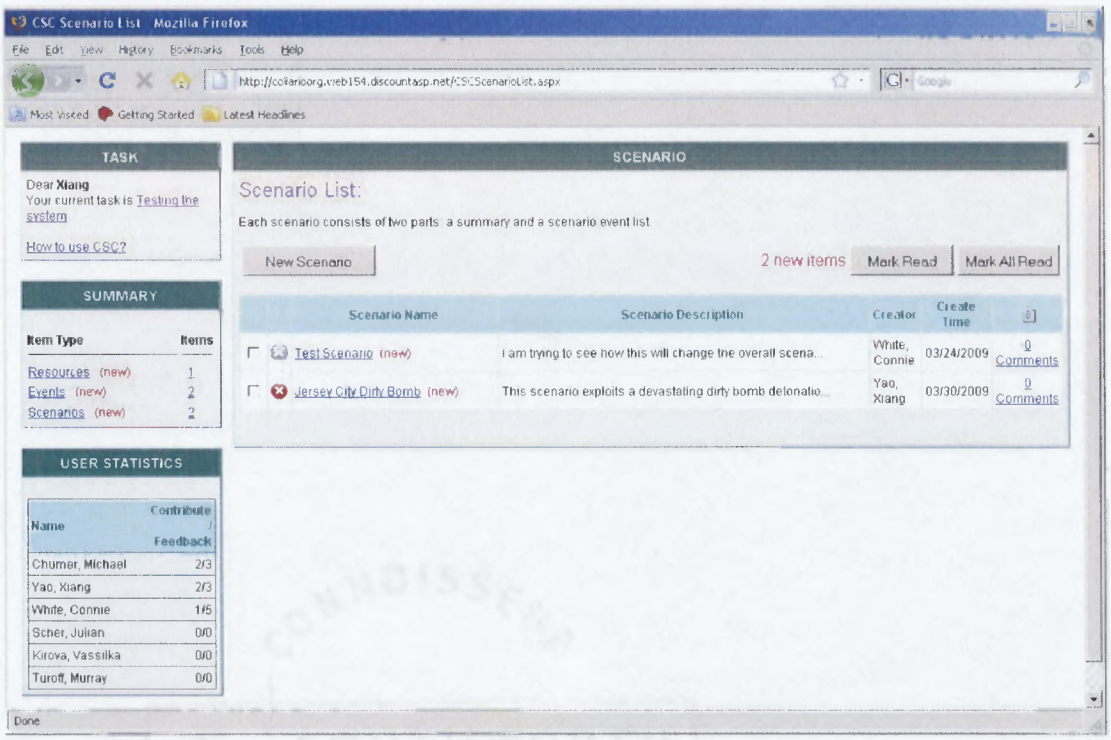

Figure 3.6 Screenshot for the scenario list page.

All these element lists have in common that they have a "Comment" column, which contains links to view the comments given to an element, or to compose comments for this element. Clicking on a comment link will trigger a template to define and view comments. Designing a comment template can be very easy. Basically, it needs an input field for users to add new comments and a list to display current comments. The design can also be very flexible. For these reasons, details about the comment template are not shown here.

3.5.3 Field-Level Comments

In Collario, comments can be given to not only records, but also data fields. This fine-grained commenting ability makes it possible for users to organize comments around the tiniest piece of the information. As a result, it might help users locate the comments more easily.

Like the record-level comments, the field-level comments are also stored in the FEEDBACK table. The ENTITY_FIELD dictionary table defines the field identifiers determining to which data field (or the whole record, as used in the previous section) a comment is given.

Unlike the record-level comments, entrances to the field-level comments are through the review templates (Section 3.4). The review template for scenario overviews has been provided in Figure 3.4. Figure 3.7 is a copy for ease of discussion.

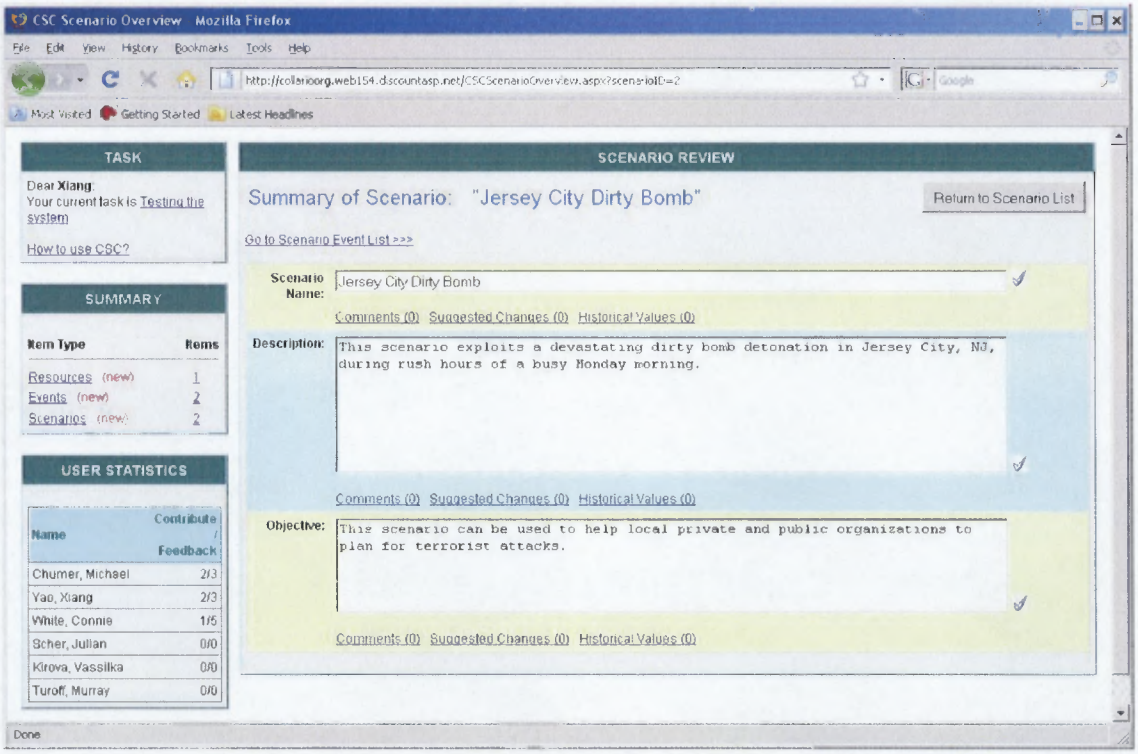

Figure 3.7 The template to review the summary of a scenario (copy).

The "Comment" links under each input field are the entrances to the field-level comments. When these links are clicked, a template for viewing and composing comments will be displayed. How to design a comment template can be found in the previous sub-section.

The comments given to a particular data field can be identified using TableID, FieldID, and RecordID. The SQL statement to retrieve the comments given to a data field can represented using the Relational Algebra expression shown in Equation 3.1:

$$\sigma_{\left(\begin{array}{c} FeedbackTypeID=1 \\ TableID=[TableID] \\ FieldID=[FieldID] \\ RecordID=[RecordID] \end{array}\ \&\right)}(FEEDBACK) \tag{3.1}$$

The dictionary tables (FEEDBACK_TYPE, ENTITY, and ENTITY_FIELD) are needed to find the proper values to replace [FeeedbakeTypeID], [TableID], and [FieldID]. The pre-defined values of these dictionary tables can be found in Appendix A. The last parameter, [RecordID], should be replaced using the primary key of the scenario element table.

For example, the SQL statement to retrieve comments given to the scenario name field of a record identify by ScenarioID in the scenario overview entity can be represented using the Relational Algebra expression shown in Equation 3.2:

$$\sigma_{\left(\begin{array}{c} FeedbackTypeID=1 \\ TableID=4 \\ FieldID=1 \\ RecordID=[ScenarioID] \end{array}\ \&\right)}(FEEDBACK) \tag{3.2}$$

3.5.4 Suggested Changes

Suggestions are another type of feedback which allow users to propose alternatives for a data field and allows users with proper privileges to replace the field value with the suggested alternatives. They are very similar to field-level comments. They are also stored in the FEEDBACK table, but have a different FeedbackTypeID other than comments. Entrances to the suggestions are also through the review templates. By clicking the "Suggested Changes" links in the review templates, users will enter the template for suggestions. Discussed next is the major difference between suggestions and field-level comments.

Like the comment template, the suggestion template should also include a text field for users to input suggestions and a list to display all the suggestions for a given field. However, because privileged users need to be able to accept a suggestion to replace the current field value, the template should have a place for users to do so. The screenshot in Figure 3.8 shows that by adding a button beside each suggestion, this requirement will be met. Obviously, the system needs to take care of the data manipulation after the buttons are clicked.

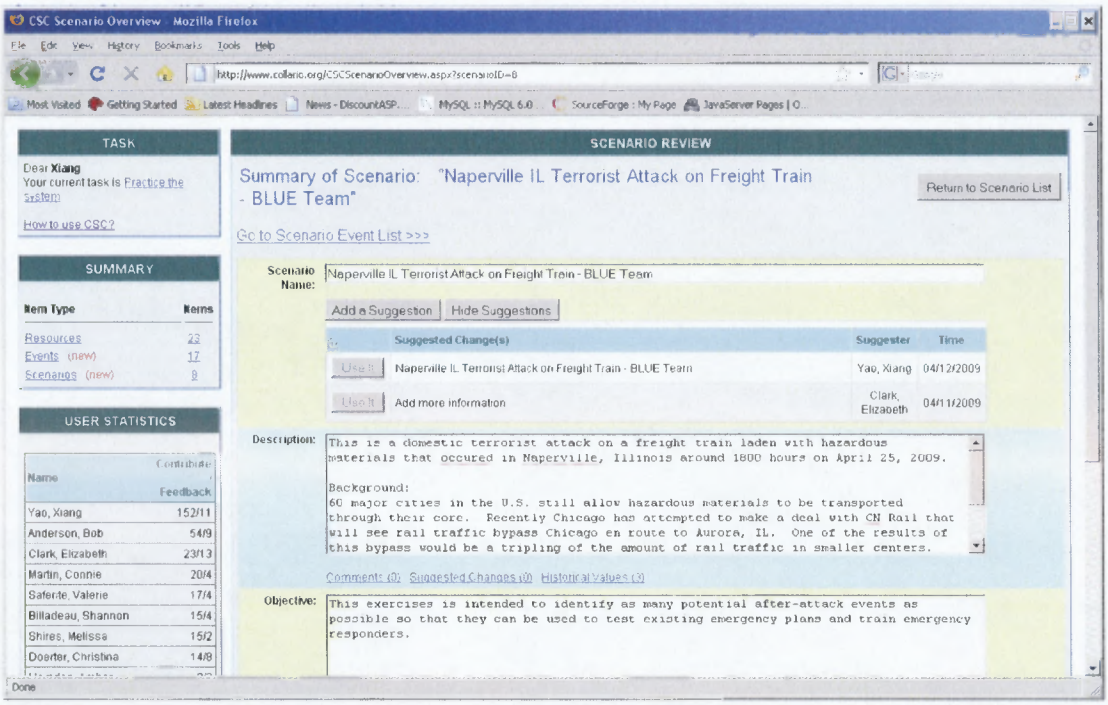

Figure 3.8 Screenshot for reviewing suggested alternatives.

In the above screenshot, two alternatives have been suggested as alternative scenario names. Among these two alternatives, syntactically, "Add more information" is obviously not an appropriate name. Collario cannot prevent improper alternatives from being suggested. However, it does provide a way to accept a good alternative. In the screenshot, beside each suggestion, there is a "Use it" button. If these buttons are enabled, clicking on these buttons will replace the field value with the suggestion. However, in this screen, these buttons are disabled. This is because the current user doesn't have sufficient privileges. To be able to accept a suggestion, the user has to be (1) the creator of this item, or (2) the team leader, or (3) a system administrator.

3.5.5 Historical Field Values

In Collario, whenever a field changes its value, the old value will be stored in the HISTORY_RECORD table. Users can view all the historical values of the field by clicking the "Historical Values" link in the review templates. The Relational Algebra expression shown in Equation 3.3 shows how to extract historical values of a particular data field to populate the historical values template:

$$\sigma_{\left(\begin{array}{l} TableID=[TableID] \\ FieldID=[FieldID] \quad \& \\ RecordID=[RecordID] \end{array}\right)}(HISTORY\_RECORD) \tag{3.3}$$

Like the Relational Algebra expression to retrieve comments and suggestions, this expression needs to find the correct [TableID] and [FieldID] parameters from the ENTITY table and the ENTITY_FIELD table. The [RecordID] parameter should be replaced with the primary key of the corresponding scenario element table.

Collario allows users with proper privileges to restore historical field values. The screenshot in Figure 3.9 shows how this function is provided in Collario:

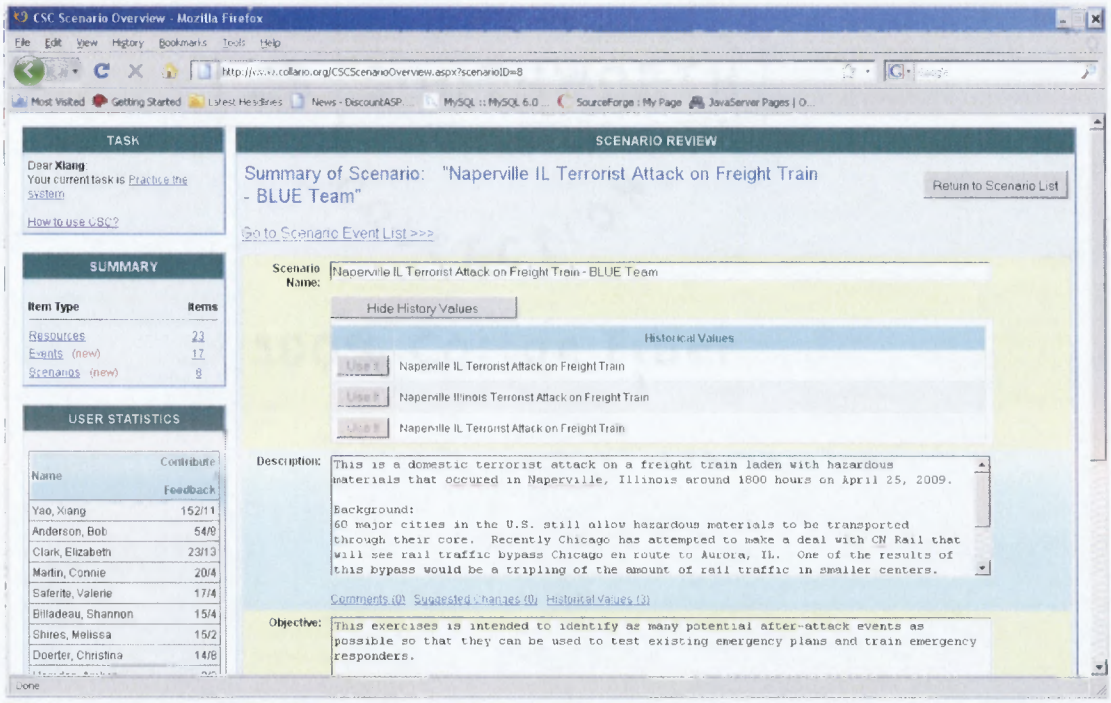

Figure 3.9 Screenshot for reviewing historical values.

In this screenshot, it can be seen that there are three historical values for the Scenario Name field. However, the "Use it" buttons next to these values are disabled, because the user doesn't have sufficient privileges. If a user has sufficient privileges, he/she will be able to click these buttons to replace the current field value with the historical values. After doing so, the current value will be inserted into the historical value list as the latest update.

3.5.6 Data Field Modification

In the review templates, e.g., the review template for scenario overviews in Figure 3.5, there is an image button to the right of each data field. They are used to update the data fields. Because of role management, only three roles are privileged to make changes to non-empty fields. They are (1) the creator of the element, (2) the team leader, (3) the system administrator. When a user does not have sufficient privileges, the image buttons

will disappear if the tied field is not empty. There is one exception: if a data field is empty, such role check will be nullified, and thus anybody can have the image button visible. This collaborative operation is called fill-in empty fields.

After changes have been made to a field, the old field value will be stored in the HISTORY_RECORD table.

3.5.7 Reusing Stand-alone Elements

One benefit of integrating the scenario knowledge structure into Collario is the ability to reuse existing scenario elements to create new ones. Two types of reusability have been designed: (1) Stand-alone resources should be reused to create new stand-alone events and scenario events; (2) Stand-alone events should be reused to create new scenario events. However, only the second function has already been implemented in Collario. The screenshot in Figure 3.10 shows how this function is provided in Collario:

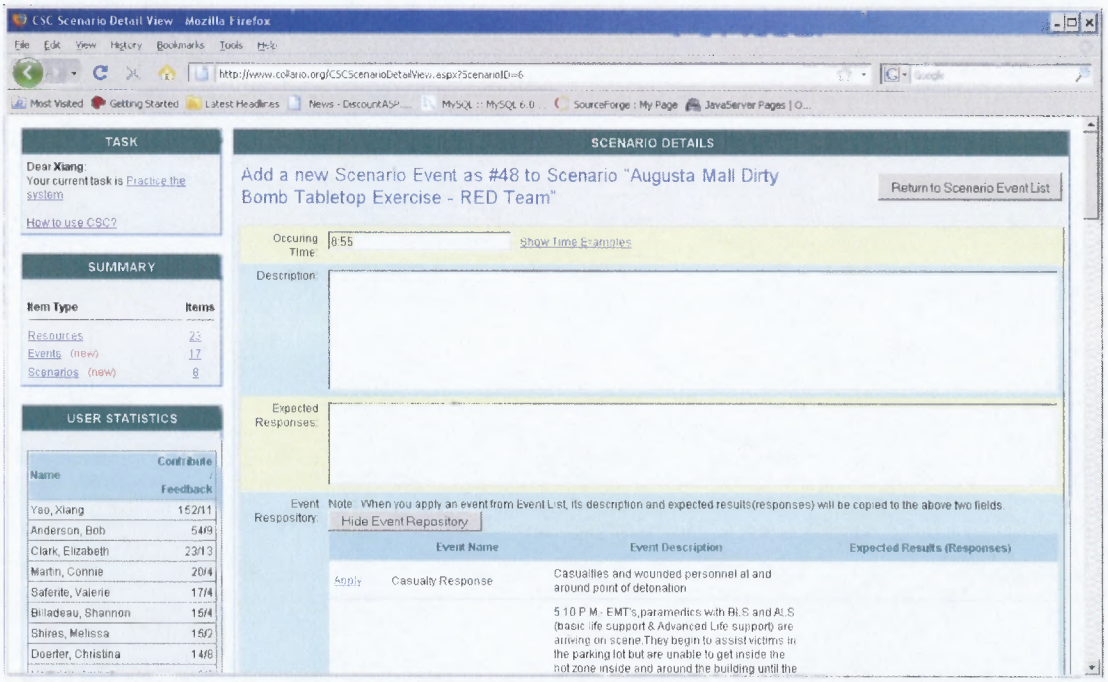

Figure 3.10 Screenshot for reusing stand-alone events.

In this screenshot, all the stand-alone events are listed under the "Event Repository" section. Each stand-alone event has an "Apply" link button next to it. By clicking these link buttons, the event definitions will be copied from the attached stand-alone event into the corresponding text fields above.

3.6 Group Awareness (GA) Support

The importance of GA in designing GSS has been discussed in Section 2.2.3.2. This section focuses on the GA support provided by Collario.

3.6.1 New Elements

It would be helpful if users can be notified when new items have been created. In Collario, notifications of new items are provided in several places.

SUMMARY Panel: Inside the summary panel on every Collario page, whenever a new element is added, a red "(New)" sign will be display beside the element type.

Element Lists: If entering the list of the element type with elements newly added, one will find that each new element has a "(New)" sign attached to the name field. The total number of new items is shown above the list in red.

Mark Read: Above the element lists, there are two buttons, "Mark Read" and "Mark All Read", for removing the "(New)" signs. By checking the items first in the list and clicking the "Mark Read" button, one can mark those selected items as read and thus remove the corresponding "(New)" signs. By clicking the "Mark All Read" button, one will mark all new elements in the list as read, thus remove all the "(New)" signs.

The screenshot in Figure 3.11 shows the "(New)" indicators and the "Mark Read" buttons.

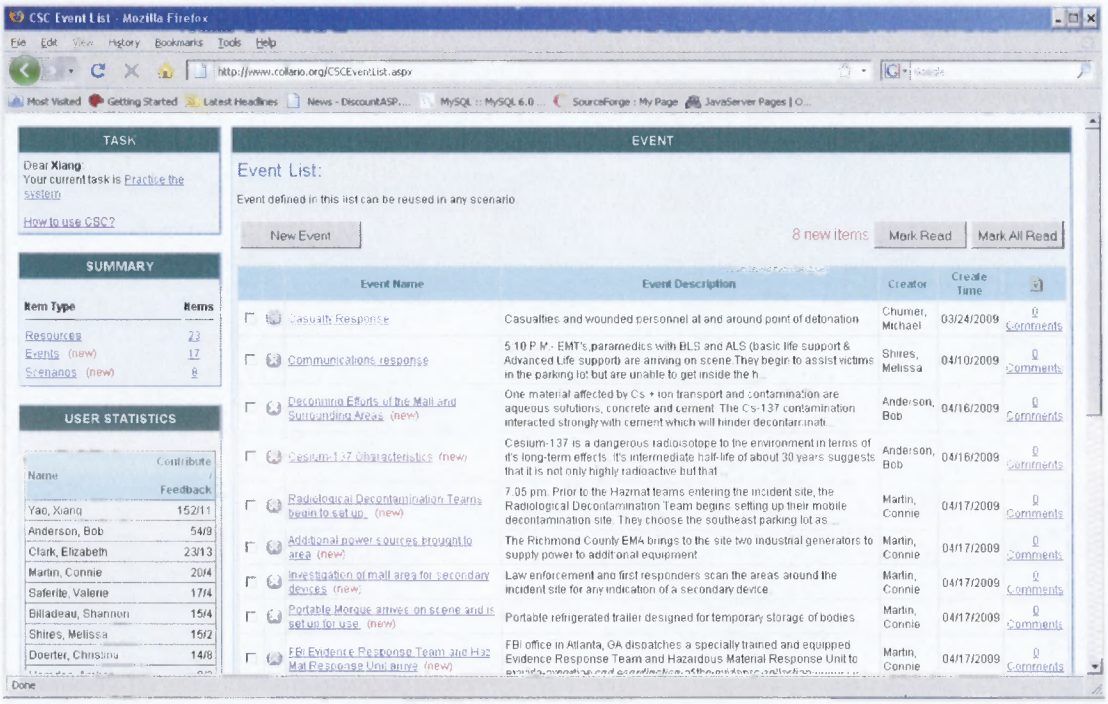

Figure 3.11 Group Awareness (GA) support for new elements.

3.6.2 Usage Statistics

All of the web pages in Collario contain a "SUMMARY" panel and a "USER STATISTICS" panel. This can be seen in all the screenshots shown in this chapter. The "SUMMARY" panel displays numbers of the scenarios, stand-alone events, and stand-alone resources created by the team. The "USER STATISTICS" panel displays the number of contributions and feedback given by each participant.

CHAPTER 4

EVOLUTION OF COLLARIO

The previous chapter three introduces the design details of the Collario system in its current form. However, that view doesn't show the dynamic nature of the design of Collario. Being a research project which follows the Design Science paradigm, the design of Collario has never been static and unchanged, but evolves constantly over time. This chapter first briefly introduces the Design Science paradigm. It then discusses why the Collario research project was initiated and how it has evolved from the beginning to the current status.

4.1 Design Science Paradigm

In the field of Information Systems, there are basically two approaches to conducting research: the behavior science paradigm and the design science paradigm. While the behavior science paradigm "seeks to develop and justify theories that explain and predict organizational or human phenomena surrounding the analysis, design, implementation, management, and use of information systems," (Hevner et al., 2004, p.76) the design science paradigm aims at moving forward the knowledge of IS domain through building, applying, and evaluating innovative artifacts for unsolved problems. These two paradigms are complementary to each other. Established theories from behavioral science research help the design of new artifacts. In return, new artifacts open new realms for behavioral science research. This dissertation follows the design science

paradigm to design, develop, evaluate, and evolve a group support system supporting collaborative scenario creation.

An iterative model with five steps for each iteration has been frequently used by researchers (Hevner et al., 2004; Vaishvani and Kuechler, 2007) to illustrate how to conduct design science research. The five steps are

- Awareness of the Problem
- Suggestion of New Design
- Development of the Artifact
- Evaluation of the Artifact
- Conclusion

Figure 4.1 illustrates the spiral research framework suggested by Vaishvani and Kuechler's (2007):

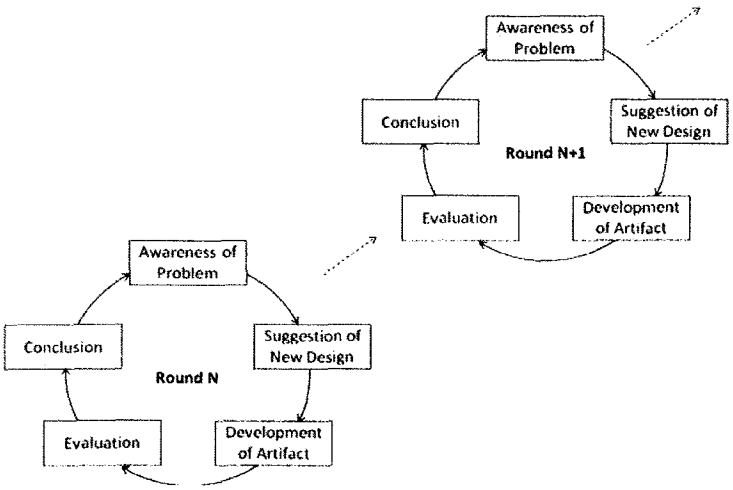

Figure 4.1 The iterative framework for the Design Scenario Paradigm.

Source: Vaishnavi, V.K. and Kuechler, W. Jr. (2007). "Design Science Research Methods and Patterns: Innovating Information and Communication Technology" Auerbach Publications, New York, NY.

The first step in each loop, Awareness of Problem, is a critical step. Any further steps to solve a problem will require a significant investment. Choosing a wrong

problem might result in a waste of a large amount of money, time and effort. Therefore, it is crucial for anybody planning to conduct design science research to carefully examine the problem(s). A comprehensive literature review is necessary for design science research, just like as behavior science research. In addition, for artifacts needing user interactions, it is important to verify the problems with potential users. User interviews, surveys, and participatory observations can all be used to verify the characteristics of the problems.

The second and third steps are designing and development new technologies to solve the problem(s). These steps are very similar to the designing and development processes in the Spiral Software Development Models (Sommerville, 2006). However, their objectives are different: software development processes are focused on effectively developing high quality software. They seek to improve the development process itself, while the design science paradigm is focused on creating artifacts (any, maybe software) that will improve the organizational performance.

The fourth and fifth steps are unique to the design science paradigm. Design science research applies innovative solutions to unsolved problems, thus it is highly likely that software requirements will be vague during the time of system design. Effectiveness of the solutions thus needs to be confirmed through evaluation. Because during the research life cycle the artifacts go through different Technology Readiness Levels (TRLs), evaluation methods might be different in different stages. The design science paradigm is flexible with the methods to evaluate the artifacts.

4.2 Initiation of Collario

As early as in 2004, two Ph.D. students in the Information Systems department of the New Jersey Institute of Technology (NJIT) started to explore asynchronous scenario creation under the direction of Professor Murray Turoff using a web-based conferencing system called WebBoard. Students in one undergraduate class and one graduate class in the Information Systems department were recruited to create emergency scenarios using WebBoard. A set of discussion threads were created in WebBoard to help the students organize their discussions. However, these early attempts were not successful. Participation in the scenario creation tasks was sporadic, even though incentives and encouragement were given to them through the class instructors (Yao et al., 2004; Hendela et al., 2005). Analysis of these trials found four key reasons for the failure:

Lack of Experience: All the students were IS undergraduate students without any experience in the emergency field. The task to create emergency scenarios seemed difficult for some and those few students who were stimulated by the uniqueness of the task often did not have the knowledge to come up with creative insights.

Inappropriate Tool: WebBoard is a generic GSS with only reply comment discussion structures. It discouraged retrieval by copying subject headings of the root to replies which lead to inability to visualize the resulting discussion. A given reply was usually a response to a number of prior comments. This made it very difficult to follow and to remember what had taken place in the past and obliterated the ability to segment the task of creating scenarios. Many students felt it was very difficult to use WebBoard to create and discuss emergency scenarios.

Organization of data: When students attempted to integrate the elements of the discussion into some sort of final report, a number of the ideas and concepts that represented a contribution did not appear in the final report because useful information was lost in the noise created by the lack of ability to define a suitable discussion structure or knowledge structure oriented to the creation of a complex emergency scenario.

Information Overload: The combination of the above factors led to a classical information overload situation that had been identified in early studies of the use of Computer Mediated Communication systems (Hiltz and Turoff, 1985). This occurred at even low levels of average participation which tended to further discourage participation.

However, this doesn't mean that asynchronous scenario creation and discussion is useless. From 2006 to 2007, through Professor Michael Chumer, the author was sent to observe four mid-to-large scale emergency preparedness Tabletop exercises (TTXs) held in the state of New Jersey. These TTXs included a bomb explosion scenario in the PATH train tunnel near Jersey City, NJ; two Hurricane scenarios landing in NJ; and one dirty bomb attack scenario in the financial district in Jersey City, NJ. The number of participants in these TTXs ranged from under thirty to more than one hundred. The duration of the TTXs was from a half day to two days. From these observations, several insights about FtF TTXs surfaced.

1. **Duration**: FtF TTXs cannot be too long, because participants have their own schedules and other responsibilities.
2. **Limited Coverage**: Because of the duration limitation, issues that can be covered in FtF TTXs are normally limited. To use the time wisely, TTX organizers would prepare the prominent problems and direct the participants to discuss the problems.
3. **Communication Blocking:** The nature of FtF communication is that whenever a person is speaking, others have to listen. Coupled with limited duration, it is not

unusual to see only a small portion of participants joining discussion during a TTX.

4. **Overhead**: FtF TTXs are not comprised of just the several hours to discuss the scenarios. TTX organizers need to deal with logistics before and after a TTX. Participants need to drive to a single meeting location. If a TTX spans several days, there are extra costs for meals and accommodations.

5. **Insufficient Follow-up**: To make the participants feel safe to discuss issues freely in FtF settings, all four observed TTXs were not recorded. The only follow-up activity was a summary composed by the TTX organizers.

6. **Participant types:** Involvement was usually dominated by the higher management levels and in most cases did not have adequate representation from those who were expected to actually execute the responses to a given disaster.

7. **Group Memory:** With the lack of a memory for the results of these FtF exercises very little evolution of the exercise or learning from the experience took place.

8. **Coherency:** With the typical occurrence being once or twice a year, each occurrence did not usually have a majority of the same persons participating.

These limitations have become obstacles to make TTXs more useful. After entering the new millennium, emergencies and disasters have become more diverse and in some cases unexpected. The result is a challenge for emergency preparedness to be more creative and responsive to a wider range of emergencies than what has been experienced in the past. To better prepare for the emergencies and disasters with these new characteristics, emergency preparedness has to be more flexible (Yao et al., 2009). Asynchronous scenario creation and discussion might become a useful planning and training tool because:

- It can be launched whenever there is a need.
- It allows for anywhere-anytime participation.
- It allows participation from all over the world.
- It records discussion histories automatically for review after the exercise.

It was also clear that the typical bulletin board-oriented asynchronous conference systems such as WebBoard are lacking many features to facilitate the ability of a group to truly work together to explore and improve on a relevant emergency scenario. To improve this situation, observations from prior work in such areas as Delphi Design and Group Decision Support (Linstone and Turoff, 1975) have been utilized. This included the need for

- A data structure that applies to scenarios that could be used by the participants to create information that would then be automatically organized into fundamental components of a scenario.
- To provide collaboration incentives to encourage active participation of members of the group so that it would overcome the tendency of a group to use a "divide and conquer" approach where they divide up the components of a problem and assign them to individuals and then paste together the results.

Attempting to meet these design objectives has been one of the primary motivations for adapting a design science approach to the development of this system along with the typical HCI (Human Computer Interaction) objectives of usability and ease of learning.

4.3 Four Development Iterations: Introduction

The essence of the design science paradigm is iterative design, implementation, evaluation, and evolvement (Hevner et al., 2004; Vaishnavi and Kuechler, 2007). After identifying the problem to be solved, this dissertation utilized four iterations to improve the Collario system into its current status. Each of the iterations has different sub-problems to solve, results in artifacts in different maturity levels, and requires different methods for evaluation. Table 4.1 summarizes these development iterations.

Table 4.1 Four Collario Development Iterations

	Key Problems to Solve	Artifact Maturity Level	Evaluation Focuses	Evaluation Method	Duration
1	To understand the field and compare different approaches to visualize scenarios.	Several Mockup visualization prototypes to display scenarios were created.	Which would be the best visualization approach to display scenarios?	Internal Evaluation	06/2005 – 03/2007
2	To develop a visual component that can display scenarios effectively.	A component to display scenario details in a temporal order was created. However, no collaborative support was provided.	How would users feel about the Event-Log display of scenario details?	Informal Demonstration, and Cognitive Walkthrough	03/2007 – 08/2007
3	To develop a collaborative workspace for scenario creation.	A sub-system to integrate collaborative support with scenario event list display was created. However, necessary GSS requirements such as Group Awareness and Role Management support had not been integrated.	How would users feel about the deep collaborative support integrated with the scenario event list artifact?	Informal Demonstration and Cognitive Walkthrough	08/2007 – 02/2008
4	To develop a holistic GSS that allows users to create and discuss scenarios in VTs	A working prototype system to support collaborative scenario creation in VTs was created.	Will the users have difficulties learning to use Collario by trial-and-error?	Protocol Analysis	02/2008 – 04/2009
			Can distributed teams create complex scenarios using Collario successfully?	Field Study	

4.4 Iteration I: Choosing Scenario Display Approach

User Interfaces (UI) are fundamental components for Information Systems. In the case of Collario, the fundamental part in UI design is to find the best approach to present scenarios. To display scenarios effectively, three approaches typically suggested in the literature have been tried:

Approach 1: To present scenarios using Event-Log as a metaphor.

Approach 2: To visualize scenarios using a Bow-Tie diagram.

Approach 3: To visualize scenarios using a Timeline Graph.

Figure 4.2 illustrates these three approaches.

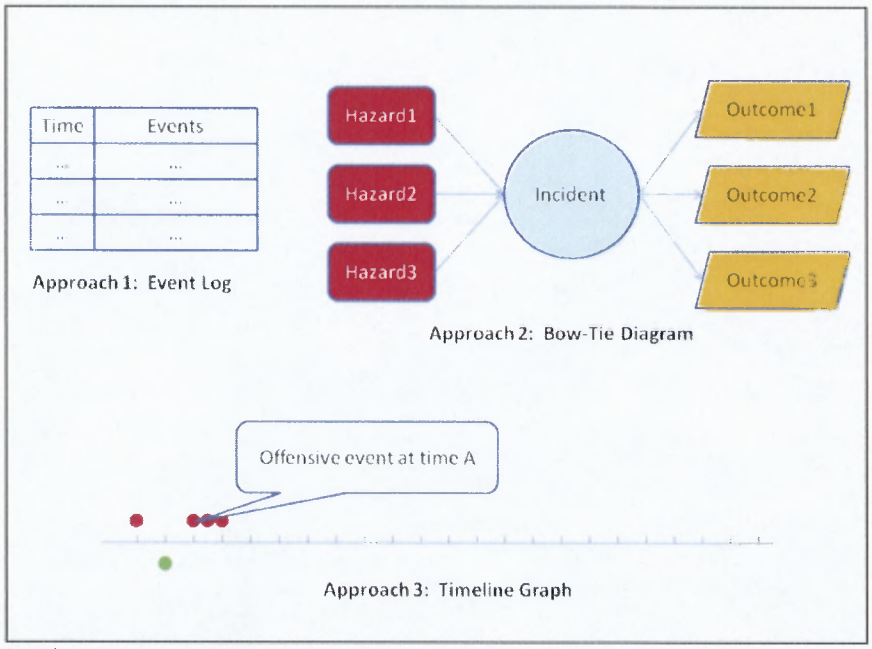

Figure 4.2 Three approaches to visualize a scenario.

Three mockup prototypes were developed using Microsoft Visual C++ following these three approaches. Comparison of these approaches was conducted internally to address their strengths and weaknesses. The comparisons were focused on how much information each approach could convey in one screen, how well each approach handled

a large number of events, and how easy with which new events may be added. Several events with times and descriptions were inserted into each visualization to identify the strengths and weaknesses of each approach.

Internal evaluation results of these three scenario display approaches are summarized in Table 4.2:

Table 4.2 Analysis of the Three Scenario Display Approaches

Representation Approaches	Strengths	Weaknesses
Event Log Metaphor	Emergency professionals are familiar with event log. Easy to add a new event. Able to contain a large number of events.	Less visually attractive. Linearity, no explicit relation among events. Might lead to information overload.
Bow-Tie Diagram (McConnell and Davies, 2006)	Visually attractive. Dependency is clearly shown.	Hard to add a new event. Hard to include a large number of hazards and outcome.
Timeline Graph	Intuitive. Easy to add a new event. Able to contain a large number of events. Can use sliding window to show a long period of time.	Not all information is displayed. Extra operations are needed to view event details.

From Table 4.2, it can be seen that although the Bow-Tie diagram is visually attractive and shows dependency clearly, its major weakness is that it is hard to expand to include large numbers of events. As it is expected that complex scenarios could easily include dozens of even hundreds of events, the Bow-Tie diagram would not be an appropriate approach.

Both the Event Log approach and the Timeline Graph approach can accommodate large number of events and it is easy to add new events to the displays. A significant difference between these two approaches is that the Event Log approach can display much more information in the screen than the Timeline Graph approach, thus requires users to take fewer operations to get the same information.

After comparing these three approaches, the Event-Log metaphor was finally chosen as the best scenario display approach. Furthermore the event-log metaphor is quite familiar to those in the emergency management profession and is often the structure used to evaluate responses to a given emergency (Turoff et al. 2004).

4.5 Iteration II: Developing and Evaluating the Scenario Display Component

After choosing the scenario display approach, the development entered the second phase: to develop and evaluate a scenario display component. Because this component is the basis for building other functions to support collaborative scenario creation, it is critical to make sure that this fundamental piece is in good shape before going any further. Also, the component should be developed in such a way that it can be reused and expanded to build other Collario functions.

This iteration evaluated the scenario display component using system demonstration and cognitive walkthrough. System demonstration, which is to show the functionalities of an artifact to a potential user, is a light-weight evaluation method which can be conveniently applied (Shneiderman, 1998). Cognitive walkthrough, which is to describe the interactions with an artifact, can be applied even to incomplete artifacts

(Shneiderman, 1998). These methods are especially useful to evaluate artifacts in their early development life cycles to get rapid user feedback.

The functionalities for the scenario display component implemented and/or prototyped in this iteration are summarized in Table 4.3.

Table 4.3 Details of the artifacts in the Second Development Iteration

Category	Details	Status
Scenario Event List	Six columns were provided to display scenario details. The first column contained check boxes for selecting scenario elements (events and responses). The second column displayed the times the scenario elements happened. The third column displayed the situations. The fourth column displayed the responses. The fifth column displayed the creators. The sixth column displayed the times the scenario elements were created.	Working
	The last column was provided to display hyperlinks to give and review comments to the scenario elements	Mockup
	Buttons were provided to allow users to add a new scenario element to a scenario at the end of or after a selected one.	Working
	Radio buttons were provided to select element types.	Working
	An edit button was provided to review a selected scenario element.	Working
	A delete button was provided to delete a selected element.	Working
Templates for Scenario Element Definition	Input fields were provided to define scenario elements.	Working
	A "Submit" button was provided to add a new element into a scenario.	Working
Templates for Scenario Element Review	Input fields were provided to display scenario elements	Working
	Three hyperlinks were provided under each input field, one to give/review comments, one to give/review/use suggestions, and one to review/restore historical values.	Mockup
	One image button was provided besides each input field to update the value of the field.	Mockup

From this table, it can be seen that this iteration was focused on creating new scenario elements and displaying them in a scenario event list. Collaborative features were displayed in the interfaces as mockups. These functions had not been implemented yet in the prototype.

4.5.1 Evaluation Subjects

Emergency management professionals would be one of this system's most relevant user groups. Following User-Centered Design principles (Norman, 1989), it would be most beneficial to involve this user group in the design processes as early as possible. Because of this, two local emergency management professionals were invited for system demonstrations and interviews. In March and June of 2007, the author attended two emergency preparedness TTXs, during which he met those two persons and introduced the Collario research project to them. Both expressed interest in participating in the research. In August of 2007, when the prototype was finished, invitations were sent to them for system demonstrations. Both agreed and participated in the demonstrations.

Of these two professionals, one is an Exercise Coordinator working for New Jersey State Depart of Health and Senior Services (NJ DHSS). The other is a Corporate Safety Loss Prevention Manager working for one of the largest national retailer-owned cooperative in the United States.

The first round of system demonstrations was given in August, 2007.

4.5.2 Evaluation Processes

For a system demonstration and cognitive walkthrough session, the researcher first introduced the background and objectives of the research and then spent around 30 minutes to demonstrate the scenario element definition and display functions. Cognitive walkthrough was used when the functions had not been implemented yet, such as the collaborative features. After that, the subjects were interviewed using semi-structured questions.

The whole demonstration and interview processes were audio recorded. User feedback was extracted and summarized out of the recordings.

4.5.3 Evaluation Results

After seeing the system demonstrations, both professionals were very interested in the idea of being able to create and discuss scenarios with a group of people through the Internet and thought that it would provide them with a great deal of flexibility. Based on their different job responsibilities, these two professionals envisioned different applications of such a system. The exercise coordinator thought such a system would help her in creating exercise scenarios. At the time of the system demonstration, she still relied on emails to communicate with her colleagues if she needed others to help her create an exercise scenario. She thought a collaborative scenario creation system could make it much easier for her to work with a group of experts to create scenarios.

On the other hand, the Safety Loss Prevention manager expressed interest in another potential use of such a system. He commented that his organization had created many emergency plans over the years. However, what was missing was a convenient

way to practice them on a regular basis. This created a large challenge for his team because his team was scattered all over the country. With the support of such a system, "I could create exercise scenarios and ask my team to log on to the system everyday at 9 o'clock in the morning to discuss the scenarios." He thought he could also give the scenarios to different departments and ask them to come up with responses. In this way, the exercises could be conducted in a timely manner. This would be valuable since plans need to be reviewed and revised over time. "Before 9-11, we didn't have plans for terrorist attacks. Now, terrorist attack is an important consideration." Note that this particular user did not yet recognize the potential for asynchronous group communications and still focused on synchronous use of this technology. This just illustrates the classic problem that electronic mail, which he was familiar with, does not aid people in understanding asynchronous group communications and only actual group usage can help users gain an understanding of that potential.

In terms of usability, both professionals felt the prototype was easy to understand.

One of the system demonstration objectives was to get quick feedback and critiques from domain experts about the research ideas. Feedback from these two professionals reinforced the research idea that collaborative scenario creation in VTs might be a useful application for the Emergency Management field. This finding motivated the research group to move forward in this direction. Another objective was to establish a connection with the practitioners and hopefully attract them to participate in the follow-up research. At the end of each system demonstration, the subject was asked if he/she would like to attend another demonstration when a more mature prototype would be ready. Both agreed readily.

4.5.4 Suggestion for System Improvement

Through the system demonstrations and interviews, feedback to improve system design was also collected. The exercise coordinator commented that she would like to know the objectives and background before creating a scenario. As a result, a new Objective field was added to the SCENARIO_OVERVIEW table.

4.6 Iteration III: Developing and Evaluating the Collaborative Workspace

After getting positive feedback from emergency management professionals regarding the potential usefulness of a collaborative scenario creation system and ease of use of the scenario display component, the development entered the third phase. This phase included the following tasks, with regard to providing a collaborative workspace:

1. To implement the collaboration support not included in the previous iteration.
2. To develop templates to define stand-alone scenario elements such as events and resources.
3. To develop templates to review stand-alone scenario elements, with collaboration support included.
4. To develop an Administrative interface for administrators to load scenarios in plain text format and other supporting documents.
5. To develop an interface to view the supporting documents.
6. To develop an interface for participants to have general discussions.

The first three tasks in this list were a natural extension of the previous phase. The next two tasks were based on observations of the FtF TTXs, which found that the exercise organizers always had scenarios (or more accurately the MSEL, standing for Master Scenario Event List) and a set of supporting documents, such as maps, charts, etc.

prepared before a TTX. It would be helpful if the exercise organizers were able to load the scenario events and supporting documents to the system.

There are certain objectives that potential users cannot usually appreciate. One example was the goal to create a system which would allow reuse of the elements that made up scenarios so that in an organization the database resulting from the use of the system could be a resource for evolving and improving scenarios over time, because it might require some users to do extra work. There is definitely a tradeoff between a design which allows the simplest approach to designing a single scenario and the added complexity of a system that would allow the creation of new scenarios out of pieces of existing ones. In the above list, items 2, 3, and 4 create a foundation for allowing reusability and will promote user perception of the possible benefits of this approach to the design.

The last task was based on McGrath's (1991) Time, Interaction, and Performance (TIP) theory which says effective groups are engaged simultaneously and continuously in three functions: (1) production, (2) member support, and (3) group well-being. While support for collaborative scenario creation help to make "production" more effective, general communication support would contribute to "member support" and "group well-being." In addition, the use of the capability to assign comments to any major structured item in the template for scenarios allows for well organized (structured) feedback on specific improvements to any prior item. If the suggested improvement and feedback is delayed to a later time, the idea might be forgotten by the user.

Altogether, the functionalities for the collaborative workspace implemented in this iteration are summarized in Table 4.4. Functionalities already implemented and

working from the previous iteration are not included here. Please refer to Table 4.3 for those functionalities.

Table 4.4 Details of the Artifacts in the Third Development Iteration

Category	Details	Status
Scenario Event List	Hyperlinks showing the number of comments to each scenario element were provided in the last column of the scenario event list. The hyperlinks could lead users to view and give comments for each scenario element.	Working
Templates for Scenario Element Review	Three hyperlinks were provided under each input field, one to give/review comments, one to give/review/use suggestions, and one to review/restore historical values.	Working
	One image button was provided besides each input field to update the value of the field	Working
Templates to Define Stand-Alone Events and Resources	Input fields were provided to define stand-alone resources and events.	Working
Templates to Review Stand-Alone Events and Resources	Collaborative support was provided to give/view comments, give/view suggestions, view/restore historical values, and update current values.	Working
Administrative Support	Administrators were allowed to load MSEL in certain text format.	Working
	Administrators were allowed to mark events as different colors to represent different statuses. (Yellow for under current discussion focus, gray for out of discussion focus, white for non-MSEL scenario elements added by participants.)	Working
	Administrators were allowed to load supporting documents.	Working

Table 4.4 Details of the Artifacts in the Third Development Iteration (Concluded)

Supporting Documents Review Page	Exercise administrators and participants were allowed to browse and view supported documents.	Working
	Exercise administrators and participants were allowed to view and give comments to the documents.	Working
General Communication Page	Exercise participants were allowed to leave and view messages.	Working
	Exercise administrators were allowed to move important messages to the top.	Working

It can be seen from this table that this iteration was focused on adding deep collaboration support, and providing administrative and auxiliary support for conducting on-line TTXs. The design attempted to make it as easy as possible for individuals to contribute comments, suggestions, and/or modifications to each other's work and to make such inputs easily viewable by the group as a whole as a mechanism to stimulate true collaboration. With these functions in place, a second round of demonstrations was given to emergency management professionals.

4.6.1 Evaluation Subjects

In January of 2008, after the new prototype was developed and tested, invitations were sent to the two professionals who attended the first round demonstrations. Both agreed to participate in the second round.

In addition, through contact supplied by Dr. Murray Turoff, a FEMA (Federal Emergency Management Agency) region II (New York and New Jersey) Voluntary Groups Liaison (VGL) was invited through email. The FEMA VGL was very experienced with more than thirty years of experience in EM. He also agreed to view the

system demonstration. He, in particular, had experience in running major training exercises for local and community organizations that were prepared to supply emergency community services for urban areas in the tri-state area. The training exercises usually involved 50-70 different government and private Non-Profit Organizations (NPO) in a very detailed all day and multi-day workshop with many paper templates to try and capture problems such as coordination and conflicts to eliminate between organizations that ordinarily do not work together as one organization. Such exercises were extremely person power intensive and required a great deal of pre and post setup and analysis efforts. He was very generous to share with the research team a 1400-page exercise document which summarized a state-wide TTX for a hurricane scenario, through which the research team had a chance to realize the scale of such exercises.

The second round of system demonstrations was given from January to February in 2008.

4.6.2 Evaluation Processes

For the system demonstrations in this iteration, a usage scenario was designed to make the demonstrations more realistic. The usage scenario assumed an exercise administrator was needed to create an on-line TTX. To do that, the administrator first needed to prepare MSEL in Collario by loading a pre-defined MSEL in text format. Second, the administrator needed to load a supporting document, a region map, into Collario. He also had many other documents for the exercise that could be useful in support of smaller and asynchronously oriented exercises. It was very clear that being able to handle and integrate other existing material as links to any structured item in the system was

extremely important, as well as allowing Web-based links anywhere in the text of items in the database.

When the exercise started, the administrator needed to control the pace of the exercise by opening some scenario situations as defined in MSEL and closing some others at the appropriate time. When some scenario MSEL situations were opened, participants might want to discuss these situations. They might also want to add new situations as well as responses. The system demonstration was given according to this usage scenario.

As with the previous iteration, the system demonstrations in this iteration lasted about thirty minutes. Subjects were encouraged to give comments and suggestions whenever they wanted during the demonstrations. After the demonstrations, the subjects were interviewed using open-ended questions.

The entire demonstration and interview processes were audio recorded. User feedback was extracted and summarized from the recordings.

4.6.3 Evaluation Results

First, regarding perceived ease of use of Collario, all three subjects felt that the system was easy to learn and easy to understand. None of the subjects had difficulty following the demonstrations or understanding how to use Collario to create scenarios collaboratively. The FEMA Voluntary Group Liaison was very excited after seeing the demonstration. He commented: "You know what? The most beautiful thing about this system is its simplicity. It is neat."

Second, regarding perceived usefulness of Collario, all three subjects thought that the system had the potential to become a very useful tool for Emergency Management.

Being from different backgrounds, they envisioned different potential applications for Collario. The exercise coordinator thought that Collario could be useful to create MSEL, replacing their currently used inefficient email communication. The Safety Loss Prevention manager thought that Collario could help driving the process of practicing emergency planning on a regular basis and cross departmental boundaries. "I can ask transportation what they are going to do under these conditions, and ask HR what they are going to do under those." Finally, the FEMA VGL thought that in addition to the previous two applications, Collario could also be used for knowledge sharing by recording personal experiences in scenarios using Collario. He commented that there were twelve FEMA regions across the U.S. and each region had a VGL like him. Such a system would be a great tool for the voluntary group liaisons to exchange their experiences.

Third, all three demo viewers welcomed the flexibility provided by Collario. They believed that asynchronous participation might save them time, money, and efforts to prepare and attend face-to-face TTXs, as demonstrated by a comment from the FEMA VGL: "(in face-to-face TTXs), a lot of efforts were spent on things having nothing to do with the exercises."

4.6.4 Suggestions for System Improvement

As the prototype in this iteration was much more mature than that in the previous iteration, system demonstrations and interviews in this iteration resulted in many more system improvement suggestions than did the previous one. The following lists the major suggestions:

The differences between scenario events and stand-alone events were confusing for some subjects. Also, the term "Event" was not intuitive. It was suggested that users be provided tutorials with clear definitions of these terms, and preferably some examples. There was also a need expressed for simpler events such as news notifications that were concise and did not have much complexity.

The scenario elements in a scenario event list should not be ordered according to their occurring times, since the occurring times might not be known at the time the scenario elements are created. They might also be subject to changes too.

It was suggested that conditions on events be added such as their being able to generate other specific events based upon outcomes and varying time conditions. These are interesting extensions that can be implemented when the scenario system can be extended to include an execution model to set up a game playing environment. For example, a monitor or player would be able to choose outcomes and follow on events at a given point in the execution. This however was not considered to be part of this dissertation effort but as a potential follow on effort.

The scenario elements in a scenario event list might be assigned with unique numbers, called Master Scenario Event List (MSEL) numbers. The MSEL numbers can be used by scenario creators to refer to a particular element. It can also be used to order scenario elements.

The responses to a MSEL situation should be placed right after the situation to help users to locate the newly added response. At the time of system demonstration, the scenario responses and situations were ordered according to occurring time.

The load function to load pre-defined MSEL in text format was useful. However, existing scenarios might be in other formats such as an Excel file. Collario should also be able to handle them.

It would be helpful if the system could export scenario creation outputs into other data formats such as a PDF file or a DOC file.

It is clear that many improvement suggestions can be implemented when the system is set up in a professional organization intending to use this system on a regular basis. It is this dissertation's task to carry the system to the point that will demonstrate its feasibility to accomplish its primary objectives but not to add in this dissertation effort all desirable features that are possible.

4.7 Iteration IV: Integrating and Evaluating Collario

After the third development iteration, development was nearing completion. Implementing high-priority suggestions from the previous iteration needed to done. Also, there was one more critical task: to implement Group Awareness (GA) support. GA is thought to be important for a group of people to work productively (Dourish & Bellotti, 1992; Mendoza-Chapa, 2000; Lowry et al., 2004; Neale et al., 2004). GA can be from different sources such as actions, changes, presences, abilities etc. (Gutwin & Greenberg, 1996). This dissertation's plan did not include providing all the GA features possible at one time, but rather adding key ones step by step. Using this strategy, the following system improvement tasks were planned for the fourth iteration:

1. To add a Sequence field to the SCENARIO_DETAIL table and a column to the scenario event list component.
2. To sort the scenario details according to sequence numbers, instead of occurring times. This will automatically fix the misplacement problem with responses.
3. To display on the screen statistics such as number of scenarios, events, and resources, number of new (unread) scenarios, events, and resources, number of contributions and feedback provided by each user, number of comments given to each scenario element, and number of comments, suggestions, and historical values of each data field.
4. To allow users to mark selected scenario elements as read.

Table 4.5 summarizes the changes made to the Collario system in preparation for protocol analyses and field studies.

Table 4.5 System Improvements in the Fourth Development Iteration

Category	Details	Status
Scenario Event List	Scenario details were sorted according to sequence numbers, instead of occurring times.	Working
Group Awareness Support	Numbers of scenarios, events, and sources created by the team were displayed.	Working
	Numbers of new scenarios, events, and sources created by the team were displayed. New scenarios, events, and sources were marked using red '(New)' signs	Working
	Numbers of new scenario detail items (situations and responses) were displayed. New scenario detail items were marked using red '(New)' signs.	Working
	Buttons were provided to mark selected scenarios, events, sources, or scenario detail items as read.	Working

As Table 4.1 shows, this iteration utilized two evaluation methods: Protocol Analysis and Field Study. The first method was used to evaluate usability of Collario. The second method was a formal evaluation method used to evaluate both usefulness and

usability of Collario in group settings with realistic tasks. Since analysis of the field study is complex by itself, discussions about evaluation using field study are postponed to the next chapter. The remaining parts of this section will focus on the Protocol Analysis evaluation.

4.7.1 Evaluation Subjects

Five Ph.D. candidates from the Information Systems department of the New Jersey Institute of Technology (NJIT) were recruited as subjects for Protocol Analysis on the Collario system. All of them have training in Information Systems evaluation and are familiar with the Protocol Analysis evaluation method. None of them have experience in EM. Such combination of background might be very helpful for the evaluation of Collario because Collario is targeted to EM experts as well as EM students. Prior knowledge and experiences could be a hindrance to use the system. On the contrary, it is expected that the knowledge structures built in Collario to facilitate collaborative scenario creation, and the sample scenarios will help novice users quickly become comfortable with scenario creation. Therefore, IS Ph.D. candidates are thought as appropriate candidates for the Protocol Analysis evaluation.

Selection of the subjects also sought to diversify seniority in the program. Of the five subjects, one was in his fifth year in the program and about to defend his dissertation in one month. Two were in the fourth year in the program. One was in the second year in the program. One was near the end of his second semester.

Two movie tickets were given in gratitude to subjects who successfully finished all the evaluation tasks.

4.7.2 Evaluation Processes

The task for the Protocol Analysis was to compose 2-3 responses and 1-2 comments to an exercise scenario through Collario. The exercise scenario was adopted from a dirty bomb scenario used by a Table Top Exercise held in October, 2007 at the New Jersey Institute of Technology (NJIT). The original scenario portrayed a dirty bomb attack in Jersey City, New Jersey, therefore the street and building names in the original scenario were based in Jersey City. This might not be familiar to the students of NJIT, which is located in Newark, New Jersey. To help the students better make sense of the scenario, the street and building names were changed to those in Newark. The adjusted scenario was then input into Collario by the researcher.

For the protocol analysis sessions, subjects were first provided with a brief introduction to the research project. They were then given consent forms to read and sign. After that, task requirements were supplied to them. The requirement to speak out aloud was emphasized, even though all the subjects were familiar with this evaluation method from a graduate-level IS course all of them had taken. Finally, Collario was brought up for the subjects. The task required subjects to find the "Newark Dirty Bomb Attack" scenario, read through the situation reports, and create 2-3 responses and 1-2 comments to them. The researcher didn't strictly follow the researcher-needs-to-be-quiet rule, since these sessions were to identify as many potential problems as possible in a short period of time. So, once the researcher confirmed there was a problem in the system, he led the subjects to the next step. If the subjects mentioned confusion about the design, the researcher recorded the confusion and explained the design justifications to

them. In addition, when the subjects became quiet in thinking, the researcher also encouraged them to speak out by asking "What do you think now?"

The entire process was videotaped. The recordings were then viewed to extract patterns. The use patterns are summarized in the following section.

4.7.3 Evaluation Results

All the subjects had no problem using the user IDs and passwords to log in the Collario system. Once they entered the system, they saw a scenario list, with "Newark Dirty Bomb Attack" as the only item in it. All the subjects correctly interpreted this interface and successfully entered the collaborative workspace for this scenario. However, one subject expressed her confusion about the checkbox shown in the list. The researcher explained that the checkboxes were used to mark checked items as read.

After entering the workspace, the first page was the scenario overview page. The subjects experienced some difficulty here. Collario provided a hyperlink called "Go to Scenario Details" under the name of the scenario in the top of the page. Users were supposed to click on this link to enter the scenario detail page. However, only three subjects noticed this link and successfully entered the scenario detail page. One subject knew there should be another place containing the details of the scenario and he searched on the screen trying to find some clues. After several failed attempts, he became frustrated. The researcher stepped in and pointed the link to him. Another subject thought the overview page was the scenario and started to give comments in the scenario description field. She typed a comment and the researcher explained to her that it was not the content of the scenario. She was informed of the hyperlink and brought to the next page.

In the scenario detail page, all the subjects had no problem understanding the time frame and the scenario structure. However, when they tried to add some responses, some subjects experienced difficulties. Above the scenario detail list, Collario provided two buttons: "Insert an Event" and "Append an Event." The "Insert an Event" button was designed to insert a new item after a selected item in the scenario detail list, while the "Append an Event" should be used to add a new item to the end of the list. Four subjects mentioned their confusion about the differences between "Insert" and "Append." Only one subject was able to figure out how to use the "Insert an Event" button to add new responses without any help. He first checked multiple checkboxes in the scenario detail list and then hit the "Insert an Event" button. The system gave a warning that he could only check one item to use this function. He unchecked redundant items and successfully entered the template to define response events. Two subjects clicked the "Append an Event" and were routed to the template. They defined new responses, but were unable to find the new responses because the responses were appended to the end of the scenario event list and were not visible unless a user scrolled to the bottom of the page. One of two subjects scrolled up and down and finally found it at the bottom of the list. He said that this was completely unexpected. Another subject tried to add a duplicate response, because she thought the system might not store it. The remaining two subjects were so frustrated that the researcher had to step in and lead them out. One subject mentioned that "Insert" and "Append" didn't seem too much different to her.

Regarding the structure of the scenario detail list, one subject thought the responses should be positioned in the same row as the situation reports, to explicitly show the relationships between the situation reports and the responses.

Finally, none of the subjects had difficulty giving comments to the situation reports in the scenario detail list.

4.7.4 Suggestions on System Improvement

From the protocol analyses results, measures to improve Collario were determined. The hyperlink to enter the scenario detail page from the scenario overview should be more prominent. This link is very critical for a user to see the details of a scenario. This change has been completed.

The names of the two buttons to add new items to a scenario detail list should be changed. The "Insert an Event" button has been changed to "Insert Event After", while the "Append an Event" button has been changed to "Add Event to the End."

The check button in the scenario detail list to delete a scenario detail item should have a tooltip. When a user moves the mouse over this button, a popup window should appear to tell him/her what this button is. This change has been completed.

After a new item (situation or response) is added to a scenario detail list, the system should give a prompt about where the new item was added.

It is suggested that arranging all the responses to a particular situation report in the cell right next to the situation would improve usability. This change will make the relationship between the situations and the responses more intuitive. However, a drawback is waste of table spaces. In the current design, the scenario detail list is always half full, because each row can contain either a situation or a response, but not both.

4.8 Summary

This chapter introduces the four iterations this dissertation research employed to evolve Collario, with the focuses on the problems to be solved, solutions, evaluation methods, and suggestions for system improvement. This chapter discusses how internal evaluation, system demonstrations, interviews, and protocol analyses have been used in this dissertation research to evaluate the prototypes. However, this chapter doesn't discuss the formal evaluation method of field study. This is left for the next chapter.

CHAPTER 5

EVALUATING COLLARIO USING FIELD STUDY

The last iteration of evaluation for the current research endeavor was to conduct a field study to evaluate Collario in group settings to support realistic tasks with potential users. This chapter describes the field study and its findings.

5.1 Research Questions

The field studies attempt to provide insight into four research questions. The first three questions are derived from technology acceptance models (Davis, 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003). According to these models, both perceived ease of use (or effort expectancy) and perceived usefulness (or performance expectancy) can determine users' behavioral intention to use a new technology. In addition, perceived ease of use also impacts users' perceptions regarding a technology's usefulness. Thus, to understand user acceptance of Collario, it is important to answer the following three questions:

RQ1: To what extent will users feel Collario is easy to learn and use?

RQ2: To what extent will users feel Collario is useful?

RQ3: Will the users be willing to use Collario? Why? Why not?

The last question is derived from the design science paradigm (Hevner et al., 2004; Vaishnavi and Kuechler, 2007), which emphasizes using evaluation conclusions from an earlier iteration as inputs to improve artifact design for the next iteration. It is this premise upon which the fourth RQ is based:

RQ4: What lessons will be learned to improve Collario

5.2 Research Model

This research effort uses Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT) model to answer the research questions related to technology acceptance. This model unifies other the original Technology Acceptance Model (TAM) and its derived models to provide a standard approach for researchers study technology acceptance. The UTAUT explains technology acceptance using four determinants: Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions, and four moderators: Gender, Age, Experience and Voluntariness of Use. The UTAUT model was used to study acceptance of Collario in field studies. Figure 5.1 illustrates the adapted UTAUT model to study acceptance of Collario:

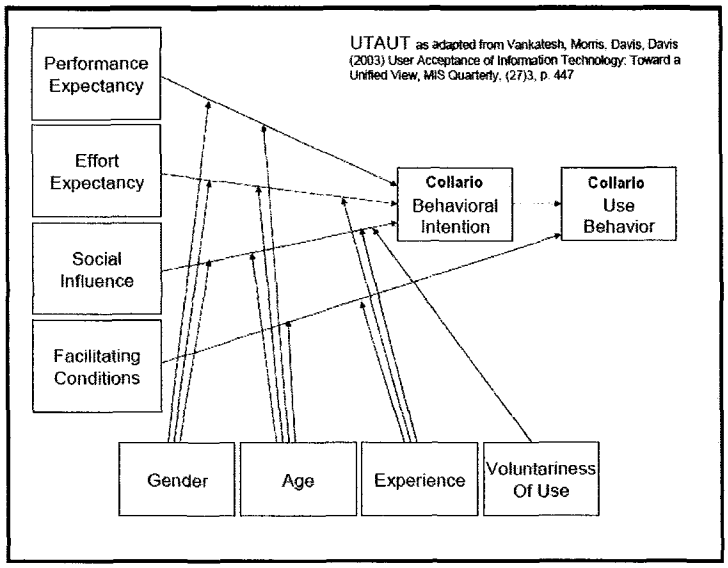

Figure 5.1 The UTAUT model to study acceptance of the Collario system.

Source: Adapted from Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). "User acceptance of information technology: toward a unified view." MIS Quarterly 27(3): pp. 425-478.

5.3 Pre- and Post- Survey Questionnaires

Surveys were distributed to the study groups both before using Collario to measure subjects' background and expectations about collaborative scenario creation in Virtual Teams (VT) before using Collario. Post-survey questionnaires measure subjects' perceptions and reflections regarding their experiences of using Collario to create and discuss scenarios.

The pre-survey questionnaires are created by referring to the moderating factors of the UTAUT model (Venkatesh et al., 2003), and three motivation theories (Maslow, 1954; Herzberg et al., 1959; Agarwal and Karahanna, 2000). Table 5.1 summarizes the pre-survey questionnaires.

Table 5.1 Summary of Pre-Survey Questionnaires

Constructs	Measurements	Question Number
Gender	GENDER1: Gender (UTAUT)	Q2
Age	AGE1: Age (UTAUT)	Q3
Ethnic Group	ETHNIC1: Ethnic Group (UTAUT)	Q4
Native Language	LANGUAGE1: Native Language (UTAUT)	Q5
Educational Background (UTAUT)	ED1: Undergraduate or graduate?	Q6.1
	ED2: Years in program	Q6.2
	ED3: Is part time?	Q6.3
	ED4: Undergraduate degree subject	Q6.6
	ED5: Highest degree subject	Q6.7

Table 5.1 Summary of Pre-Survey Questionnaires (Continued)

General Working Experiences (UTAUT)	JOB1: Employer	Q6.4
	JOB2: Job Title	Q6.5
	JOB3: Years of EM experiences	Q7
	JOB4: Years of EM related experiences	Q8
	JOB5: Working experience statement	Q9
Scenario Experiences (UTAUT)	EXP1.1: Involved in scenario creation before?	Q10
	EXP1.2: Involved in scenario-based planning before?	Q11
	EXP1.3: Involved in scenario-based training before?	Q12
Teamwork Experiences (UTAUT)	EXP2.1: Nervous to express opinions in a team	Q17
	EXP2.2: Overall experience in teamwork	Q18, Q27
IT Experiences (UTAUT)	EXP3.1: How often use email?	Q21
	EXP3.2: How often use conferencing system?	Q22
Self-Efficacy (UTAUT)	EFFICACY1: Educational preparedness.	Q13, Q26
Motivation [Based on Hierarchy of Needs (Maslow, 1954); Two-Factor Theory (Herzberg et al., 1959); Cognitive Absorption (Agarwal and Karahanna, 2000)]	MOTIVE1: To learn more about planning methods.	Q14.1
	MOTIVE2: To learn more about Emergency Preparedness	Q14.2
	MOTIVE3: To learn more about scenario creation	Q14.3
	MOTIVE4: To get extra points	Q14.4
	MOTIVE5: To improve scenarios	Q14.5
	MOTIVE6: To have fun	Q14.6; Q15
	MOTIVE7: This task will motive me to do my best.	Q25
	MOTIVE8: To learn from peers	Q28

Table 5.1 Summary of Pre-Survey Questionnaires (Concluded)

Task Expectation (UTAUT)	TASK1: Difficult to create his scenario in VT	Q19
	TASK2: Difficult to plan for man-made disasters	Q23
	TASK3: Difficult to design high-quality scenarios	Q24
Contribution Expectation (UTAUT)	CONTRIB1: How much effort will be spent?	Q16
	CONTRIB2: Expect to contribute a lot	Q20

The post-survey questionnaires were created by adapting existing UTAUT measurements for the four determinants: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating factors (Venkatesh et al., 2003). Table 5.2 summarizes Venkatesh et al.'s UTAUT measurements.

Table 5.2 UTAUT Measurements

Constructs	Measurements
Performance Expectancy	I would find the system useful in my job.
	Using the system enables me to accomplish tasks more quickly.
	Using the system increases my productivity.
	If I use the system, I will increase my chances of getting a raise.
Effort Expectancy	My interaction with the system would be clear and understandable.
	It would be easy for me to become skillful at using the system.
	I would find the system easy to use.
	Learning to operate the system is easy for me.
Social Influence	People who influence my behavior think that I should use the system.
	People who are important to me think that I should use the system.
	The senior management of this business has been helpful in the use of the system.
	In general, the organization has supported the use of the system.
Facilitating Conditions	I have the resources necessary to use the system. .
	I have the knowledge necessary to use the system.
	The system is not compatible with other systems I use.
	A specific person (or group) is available for assistance with system difficulties.

Source: Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). "User acceptance of information technology: toward a unified view." MIS Quarterly 27(3): pp. 425-478.

In addition, the post survey also measured motivation (Maslow, 1954; Herzberg et al., 1959; Agarwal and Karahanna, 2000), leadership (George and Sleeth, 2000; Yoo and Alavi, 2003; Heckman et al., 2007), and trust (Javenpaa & Leidner, 1999; Coppola et al.,

2004), because of their important impacts in affecting knowledge sharing and VT performance.

Table 5.3 summarizes the post survey.

Table 5.3 Post-Survey Questionnaires

Constructs	Measurements	Question Number
Performance Expectancy (UTAUT)	PE1: Collario is useful for creating emergency scenarios.	Q15
	PE2: Collario is useful to promote knowledge sharing and learning from peers.	Q16
	PE3: Collario enables groups to create emergency scenarios more quickly.	Q17
	PE4: Collario increase group collaboration and group wide understandings.	Q18
	PE5: Collario increases the amount of group discussion about individual contributions.	Q19
Effort Expectancy (UTAUT)	EE1: Using Collario, it is clear and understandable to interact with the group.	Q20
	EE2: It is easy for a group to become skillful for using Collario.	Q21
	EE3: It is easy to discuss scenarios asynchronously using Collario.	Q22
	EE4: It is easy for me to learn to use Collario to discuss scenarios asynchronously.	Q23
Social Influence (UTAUT)	SI1: My manager would support me to try the system.	Q24
	SI2: My professional friends would support me to use the system.	Q25
	SI3: My group members give me a lot of help to use the system.	Q26
	SI4: In general, my group has supported me trying the system.	Q27

Table 5.3 Post-Survey Questionnaires (Concluded)

Facilitating Conditions (UTAUT)	FC1: I have the resources necessary to use the system.	Q28
	FC2: I have the knowledge necessary to use the system.	Q29
	FC3: I have enough training before using the system to work on the scenario.	Q30
Motivation (Maslow, 1954; Herzberg et al., 1959; Agarwal and Karahanna, 2000)	MOT1: The collaborative scenario creation (CSC) exercise is enjoyable to me.	Q1
	MOT2: The CSC exercise is relevant to my job responsibilities.	Q2
	MOT3: How much time spent weekly?	Q3
Leadership (George and Sleeth, 2000; Yoo and Alavi, 2003; Heckman et al., 2007)	LEAD1: The group leader makes the group's role clear.	Q5
	LEAD2: The leader makes the group's priorities and directions clear.	Q6
	LEAD3: The leader wisely anticipated workflow problems and takes necessary actions to avoid crisis.	Q7
	LEAD4: The leader brings a sense of order into the group.	Q8
	LEAD5: Overall, the leader did an excellent job.	Q9
	LEAD6: Overall, the leadership functions were well served.	Q10
Trust (Javenpaa & Leidner, 1999; Coppola et al., 2004)	TRUST1: The people in my group were trustworthy.	Q11
	TRUST2: We were usually considerate of one another's feelings on this team.	Q12
	TRUST3: The people in my group were friendly.	Q13
	TRUST4: I could rely on those with whom I worked in my group.	Q14

Table 5.4 lists the open-ended questions included in the post survey.

Table 5.4 Post Survey Open-Ended Questions

Question Number	Questions
Q31	What features in Collario do you think most useful?
Q32	What features in Collario give you most trouble?
Q33	Do you have any suggestions or comments on how to improve Collario?
Q34	Will you recommend Collario to your colleagues?
Q35	Please give comments that have not been covered in the previous questions.

It can be seen from this summary that the post survey did not measure BI (Behavioral Intention). At this stage, Collario is an experimental prototype. In order to receive more insights to produce a working and usable system, open-ended questions were used to ask subjects if they would like to recommend Collario to their colleagues to measure BI.

5.4 The First Field Trial

From April 9th, 2009 to April 19th, 2009, eleven undergraduate students majoring in Emergency Management participated in a 10-day exercise to use Collario (http://www.collario.org) to create and discuss terrorist attack scenarios as a course assignment. This sub-section describes the field trial. The tutorials for using Collario can be found in Appendix B. Anybody interested in using Collario can send an email to its creator, Xiang Yao (xiang.yao@gmail.com).

5.4.1 Subjects

The subjects of this field trial were undergraduate students from a university in the southern U.S. enrolled in a course on Terrorism and Homeland Security, in the spring semester of 2009. This was a distance learning course taught through Blackboard (http://www.blackboard.com), a course management system provided by Blackboard Inc. A total of nineteen students were in this class from all over the world.

The field trial was given to the students as an optional assignment. The field trial was highly related to the pedagogical purposes of this class, because it would improve terrorist scenarios created in a previous course project with the help of Collario. This also created more opportunity for collaboration in a structured environment. To motivate students to take the assignment seriously, up to 5% points for the assignment and up to 5% extra points would be awarded to the students who created the best scenario as there were two teams. However, the consent forms made it clear that students could choose not to participate in the exercise and the instructor could provide an alternative assignment to earn the same points in compliance with normal IRB policies.

Out of the nineteen students, eleven finished. Another two students attended the exercise too late. They submitted pre surveys, but not post surveys. The results do not include these two students.

Out of the eleven students who participated in the exercise, ten of them finished pre-survey questionnaires. The majority of them (70%, N=10) were of age 30 or above. Table 5.5 gives a finer distribution of the ages:

Table 5.5 Age Composition of the Subjects

Age	20-30	30-40	40-50	50-60	Total
Count (%)	3 (30%)	4 (40%)	2 (20%)	1 (10%)	10 (100%)

All of the subjects (100%, N=10) had English as their first language. Nine of them (90%, N=10) were white, one was Africa-American (10%, N=10).

Regarding the subjects' working experiences, both pre-survey questionnaires and the students' self-introductions were analyzed. It was found that although five subjects announced they didn't have EM or EM related working experiences in pre surveys, their job descriptions showed that two were working in the fields highly related with EM (firefighter and public safety communication). Another student was a volunteer for CERT (Community Emergency Response Team) and the Red Cross. Thus, majority of the subjects (80%, N=10) had EM related experiences. The subjects were quite different from the usual undergraduate class.

This is a true distant learning (DL) class. The subjects were from all over the world. One of them was serving his duty as a firefighter in Iraq. Another was located in Canada. Others were from the United States, but they were scattered in Alabama, Colorado, Georgia, and Alaska. No FtF communication occurred. All the communication between subjects was conducted using a combination of Collario, Blackboard, email, IM, and Skype.

The team leaders were selected by the course instructor. The team leaders were the same for before and after using Collario.

Details about the subjects' EM experiences are summarized in Table 5.6:

Table 5.6 EM Experiences of the Subjects in the First Field Trial

Team	UID	EM Related Experiences	Years of EM Experiences
Blue	8	A volunteer for CERT and the Red Cross	N/A
	14	Not working, but was a police officer and a dispatcher providing first line response to emergencies	6 years
	16	Contract firefighter providing fire suppression and life safety inspections on military installations in Iraq	2 years
	18 (Team Leader)	A manager in a large, tri-service, integrated Public Safety Communications Centre in Canada	15 years
	20	Undergraduate student majoring in EM	None
Red	11 (Team Leader)	The manager of the Emergency Preparedness department at a Nuclear Power Plant.	8 years
	13	Readiness and Emergency Management for US Air Force (USAF)	6 years
	15	Junior undergraduate student majoring in EM	None
	17	An Amateur Radio Operator, or "Ham Radio Operator" and the Communications Officer in their local Red Cross Chapter, managing everything related with communication in the chapter.	15 years
	21	Healthcare Administrator, Financial Counselor in Healthcare. Also have worked as a Nurse (BS in Nursing) Psychology degree also (minor).	N/A

5.4.2 Processes

The first field trial was conducted as a second phase in a month-long course project to create and revise terrorist attack scenarios. In the first phase, all the students in this class were divided into two groups (Blue team and Red team). Each group was required to generate a terrorist attack scenario for a tabletop exercise without the support of Collario. In the second phase, students were invited to use Collario to revise the scenarios created in the first phase.

The first phase of the course project started from March 10th, 2009. A web forum was created by the instructor on Blackboard for the subjects to generate ideas, discuss issues, and coordinate their work. The two teams then worked on the scenario creation task using the Blackboard forum as their primary communication channel. By April 1st, both teams submitted their initial scenarios. The initial scenarios can be found in Figure C.1 and Figure C.2 in Appendix C.

After the subjects submitted their initial scenarios, the scenarios were given to Dr. Murray Turoff, a renowned EMIS (Emergency Management Information Systems) researcher, for review and comments. His feedback was returned to the two teams on April 5th.

The second phase started from April 1st. Between April 1st and April 9th, introduction of the Collario system and on-line tutorials were posted on Blackboard for the students to get familiar with the software. A dedicated Web forum was created in Blackboard by the instructor as the main communication channel for the subjects to discuss the Collario project. The subject could use emails if necessary, but the team leaders were asked to forward the emails to the researcher. The subjects were asked to

sign consent forms and fill out pre surveys before accounts were created for them. On-line tutorials were also provided to the subjects to assist them in learning to use the system. The tutorials can be found in Appendix B. To help the subjects understand what the final scenarios would look like, a sample terrorist attack scenario was provided, which was adopted from a dirty bomb scenario used by New Jersey Business Force (NJBF) to conduct a TTX in October 2007.

From April 9th to April 19th, eleven students participated in and finished the second phase tasks. In the second phase, the students remained in their original teams. Each team was instructed to accomplish the following three tasks using Collario:

- The team leaders needed to spend first 3-5 days to load their current scenario on the forms of events, resources, etc into the system.
- Each team then needed to try and make suggestions for improvement to their and the other team's entries using comments.
- Members of the original team should add actual changes to their scenario when they felt one of the ideas suggested or generated caused them to feel a change or addition should be made.

On April 19th, both teams finalized and submitted their scenarios in Collario for grading. The subjects were sent the link to the post survey web page and invited to fill out the survey. Nine out of the eleven students finished the post survey.

5.4.3 Data Collection

This field study collected both quantitative and qualitative data from multiple sources:

- Background information on the subjects and their opinions was collected through pre and post surveys. (Quantitative)
- Communication transcripts and self introductions in Blackboard and through emails were collected for analysis. (Qualitative)

- The collaborative activities were recorded by the Collario database automatically. (Quantitative)

Data from all these three sources were collected and analyzed.

5.5 Data Analysis of the First Field Trial

The field study is a combination of qualitative and quantitative research. Conducting qualitative research instead of quantitative research is beneficial to our objectives for the following reasons. First, it is hard to reproduce dynamic group settings in laboratory environments (Myers, 1997). Second, the researchers are interested in not only knowing whether this tool is useful and easy to use, but also in understanding to the extent possible, the reasons for the outcomes (Myers, 1997). Field studies are the best choice to evaluate Collario and demonstrate the feasibility of this approach to creating scenarios.

As introduced in the previous sub-section, the field study collected both qualitative and quantitative data. Triangulation is a research approach to combine the qualitative and quantitative research methods as well as combining the qualitative and quantitative data analysis, which would lead to a better explanation of social phenomena (Myers, 1997). This dissertation relies on triangulation to analyze field study data.

5.5.1 Scenario Creation Outcomes

Collario's contribution to the scenario creation task can be best revealed by comparing the scenarios before and after using Collario. The two initial team scenarios before using Collario can be found in Figure C.1 and Figure C.2 in Appendix C. The two team scenarios after using Collario can be found in Figure C.3 and Figure C.4 in Appendix C. By reviewing the items in these figures, one can directly perceive that the amount of

qualitative detail and specification of the events in the scenarios has undergone significant improvement. More detailed information about the scenarios, including creators, creating times, comments, and change histories, can be found in Figure C.7 and Figure C.8 in Appendix C

Because the team leaders were required to transfer their initial scenarios into Collario as the first step of the Collario exercise, it is easy to find out to what extent these two scenarios have been expanded. Table 5.7 summarizes the degree of expansion of the scenarios before and after using Collario.

Table 5.7 Degree of Expansion of the Scenarios before and after Using Collario

Parameter	Team	Before	After	% of Increase $\left(\frac{\#After-\#Before}{\#Before}\right)$
Word Counts	Red	682	2876*	322%
	Blue	305	1514*	396%
Number of Events	Red	16	48	200%
	Blue	7	46	557%

*: Because bolded words in Figure C.3 and Figure C.4 are not counted, these numbers might not be exactly same as the word counts of Figure C.3 and Figure C.4.

In Table 5.7, the word counts and the number of events are counted based on the contents in Figure C.1, C.2 (Before) and Figure C.3, C.4 (After).

A closer look at the scenarios both before and after using Collario indicates that additional detail has been inserted into the scenarios. Take the red team as an example, the final scenario covers many more issues such as emergency operation center (EOC), communication, search and rescue, decontamination, and criminal investigation. One member in the red team was an Amateur Radio Operator or Ham Radio Operator, and the

Communications Officer in their local Red Cross Chapter, managing everything related with communication in the chapter. This person contributed a lot of details about emergency communication into the final scenario.

Unlike the red team, whose team leader had prior working experiences in creating emergency scenarios and was able to structure their initial scenario pretty well, the blue team once had some trouble in figuring out how to create such a terrorist attack scenario. Their initial scenario was quite preliminary. For this team, Collario's aids were more critical to accomplish their team project. The example scenario provided in Collario helped them to understand what a practical emergency exercise scenario looked like. The structures and templates provided in the system guided the team members to weave the details into the scenario. Ultimately, this team was able to finish a scenario with good details.

In addition, along with improving the team scenarios, both teams created several stand-alone resources and events, as instructed. These resources and events can be found in Figure C.5 and Figure C.6 in Appendix C.

None of these stand-alone resources and events had been covered in the initial scenarios. These reusable records can only be created with the support of some sort of structures, such as that provided in Collario. However, while all of the subjects were able to create stand-alone resources pretty successfully, some of them had trouble understanding what should be stored as stand-alone events versus what should not. Adjustment to the system is still necessary.

5.5.2 Participation

There are two major categories of participatory activities in using Collario: self-initiated activities to contribute new items, and collaborative activities to help peers to improve their items. This section analyzes both categories of activities.

First, self-initiated contributing characteristics are revealed through the following two variables:

1. **Number of Elements Created** (NEC): Three categories of scenario elements are counted per subject:
   - NEC1 for scenario events
   - NEC2 for stand-alone events
   - NEC3 for and resources
2. **Word Counts of Created Elements** (WCCE): Same as NEC, three element types are counted:
   - WCCE1 for scenario events
   - WCCE2 for stand-alone events
   - WCCE3 for resources

NEC1s and WCCE1s are counted based on the scenario detail information stored in the SCENARIO_DETAIL table. NEC2s and WCCE2s are counted based on the event information stored in the EVENT table. NEC3s and WCCE3s are counted based on the resource information stored in the RESOURCE table.

Table 5.8 Individual Contribution Variables

Team	UID	NEC1	NEC2	NEC3	NEC Total	NEC (%)	WCCE 1	WCCE 2	WCCE 3	WCCE Total	WCCE (%)
Blue (N=6)	8	2	0	2	4	7.5%	110	0	56	166	5.7%
	12	10	0	2	12	22.6%	555	0	92	647	22.3%
	14	10	0	0	11	18.9%	655	0	0	655	22.6%
	16	8	0	0	8	15.1%	369	0	0	369	12.7%
	18	10	0	1	11	20.8%	596	0	39	635	21.9%
	20	6	1	1	8	15.1%	243	161	27	431	14.8%
	Total	**46**	**1**	**6**	**53**	**100%**	**2528**	**161**	**214**	**2903**	**100%**
	Average	7.67	0.17	1.00	8.83		421.33	26.83	35.67	483.83	
	SD	3.20	0.41	0.89	2.86		216.54	65.73	35.26	197.87	
Red (N=6, including 14#)	11	36	2	5	43	54.4%	2425	134	152	2711	50.6%
	13	0	0	0	0	0.0%	0	0	0	0	0.0%
	14 (Blue)	1			1	1.3%	35			35	0.7%
	15	6	0	0	6	50.0%	185	0	0	185	3.5%
	17	5	7	0	12	15.2%	742	992	0	1734	32.4%
	21	0	6	11	17	21.5%	0	323	365	688	12.9%
	Total	**48**	**15**	**16**	**79**	**100%**	**3387**	**1449**	**517**	**5353**	**100%**
	Average	8.00	3.00	3.20	13.17		564.50	289.80	103.40	892.17	
	SD	13.96	3.32	4.87	15.99		954.43	414.25	160.37	1103.57	
Total (N=11)	**Total**	**94**	**16**	**22**	**132**		**5880**	**1610**	**731**	**8221**	
	Average.	8.55	1.45	2.00	12.00		534.55	146.36	66.45	747.36	
	SD	9.89	2.58	3.35	11.24		679.84	299.44	110.27	794.99	

Keys: NEC1 (Number of Elements Created for Scenario Events) = 46(blue), 48(red), 94(total); NEC=53(blue), 79(red), 132(total);
WCCE1 (Word Counts of Created Elements for Scenario Events) =2528(blue), 3387(red), 5880(total);
WCCE2 (Events) =161(blue), 1449(red), 1610(total); WCCE3 (Resources) =214(blue), 517(red), 731(total); WCCE=2903(blue), 5353(red), 8221(total)

Using two bar charts, Figure 5.2 visualizes Numbers of Elements Created (NECs) and Word Counts for Created Elements (WCCEs) for the blue team:

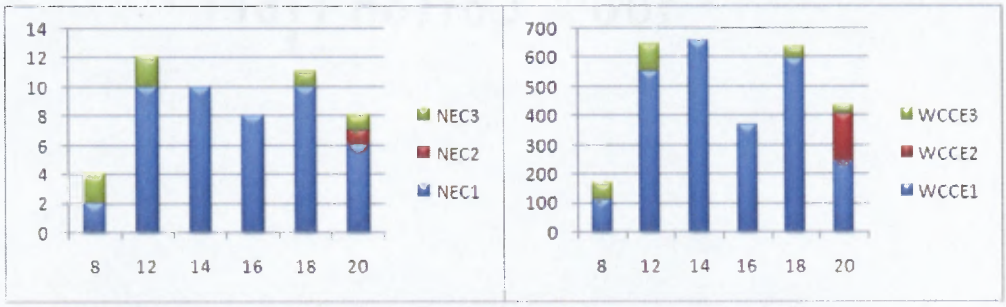

Figure 5.2 Visualization of individual contributions in the blue team.

Figure 5.3 visualizes NECs and WCCEs for the red team using the same method.

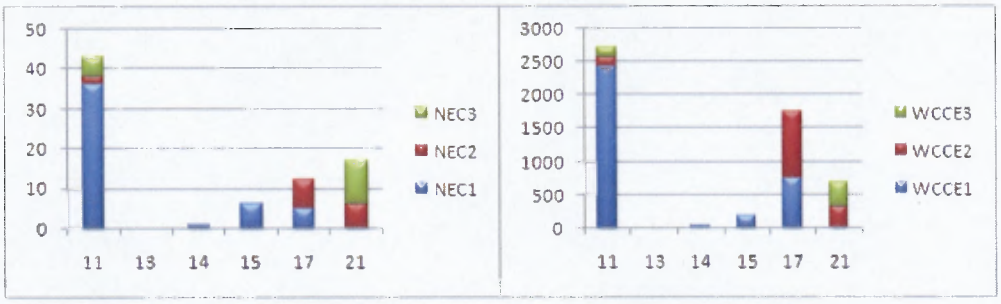

Figure 5.3 Visualization of individual contributions in the red team.

From both the descriptive statistics shown in Table 5.8, and Figures 5.2 and 5.3, it can be observed that contributions were more evenly distributed in the blue team than in the red team. The red team was more like a traditional FtF meeting, where a few people do most of the talking. The blue team indicated brainstorming active, where many people contribute to solve a problem. At the end of the trial, both participation styles were able to expand their scenarios significantly. This field trial demonstrated that Collario had the ability to support both execution modes.

Next, collaborative characteristics are revealed through another set of variables:

Number of Comments (NoC): NoC measures number of comments given by a subject. Collario supports two levels of comments. First, comments can be given in the record level through element lists. The number of record-level comments is represented as NoC1. Second, comments can also be given in the field level through review templates. Number of field-level comments is represented as NoC2. Details about the element lists and review templates can be found in Section 3.3 and Section 3.4. NoC is the sum of NoC1 and NoC2.

Number of Suggestions (NoS): NoS measures number of suggested alternatives to a data field by a subject. Collario supports suggestions through review templates, which can be found in Section 3.4.

Number of Fills (NoF): Collario allows non-privileged users (not a creator, not a team leader) to fill in values for empty fields. This activity is measured using NoF.

Number of Overrides (NoO): Collario gives team leaders special ability to override the contents created by others. NoO measures how many times team leaders execute this right. It reflects a special collaborative activity which is only applicable to team leaders.

Collario provides collaborative support such that to the user, giving a comment to a scenario event is no different than giving a comment to a resource. It is due to this reason that when counting these variables, all the element types are pooled together. The FEEDBACK table and the HISTORY_RECORD table are the data sources. Table 5.14 shows the results of these variables:

Table 5.9 Collaborative Activity Variables

Team	UID	NoC1	NoC2	NoC Total	NoS	NoF	Total	NoO
Blue (N=6)	8	0	0	0	0	0	0	
	12	4	0	4	0	0	4	
	14	3	1	4	0	0	4	
	16	0	0	0	0	0	0	
	18	11	1	12	1	0	13	56
	20	0	3	3	0	0	3	
	Total	18	5	23	1	0	24	56
	Average	3.0	0.8	3.8	0.2	0.0	4.0	
	SD	4.3	1.2	4.4	0.4	0.0	4.8	
Red (N=5)	11	9	0	9	0	0	9	3
	13	4	0	4	0	0	4	
	15	8	0	8	0	0	8	
	17	2	0	2	0	0	2	
	21	0	2	2	2	0	4	
	Total	23	2	25	2	0	27	3
	Average	4.6	0.4	5.0	0.4	0.0	5.4	
	SD	3.8	0.9	3.3	0.9	0.0	3.0	
Total (N=11)	Total	41	7	48	3	0	51	59
	Average.	3.7	0.6	4.4	0.3	0.0	4.6	
	SD	4.0	1.0	3.8	0.6	0.0	3.9	

Key: NoC1=18(blue), 23(red), 41(total); NoC Total = 23(blue), 25(red), 48(total)
Total =24(blue), 27(red), 51(total)

From Table 5.9, it can be seen that if leader overrides (NoO) were not counted, the majority of the collaborative activities of both teams fell in the category of record-level comments (NoC1). The blue team had in total 24 collaborative activities, out of which 18 (75%) were record-level comments. The red team had in total 27 collaborative activities, out of which 23 (85%) were record-level comments.

This is intriguing. In designing Collario, it was assumed that finer-grained feedback may help users to locate specific feedback more quickly. Users did take advantage of record-level comments, but largely ignored field-level comments and suggestions. It seems that there might be an optimal point where finer-grained feedback results in increased benefits. Exceeding that point, benefits to the users tend to flatten.

However, there could be another explanation, a lack of necessary Group Awareness (GA) support. The list views of the scenario elements, such as the scenario detail list view in Figure 3.1 and the scenario list view in Figure 3.4, show a number of comments to the records in the lists. In Collario, these list views are the entries to review templates showing the details of the scenario elements. When users see the lists and have something to add, they might choose rather to give comments initially. In contrast, record-level comments and suggestions are embedded in the review templates. There is no indication in the lists whether there are field-level comments or suggestions given to each item, nor is any indication of the number of feedback. As a result, users won't know in advance if they are going to find field-level feedback. Users might choose not to use these features, because even if they do, others might not know of those contributions. However, this field study didn't provide a way to identify the reason for the underutilization of these collaborative features. More studies will be needed to reach a conclusion.

Tables 5.13 and 5.14 also reveal the different leadership styles of the two team leaders. It seemed that the blue team leader didn't have much experience in creating terrorist attack scenarios. However, she was supportive and cooperative, encouraging her members to contribute their knowledge and insights. She also took the time to correct

grammar errors and supplement information to the contents created by other members. Towards the end of the project, she adjusted the occurring times of all the scenario events. Altogether, she made 56 modifications to the contents of her members. Because of her housekeeping work, the blue team scenario looked more consistent than the red team scenario.

On the contrary, the red team leader was a manager of the Emergency Preparedness department at a nuclear power plant and had extensive experience in nuclear emergency management. He was experienced with emergency scenario creation and scenario-based exercises. He was the most experienced person in the red team on the dirty bomb topic. Because of his extensive experience, he made a lot of contributions in creating their team scenario. However, on the other side, he did give some comments to help his members move on, but didn't attempt to make changes to others' contents. It can be seen that the occurring times in their final scenario were not consistent, which could only be achieved through the team leader. He was the only person on his team who could change others' content.

Record-level comments can be given to one of four recipients: scenario overviews, scenario details, stand-alone events, and stand-alone resources. Table 5.10 decomposes the distribution of these comments:

Table 5.10 Distribution of Record-Level Comments

Team	UID	NoC1: Total	NoC1: Scenario Overview	NoC1: Scenario Detail	NoC1: Event	NoC1: Resource
Blue (N=6)	8	0	0	0	0	0
	12	4	0	4	0	0
	14	3	0	3	0	0
	16	0	0	0	0	0
	18	11	2	9	0	0
	20	0	0	0	0	0
	Total	18	2	16	0	0
	Average	3.0	0.3	2.7	0.0	0.0
	SD	4.3	0.8	3.6	0.0	0.0
Red (N=5)	11	9	3	5	1	0
	13	4	0	4	0	0
	15	8	0	8	0	0
	17	2	0	2	0	0
	21	0	0	0	0	0
	Total	23	3	19	1	0
	Average	4.6	0.6	3.8	0.2	0.0
	SD	3.8	1.3	3.0	0.4	0.0
Total (N=11)	Total	41.0	5	35	1	0
	Average.	3.7	0.5	3.2	0.1	0.0
	SD	4.0	1.0	3.2	0.3	0.0

From this decomposition, it can be seen that the majority of the record-level comments were given to scenario details. The blue team had 18 record-level comments, out of which 16 (89%) were given to scenario details. The red team had 23 record-level comments, out of which 19 (82%) were given to scenario details.

There is one more interesting issue regarding participation, temporal distribution of participation. In practice, an FtF TTX hardly has any follow-up activity after the exercise is over except an exercise report normally written by the exercise administrator. This is not enough and part of the reason why in many occasions, the same problems reoccur. Exercises don't have to be face-to-face. They should not be constrained by time or duration. A good exercise should be on-going without a definite end point. A prolonged duration would give users more time to think about problems and solutions more thoroughly. This field trial showed that Collario has the potential to support on-going exercises. Figures 5.4 and 5.5 illustrate temporal distribution of the contributions in the two teams:

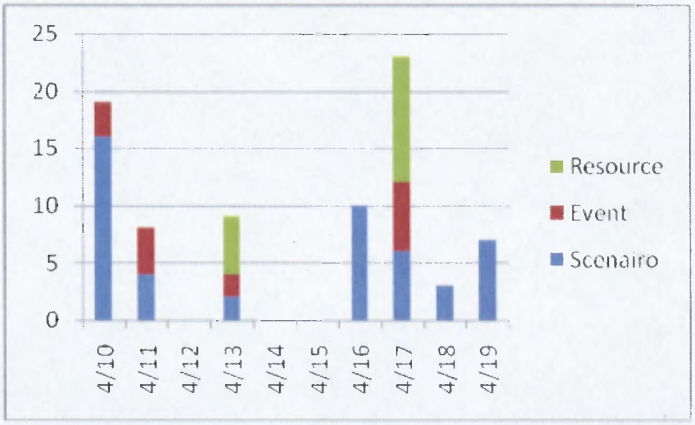

Figure 5.4 Visualization of temporal distribution of red team contributions.

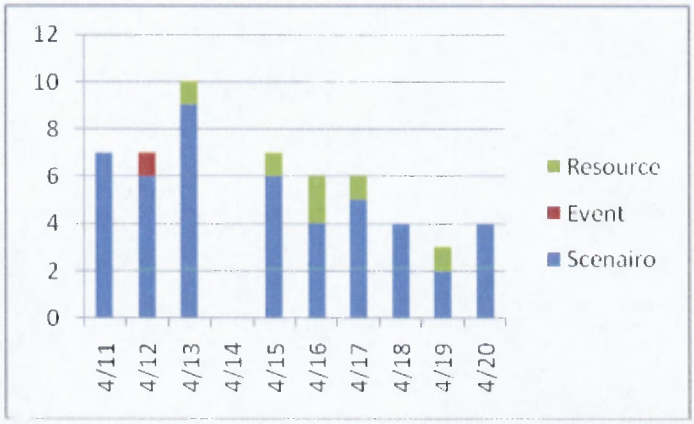

Figure 5.5 Visualization of temporal distribution of blue team contributions.

In Figures 5.4 and 5.5, the blue bars on the first day represent the initial scenarios loaded by the two team leaders. The remaining bars represent new scenario elements added afterwards by the leaders and other members. It can be seen that there were a good number of new contents added towards the end of the exercise. This result suggests that exercises could be conducted for an extended period of time. This can be important for identifying non-obvious problems and indirect solutions.

5.5.3 Analysis of the Comments

Figures C.7 and C.8 in Appendix C list the scenario creation and discussion details for both the red and blue team. This section looks deeper into the contents of the comments and attempts to discover how the discussions helped the two teams in improving their scenarios.

The discussions start with the red team scenario. The following findings about the red team were based on the transcripts in Figure C.7:

Comments #1, #2, and #3 were given to scenario event #5, "The initial 9-1-1 calls come into both Richmond and Columbia county 9-1-1 centers", initially created at 7:55am on April 10th by subject #11. At 20:18pm the same day, subject #14 asked two

questions in comment #3 "Has jurisdiction been established? Are both agencies responding or just one?" This comment raised important issues that seemed not to be covered in the original event, who would respond? Subject #11 answered the question that both would. If both of them would respond, then how would they coordinate their efforts? This was an implicit issue in the first comment. Subject #11 had not touched this part yet. On April 13th, subject #17 left a comment saying he had created Unified Command to the communication part. Through this thread, it can be seen that the discussion had been further developed with constructive new information.

Comment #4 was given by subject #18 to point out that a stand-alone event was also used in the other team's scenario. Reusability was one of the design objectives of the Collario system. This comment confirmed that this objective had been met.

Comment #5 was left by subject #15 on April 13rd about "When does the media find out about the emergency? Has the event been shown to the public by now?" This was obviously an important issue for a major terrorist attack emergency. Without getting any response, the commenter went on creating a new event for the scenario, the scenario event #16, and expanded this issue. It was observed that Collario provided multiple ways for users to raise their points. It is important to capture good ideas before they are lost.

Comment #6 suggested adding triage as part of the response actions. It was given by subject #14 on April 10th. No further discussions followed this comment. However, subject #17 added a scenario event to set up an on-scene triage on April 17th, probably inspired by this comment.

Comment #7 provided a situation assessment.

Comment #8, "Should we include a time when the EOC is activated?" given by subject #15 on April 18th to scenario event #15, suggested a missing part in the scenario. On the next day, April 19th, scenario event #14, "Both Richmond and Columbia county EOC's are activated", was added by subject #11. The temporal relationship between the comment and the event suggests that the creation of the event was caused by the comment.

Comment #9 given also subject #15 on April 18th, was about the necessity of Public Information Officer (PIO) to coordinate with the media which may have led to an important stand-alone resource. However, this did not occur.

Comment #10, another comment given by subject #15 on April 18th suggested the 4th Weapons of Mass Destruction – Civil Support Team, a new resource, would be called in for help. This could have been a very useful comment. However, no further actions were taken by the red team out of this comment. By examining the final stand-alone resource list, it can be seen that nobody seemed to pick up this comment and create a resource for the civil support team.

Comment #11 gave another situation assessment.

Comment #12 and #13 were given to scenario event #36. Comment #12, given by subject #15 on April 13rd, raised some questions "Where will the contamination take place? Should the triage center be set up here or should the Hazmat team arrive first?" These questions were answered by subject #11 on April 15th as in comment #12.

Comment #14, #15, and #16 were given to scenario event #40, "Reporters, family members, and other agencies are calling non-stop wanting information." This scenario event seemed ambiguous to subject #17, who left comment #16 on April 12nd asking

"What (should be who) are they calling?" and "What specific information are they looking for?" Following that, subject #15 gave comment #15 on April 13rd suggesting the need for a hotline for family members and others to find out information. Subject #13 gave comment #14 on April 15th assessing the situation. Comment #14 suggested news released being sent out within one hour after responders arriving on-scene and Information Center (IC) being set up. However, from the contents of the final scenario, it seems that no change has been made to the scenario based on these comments.

Next, the following findings about the blue team were based on the transcripts in Figure C.8:

Comment #1, #2, and #3 were given to scenario event #5, "Naperville Police Department arrives onscene (on scene). They begin scene assessment. A loud crowd has developed due to the explosion. Multiple victims are scattered all over the area." which was created by subject #14 on April 11st initially. Since this was still in the early stage of the scenario, subject #18 thought it was still too early to tell if this was a hazmat event or not and posted this thought in comment #3 one hour after the initial event was created. Following this idea, subject #16 added event #8 on April 13rd, which said EMS personnel and people in vicinity experienced adverse affects and responders advised all people out of the area. With event #8, it became clearer that this explosion was a hazmat event. Comment #2 and #3 agreed that the responders would take cautions in handling the event.

Comment #4 was given to scenario event #6 by subject #15 on April 18 near midnight. The comment raised a good point about preserving the area as a crime scene.

However, this comment was not further developed, probably because it was made too close to the submission deadline of the project.

Comment #5, #6, #7, and #8 were given to scenario event #8, which was just explained above. Comment #8 was first given by subject #18 around half an hour after the event was created. The comment thought this event was a good idea and suggested developing it further. However, this comment also asked if the EMS personnel would proceed without considering contamination. In comment #6 and #5, subjects #12 and #15 thought EMS personnel should go to the scene with precaution, based on their training and experience. However, comment #6 also pointed out that there was always a possibility of rushing in without thinking. These discussions helped to reach some common understanding between group members.

Following her own comment #8, subject #18 worked on improving the scenario event. Initially, the event was: "EMS personnel and by standards are experiencing adverse affects to their bodies in the immediate environment surrounding the explosion", without further expected actions. After several revisions, the final version became: "First EMS personnel to respond and bystanders in the immediate area are experiencing adverse affects, in particular, coughing, chest tightness, burning sensation in the nose, throat and eyes, nausea and vomitting (vomiting). The responders back out of the area and advise all people in the area to move out of the area. **Expected Action:** EMS recognizes the symptoms of chlorine exposure and pulls back to a cold zone until appropriate PPE can be delivered." It can be seen that not only the length but also the depth of the event has been improved.

Comment #9 and #10 were given to scenario event #10. Comment #10 asked for the definition of an acronym, "IDLH." Comment #9 gave the answer, "Immediately Dangerous to Life and Health."

Comments #11 through #15 were given to scenario even #15, "HAZMAT team arrives on scene and sets up zones. They suit up and begin testing for types of hazards." initially created by subject #12 on April 12nd. The initial event didn't include the resources for the testing, so subject #18 asked about the resources through comment #15. Subject #11, who created relevant resources for both teams, replied with the resources in comment #12 and #13. In comment #14, subject #12 asked if it was ok to use resources created by the other team. This was confirmed also by subject #11. Getting all the information, Subject #18 expressed her appreciation to subject #11 in comment #11.

Comments #16 through #18 were given to scenario event #25, "Local news media arrives on scene.", originally created by subject #12 on April 12nd. Subject #18 commented on the initial event (comment #18) on the next day that a Public Information Officer (PIO) should be appointed to ensure information consistency and accuracy. On April 15th, the creator, subject #12 left comment #17, "Good point, … (Name is deleted here.) beat me to it." A closer look at the next event (event #26), "The Emergency Manager contacts the public services officer and asks him to be in charge of media contact", created by the person mentioned in comment #17, might explain why subject #12 had this thought. In event #26, the need for Public Information Officer (PIO) was clearly addressed. Since comment #18 occurred before event #26 was created, it was also possible that event #26 was created because of comment #18. Further on, subject #15

suggested a press release might be useful in comment #16. This comment was not further developed.

The last comment, comment #19, was given by subject #18 to scenario event #31, which was also created by the same subject. This comment mentioned that the event reused a stand-alone event created by subject #21 of the other team.

From the above analyses, it can be seen that the comments given to the scenario events embedded a lot of insight to improve the scenarios and to make the discussion more in depth. On one hand, these comments raised and clarified issues, pointed out deficiencies, and suggested solutions. Some of the comments were successfully addressed and turned into new events and resources. On the other hand, some of the comments remained intact. Such a result has several implications: First, it confirmed the design method to provide fine-grained feedback not only helped users to locate relevant feedback more quickly, but also allowed people to leave feedback at the time of reading, which might have been lost otherwise.

Second, the intact, but potentially important comments, also called for a better design for leaving and viewing feedback. Currently, users cannot view feedback (comments and suggestions) in the context of the contents. For example, in the scenario detail page (Figure 3.1), to view comments given to the scenario events, users have to click on the comment hyperlinks, which brings them to a new screen where only comments are displayed. If users can view comments as a tooltip just by moving the mouse above the comment hyperlinks, they won't need to leave the current scenario event list to see the comments. Being able to dynamically insert comments into the events whenever they are desired would be an obvious improvement.

Third, although the general comment feature showed itself to be very effective even in a small team, there are clearly additions or augmentations needed, such as a quick endorsement of the importance level of a comment by others when they first see the comment as a new one. Merely checking a particular box would be easy and quick. Another option that would help would be to have the easy insertion of concise notification-type events that are coupled to existing events.

The general comment feature showed itself to be very effective even in a small team. However, there is no way to predict the specific incidents that caused comments and vice versa. It is also hard to provide a more accurate analysis about the effects of the comments.

Although this sub-section only analyzes the comments given to scenario events, the design improvement derived from the analysis is also applicable to all the record-level and field-level comments, as well as to suggestions and historical values, since the entrances to all these forms of collaborative support are the same: hyperlinks.

5.5.4 Subjective Opinions

This field study collects subject opinions towards using Collario through two approaches: post-survey questionnaires and user comments. Subjects could give comments in two ways. First, they could post their comments to the Blackboard. Second, in the post survey, open-ended questions were given in the end for subjects to give their opinions.

The post survey included questions to measure Performance Expectancy (PE) and Effort Expectancy (EE), Social Influences (SI), Motivations, Trust, and Leadership. This section focuses on usability (EE) and usefulness (PE). Other variables will be discussed in the next section.

The post survey uses four questions to measure Effort Expectancy (EE):

Q20: Using Collario, it is clear and understandable to interact with the group?

Q21: It is easy for a group to become skillful for using Collario?

Q22: It is easy to discuss scenarios asynchronously using Collario?

Q23: It is easy for me to learn to use Collario to discuss scenarios asynchronously?

In addition, the survey uses five questions to measure Performance Expectancy (PE):

Q15: Collario is useful for creating emergency scenarios?

Q16: Collario is useful to promote knowledge sharing and learning from peers?

Q17: Collario enables groups to create emergency scenarios more quickly?

Q18: Collario increase group collaboration and group wide understandings?

Q19: Collario increases the amount of group discussion about individual contributions?

All these questions are measured using semantic differential scales where 1 stands for strongly disagree and 7 stands for strongly agree.

The post survey was posted on-line on the last day of this trial. Nine out of eleven filled out and returned the survey. The following table shows the results of the survey for EE and PE measurements:

Table 5.11 Post Survey Results for Effort Expectancy (EE) and Performance Expectancy (PE)

Variable	Measurements	UID									Avg.	SD
		8	11	13	14	15	17	18	20	21		
EE	Q20: It is clear and understandable to interact with the group using Collario.	6	3	4	4	5	6	6	6	6	5.11	1.10
	Q21: It is easy to become skillful of Collario.	6	5	4	5	4	5	6	-	6	5.13	0.78
	Q22: It is easy to discuss scenarios asynchronously using Collario.	6	4	5	4	6	5	5	6	6	5.22	0.79
	Q23: It is easy to learn Collario.	6	4	7	5	5	6	7	6	6	5.78	0.92
PE	Q15: Collario is useful to create emergency scenarios.	6	4	7	7	7	6	7	6	5	6.11	0.99
	Q16: Collario is useful for knowledge sharing.	6	4	7	7	7	6	6	6	5	6.00	0.94
	Q17: Collario makes scenario creation quicker.	6	4	6	5	7	6	6	6	6	5.78	0.79
	Q18: Collario increase group collaboration.	6	5	6	5	6	6	6	5	6	5.67	0.47
	Q19: Collario increases the amount of group discussion.	6	5	6	5	5	6	5	7	5	5.56	0.68

1 = strongly disagree; 7 = strongly agree

Table 5.11 shows that in general the subjects gave positive Effort Expectancy (EE) and Performance Expectancy (PE) ratings. All the averages were above 5, with standard deviations equal to or less than 1.1. Some averages (Q15: useful for scenario creation, Q16: useful for knowledge sharing) were even equal to or larger than 6, with standard deviations less than 1. There was one respondent (#11), the Red Team Leader, whose ratings were generally "neutral," but the other eight respondents gave almost all positive ratings.

These positive ratings on Collario's usefulness and usability are reinforced with the subjects' comments, as well as the smoothness with which both teams managed to proceed with the scenario creation task. Subjects' comments are summarized in the next two sub-sections.

5.5.4.1 Comments on Collario Usability. Subjects gave comments on the usability issues of Collario both during and after the exercise.

On the second day of the exercise (April 10th), subject #11, the red team leader, posted the following message in their team forum to encourage red team members to join the exercise: "The software does not look that complicated and we should be fine after the team members step forward."

Soon, another red team member, #13, seconded the team leader's comment by commenting: "I am in the software is really easy just like the one i(I) posted but more in a(an) online setting. Let's get the party started."

Although the instruction asked the team leaders to load their initial scenarios into Collario within the first 3-5 days, both of them were able to finish this step on the first day they started working with this project in Collario. After that, both teams were able to

start discussing and improving their initial scenarios on their own. At one point, one red team member (#17) added new scenario events as stand-alone events, which made it necessary for the leader (#11) to insert the stand-alone events into the scenario. The researcher left a comment beside one of the stand-alone events informing #17 that every member could insert new events into the scenario. After that, #17 inserted events directly into the scenario. This is the only time the researcher needed to give specific instructions on how to work with Collario. Other than that, both teams figured out how to proceed with the project by themselves where users just depended on the on-line tutorials, trial-and-error, and peer support.

After finishing the exercise, a few subjects addressed Collario's usability in the post survey.

Subject #15 commented: "It is easy to use."

Subject #8 commented: "It is easy to work with."

5.5.4.2 Comments on Collario Usefulness. Subjects also gave comments on various usefulness issues about Collario both during and after the exercise.

First, Collario was design to facilitate collaborative scenario creation in VTs. For this aspect, User #22, who joined the exercise after it was over and hence was not included for data analysis, left a comment on the Blackboard: "This is a cool system. … It has been very useful in obtaining information and working with my fellow classmates."

In the post survey, one open-ended question asked the subjects about their opinion of the most useful function of Collario. Some answers gave insights about the usefulness of the system. For example:

User #15 commented: "The ability to view the various scenarios was useful in gaining various perspectives."

User #17 commented: "I liked the ability to see and edit my posts immediately upon making them to see how they will fit in with the rest of scenario."

User #18 commented: "The ability to produce an information flow is very useful. I particularly liked the ability to share resources and events from other scenarios and insert them into a new scenario as appropriate."

User #14 commented: "I liked the system overall. I mostly like the idea of other agencies being able to see the created scenarios and use them for their agencies. I think this will help smaller agencies to adapt scenarios that they have never been exposed to, to their community."

User #13 commented: "(For) a Table Top I feel like the fact that you can comment on the scenario helps."

User #8 commented: "Being able to work together as a team and provide input to each section (was the most useful feature.)"

User #21 commented: "The most useful feature was the ability to work off other person's input, something like a brainstorming session while creating the scenario."

Second, Collario was also designed to help emergency management professionals and students who had no experiences in scenario creation to easily learn how to do that by following the structures and learning from observing others' scenarios. User #17, who had not had any experience in creating scenarios, thought Collario helped him/her to create the first scenario. The subject commented: "Since I did not having much

experience in creating scenarios, the system allowed me to feel comfortable in creating what I did know through the informal manner of the system."

A third motivation for designing Collario was to stimulate knowledge sharing and management. Comments on this aspect were as follows:

User #15 commented: "It will provide good information for anyone in emergency management and is easy to use."

The same subject also commented on how the Collario exercise distinguished itself from other assignments: "This project was a nice change from traditional assignments. Also, while the group participation was a bit limited, our group leader took great initiative in organizing everything. Also, I would like to thank Xiang for his hard work and willingness to communicate. This was a true learning experience."

Last, but not least, according to TAM II (Venkatesh and Davis, 2000) and Cognitive Absorption (Agarwal and Karakanna, 2000), enjoyment is a great incentive to attract a user to use a new technology. For this aspect, user #15 commented: "I have found the system very interesting so far. Great work", before the subject gave a suggestion to improve the system.

Overall, many subjects in this trial were satisfied with their experiences and expressed their interests to see and use the final product. User #8 commented in the post-survey: "I thought this was a great experience and tool to use. I can't wait to see the final product! Great job Xiang!" User #18 commented in the post-survey: "I look forward to seeing and using the final product. Thank you for your contribution to Emergency Management!"

The value of Collario might be also revealed by a subject's comments before and after using Collario. From a comment left by the subject in the pre survey, the subject seemed like not a fan of team project: "I don't like the group school projects because it's hard to get everyone on board and usually one person ends up doing all the work. I like school projects just for me and then I know what is done and I get to do it!" The subject's opinion changed after the Collario project. In the post survey, the same subject wrote: "I will discuss it with colleagues because I believe it has the potential to be a useful tool for exercises and improvement from those exercises."

Furthermore, user #18 used a whole section to summarize the Collario experiences as a part in the final project. This summary was not a required part for the final project. In this summary, user #18 started by referring to Collario's three objectives expressed in the instruction given to them in the beginning of the exercise:

- To aid a group to work together to develop a complex scenario.
- To allow members to share their ideas and help improve the contributions of others
- To develop a database of components for scenarios so it becomes easier to evolve and improve existing scenarios.

The summary then said: "The web-based application proved useful in meeting all three objectives. The level of group interaction and communication increased significantly in this forum over what was previously achieved through Blackboard." The summary also admitted that the commitment level and experience level varied, some functions such as expected actions and resources, had not been used in the best way. Thus the full potential of the system might have not been realized. However, "Notwithstanding these limiting factors, overall satisfaction with the program was high

and several recommendations for enhancements were made and implemented." In conclusion, the summary believed Collario had potentials to be a useful tool for Emergency Preparedness exercises. "It is easy to see how, as the data base develops, standardized exercise components and resources will significantly reduce the time required to develop an exercise. Given the essential preparedness requirement for training and exercise, this application will become an important tool in preparing for terrorist attacks and other hazards." Also, the subject mentioned the interest to see Collario's future advancement. "I look forward to keeping abreast of the changes and development in this software application and thank Xiang Xao (Yao) for the opportunity to participate in this project and for his contribution to the field of Emergency Management."

5.5.5 Other Analyses

5.5.5.1 Why the Red Team Leader Gave Low Ratings? Uninterestingly, the red team leader (UID = 11) who contributed the most among all the subjects both in NEC and WCCE, gave almost all of the lowest ratings for both Performance Expectancy (PE) and Effort Expectancy (EE) measurements in the post survey. This result might reflect the fact that this subject contributed the most, therefore would have gotten the least support from peer members and felt some degree of dissatisfaction with the group as a whole. The red team chose to develop a dirty bomb attack scenario. The team leader was the only expert in this topic in this team. As a result, the team leader dominated the contributions for this team. There were much more information flowed from the leader to other members than vice versa, thus other members in the team felt more benefits than

the leader did. Not counting the leader, both the PE1 mean and the PE2 mean of the red team increase from 5.80 to 6.25.

5.5.5.2 Will the users be willing to use Collario? Why? Unlike the measurements used to study technology acceptance models (Davis, 1989; Venkatesh and Davis, 2000; Ventatesh et al., 2003), this field study didn't include any structured question to measure behavior intention to use Collario, because Collario was still an experimental system and still lacks quite a few necessary functionalities on the production level. Nevertheless, the post-survey did include an open-ended question (Q34) asking the subjects if they would recommend Collario to their colleagues. Our justification for this question is that as a Group Support System, Collario's contents need to be added by users. The more users will use Collario to create scenarios and scenario elements, the more knowledge will be recorded in Collario and the more value Collario will provide. Therefore, it is crucial for the success of Collario to be used by more people. Peer reference may be an effective approach to expose Collario to larger groups of potential users.

The answers to this open-ended question are very positive. Eight of the nine subjects who finished the post survey said they would recommend it. Only one subject didn't answer this question. The following lists the subjects' answers to this question.

15#: "Yes. It will provide good information for anyone in emergency management and is easy to use."

17#: "I would recommend the system to anyone who wanted an informal manner to create a scenario"

18#: "Absolutely I would recommend it. I can't wait until it is available to use at work. We will be developing tabletop exercises shortly and this tool would be invaluable

in terms of its readability, the time it saves. As always in a class there were differing levels of participation, commitment, and previous learning that made this project challenging. In a work setting I believe that would be different."

14#: "Yes, when I get into the field after graduating I will keep this program in mind to suggest to others."

20#: "yes it was very helpful"

13#: "I would if I was not working in the military. I have tried to enter the site at work and the filters keep blocking me."

8#: "I'm not in the field as of yet but as soon as I am I will suggest it. It is easy to work with and it can handle multiple users that may not necessarily get work together any other time."

21#: "Yes, I will discuss it with colleagues because I believe it has the potential to be a useful tool for exercises and improvement from those exercises."

5.5.6 System Improvement Suggestions

This field trial helped us collect a lot of useful feedback on how to improve the system. During the exercise, a forum was created on the Blackboard for the users to leave comments on system improvement. Some subjects also sent us emails for suggestions. In the post survey, there was one open-ended question (Q32) asking for the most confusing Collario feature and another (Q33) asking for suggestions and comments to improve the system. Both gave us good information. Table 5.12 summarizes the system improvement feedback received from this trial.

Table 5.12 System Improvement Suggestions from the First Field Trial

	System Improvement Suggestion	Source	Result
1	The system should let users to confirm the deletion operation, before actually deleting a scenario element.	Email	Solved
2	Team leaders should be allowed to edit all the entries of the team.	Blackboard	Solved
3	The system would better allow users to preview comments without entering another page to view them.	Blackboard	Recorded
4	When defining a new MSEL item, it would be convenient for the users to be able to see the previous MSEL item.	Blackboard	Recorded
5	The system would better provide a summary of all expected actions.	Post Survey	Recorded
6	Resources are not able to be added to events.	Blackboard	Recorded
7	It would be better to organize resources by response types.	Blackboard	Recorded
8	Some users were confused by the difference between the scenario event list and the event functions (stand-alone events)	Post Survey	Recorded
9	To be able to rearrange MSEL order by drag-n-drop would be very convenient for the team leader.	Post Survey	Recorded
10	One subject commented that it was difficult to create a chronicle timeline. Also, the subject was unable to attach specific resources to an event in the timeline.	Post Survey	Recorded

Some of the suggestions have been solved, while others have been recorded and will be addressed in the future iterations to evolve Collario.

5.6 Conclusion, Limitations and Discussion

The field study found that Collario was easy to learn and easy to use. The subjects were given tutorials and they learned how to use Collario to create and discuss scenarios quickly. No intervention from the researcher was needed for the exercise to move forward smoothly. The post survey showed an average Effort Expectancy score of 5.31, in a scale where 7 means least effort and 1 means most effort. Subjects' comments also revealed that they felt Collario was easy to use.

The field study also found that Collario was useful in supporting collaborative scenario creation, information exchange, and knowledge base build-up. After the 10-day exercise, both teams significantly increased the size of the original scenarios. The majority of the subjects contributed new information to the final scenarios. In general, the subjects were satisfied with their experiences in participating in the exercise to discuss and improve the scenarios using Collario. They felt that this exercise gave them an opportunity to learn a lot from their peer students. Best of all, their contributions were kept in the database and would not be lost after the exercise.

The major limitation of the first field study was the small sample size. In total, only eleven users joined the first field trial. Ten of them finished the pre survey and nine of them finished the post survey. With such a small sample size, no statistic analyses to test hypotheses have been conducted. The results from this field trial cannot be generalized to any other population.

Nevertheless, all the subjects of the first trial were working in or would be working in the Emergency Management field. They represented Collario's targeted user group very well. In addition, the exercise utilized a realistic type of task that the subjects

might have been and would be involved sometime in the future. As a result, the subjects' engagement in this field trial was very high. All these helped to guarantee the validity of the results.

Besides evaluating Collario's in its effort towards collaborative scenario creation, this field study also helped us to identify new problems and collect valuable feedback to improve the system. The problems and feedback will become inputs for future iterations to advance the development of the Collario system.

CHAPTER 6

CONTRIBUTIONS AND FUTURE WORK

This chapter discusses contributions and future work. Three aspects of contributions are considered: design contributions, contributions to the Emergency Management field, and contributions to the Information Systems field.

6.1 Design Contributions

The following is a summary of the design suggestions for collaborative scenario generation determined as a result of this study. The design suggestions are divided into three categories: knowledge structure, collaboration support, and group awareness support.

6.1.1 Knowledge Structure

Knowledge structure is the backbone of the Collario system. It determines what data can be processed and how they can be processed. Knowledge structure is also the foundation for providing deep collaboration support. From the literature review, this study identified 17 entities related to scenario creation. They are: Scenario, Theme, Constraint, Event, Notification, Situation, Potential Outcome, Parameter, Prerequisite, Resource, Resources Type, Alternatives Resource, Trigger, Assumption, Objective, Time, and Location.

In this research, three entities have been implemented: Scenario, Event, and Resource. Following normalization rules, the Scenario entity was further divided into two tables: SCENARIO_OVERVIEW and SCENARIO_DETAIL. The current knowledge structure can deal with descriptive information, but not numeric information. Because of these constraints, even though the field study obtained good results, the potentials of the knowledge structure are far from being fully realized. The author envisions that the following new structures and features would take Collario to the next level.

Notifications: Events are the centerpieces of emergency scenarios. The current Collario system provides great support for scenario events and stand-alone events. In the future, other types of events should also be included, such as notifications. Notifications are simplified events that can be best used as situation updates. They can also be useful for conducting exercises, in which notifications can be sent out automatically to the participants.

Resource Types: In the current design, all resources are in the same category. In the future, exercise types can be implemented to better organize the resources. The following resource types have been considered:

- Roles: Roles are human resources including expertise and experience.
- Equipment: Equipment includes all types of tools including weapons, vehicles, and machines.
- Financial Resources: Financial resources are all sorts of financial support.

Variables: Variables define the dimensions that describe a situation. Variables can be used to describe quantitative conditions, such as probabilities and losses. They can also be used to describe qualitative conditions, such as anxiety and fatigue statuses.

It is quantitative variables that make it possible to apply mathematical analysis methods such as Risk Analysis and Cross-Impact Analysis to the scenarios.

Situations: Situations are snapshots of the internal and external systems. Situations can be described using variables.

Triggers: Triggers are conditions that when satisfied would automatically lead to execution of certain events. Event triggers can be defined using variables on certain event occurrences.

Constraints: Constraints define upper or lower bounds for certain variables, e.g., number of resources available to the responders.

Although a collaborative scenario creation system might benefit from implementing more entities, the above six entities should have higher priorities. It is recommended to start from these entities.

6.1.2 Collaboration Support

In essence, Collario is a collaborative system. Thus, it has to provide support to stimulate team collaboration. Collario provides the following features to facilitate collaboration in scenario creation:

Anonymity and Penname: Hiding true identities might in some cases stimulate participants to discuss sensitive issues. Exercise administrators should be able to choose when to use pennames and when to use true identities.

Scenario Event List: The scenario event list is the place where users see the scenario details. It implements an Event Log metaphor and displays scenario events in a table structure. The scenario event list is ordered by sequence numbers. Hyperlinks to the comments on the scenario events are embedded into the scenario event list.

Entity Lists: Entity lists are the various list views that display the items of the scenario entities using a single list. These lists are on the first page displayed when users choose to browse items of a particular entity type. The lists contain hyperlinks to review entity details using entity review templates.

Entity Templates: Definition and review of entity details are achieved through entity templates. Two templates are provided for each entity type, a definition template is to create new records and a review template is to review the details. Both templates can be entered through entity lists.

Record-Level Comments: Record-level comments are the comments given to a whole record in any entity table. Since the entity records are displayed in scenario event lists and entities lists are rows, record-level comments are provided by embedding hyperlinks in these lists.

Field-Level Comments: Field-level comments are the comments given to a data field of any record in any entity table. They are attached with fields in the entity review templates.

Field-Level Suggestions: Field-level suggestions are another type of feedback which is attached to data fields provided in the review templates. Different than field-level comments, suggestions can be accepted by users with proper privileges.

Field-Level Historical Values: Collario can track all the historical changes of each data field. This function is useful to view how the values have been changed over time. Collario also provides a way for users with the appropriate privileges to restore a historical value.

Scenario Element Reusability: One important benefit from the implementation of a knowledge structure is the ability to reuse knowledge elements. Currently, reusability is supported through element lists and corresponding buttons. An improvement to the design would be to provide reusability through hyperlinks automatically added by analyzing the contents. This implicit way to provide reusability would be more flexible and intuitive.

Role Management: Ultimately, Collario should support the following five roles.

- Player: A player is a person who can create new scenario contents, as well as giving comments and suggestions, or filling in blank fields.
- Contributor: A contributor can only add comments or fill in blank fields of an item, but not create items.
- Observer: An observer can only observe but not add materials.
- Team Leader: A team leader is a super player who can override others' contents.
- System Administrator: A System Administrator has the Team Leader's privileges for all the teams. In addition, a System Administrator can create new users and assign roles.

The theoretical foundation for the design of Collario comes from the cognitive theories, which posit that humans only have limited cognitive resources to process information. In team settings, such limited cognitive resources need to be allocated among competing cognitive activities of information accessing, deliberation, and communication (Briggs, 1994). So, it is critical for the group support systems to help users find information they need at the time they want. Finer-grained knowledge elements and finer-grained feedback can also help users to access information easier and quicker.

In the user information design, this design requirement should also be followed. Currently, to review feedback, users have to click a hyperlink button and enter a page separate from the contents the feedback is given to. This requires extra operations and more memory for users to leave and view feedback. An improvement to the design will be to allow users to give and view feedback in the context of the contents. AJAX (Asynchronous JavaScript and XML), a new web development technology, can help to make this improvement.

6.1.3 Group Awareness Support

For a group of people to work together effectively, it is very important for them to establish group awareness. The Collario system provides multiple ways to help users establish group awareness.

Membership List: Membership list shows for each member how many items each person created, how many comments they made, and how many fill-ins they did. This will help encourage more equal participation and has been demonstrated in earlier collaborative systems. Clicking on what a person has created should show them all in a list to help promote social influence.

Entity Statistics: Numbers of scenarios, stand-alone events, and stand-alone resources are provided in Collario through the summary panel. The number of scenario events in a scenario is displayed above the scenario event list.

New Activities: It is important for the users to know when a new item has been added and where. In Collario, whenever a new item is added to an entity type, a red mark will be placed in the summary panel beside the entity type. In the scenario detail page, the number of new scenario events is displayed above the scenario event list in red.

Collario also allows users to mark the selected items as read, and then the red marks will disappear.

Feedback Statistics: The numbers of record- and field-level feedback are embedded in the hyperlinks through which the feedback details can be viewed.

Although the following functions have not been included in the current Collario system, these functions might be very useful.

Search Items: Another useful but not yet implemented function is a search function, which would enable a user to locate information quickly.

6.1.4 Data Analysis

After scenario-related data, both textual and numeric, will be collected through collaborative scenario creation, simulation, visualization techniques, and data mining, will then be applied to extract knowledge and insights out of the data. For example:

Simulation: If quantitative variables like probabilities and quantities of lost can be ultimately supported by Collario, simulations would be possible to estimate the losses and damages. This can be useful to compare different responses and find out the best one.

Visualization: Although Collario employs the Event Log metaphor to implement the scenario event list, it is possible to present the scenarios using other visualization approaches for different purposes. For example, the Bow-Tie diagram might be a preferred visualization approach to demonstrate cause-effect relationship. The Timeline Graph might be favorable to illustrate temporal relationship.

Once enough scenarios and scenario-related data will be collected, various data mining technologies such as classification and outlier detection might be applicable. For example:

Classification: Many applications can be rooted from classification of emergency scenarios. For example, similar scenarios can be retrieved based on classification. With a knowledge structure integrated, design of scenario classification algorithms might be easier and the results might be more accurate.

Exception (Outlier) Detection: Suppose an exercise scenario is played by several groups, it is then possible to detect exceptions in the responses for some groups. For example, if most of the groups execute a certain response after a particular offense, it would be reasonable that this response is an optimal one. If one group doesn't mention it, this group might be an exception.

6.1.5 System Integration

In this research, Collario has been used for multiple purposes. For the protocol analysis, Collario was used to support a scenario-based exercise. For the field study, Collario was used to support collaborative scenario creation. Collario has been designed to be able to support both activities, thus it is possible to translate an emergency scenario created by a group of people to a scenario-based on-line tabletop exercise used by another group. Although this function has not been implemented yet in Collario, it would not be too difficult to do.

In the long term, after quantitative information is supported, the Collario system should be able to execute scenarios automatically, both for the defense and for the

offense. Such an automatic execution capability can be used to stress test plans, training responders, and conduct system risk analysis.

6.2 Contributions to the Emergency Management Field

For the Emergency Management field, this dissertation provides an easily accessible web application to support collaborative scenario creation and discussion in virtual teams. Several potential application areas might benefit from this system.

First, Collario appears to have the potential to create high-quality exercise scenarios that will require further evaluation subsequent to actual exercise use. Creating high-quality exercise scenarios has been the most challenging part of conducting emergency preparedness exercises. As our society is getting more and more complex and interconnected, emergencies and disasters had become both more extreme and more unique or "creative", which requires emergency preparedness to be equally "creative" in planning, mitigation, and response. Collario allows exercise builders to create emergency scenarios over a long period of time and with insightful minds from wherever they may be. It also allows exercise builders to play with different configurations to find out the most relevant deviations from the primary expectations. All these would help exercise administrators to create better exercise scenarios.

Second, Collario can help exercise administrators conduct scenario-based exercises on an on-going basis. Without the need to gather all the participants at the same location and time for an exercise, exercise administrators can use Collario to launch an exercise whenever it is necessary with anyone they want, as long as they have a connection to the Internet. Such flexibility not only lowers costs and overhead as

normally occur in traditional FtF exercises, but also makes it possible to continuously monitor and review emergency plans. In an era with change being the most prominent characteristic, this capability is crucial, because changes of the circumstances would nullify the foundations and assumptions of the plans quickly.

Third, Collario can create an environment that stimulates information exchange and knowledge sharing. The knowledge management community has found that implicit knowledge is the kind of knowledge that is the most difficult to share (Nonaka, and Takeuchi, 1995). To share implicit knowledge, it needs to be externalized and communicated (Kolb, 1984). However, some implicit knowledge, such as how to deal with uncertainties under dynamic environments, might not be communicated effectively as a reflection after the fact. This is why Experience-Based Learning (EBL) is important in training emergency responders. However, in reality, such opportunities are limited because of availability. Collario provides an easy solution to recreate complex emergency situations that may not be easily accessible otherwise.

Fourth, Collario can become a knowledge creation and refinement platform. Collario builds in a scenario knowledge structure, based on which different users would be able to contribute different knowledge such as resources and events, even though they might not know the whole scenario. The knowledge structure is such that knowledge can be reused by other people to create other scenarios. Efforts to create new scenarios would be reduced over time. Collario doesn't stop here. It also provides deep collaboration support for the users to refine the contents of the knowledge. Altogether, Collario has the potential to become a knowledge creation and refinement platform for Emergency Management. There was no opportunity in this dissertation effort to

demonstrate the benefit of being able to ask very different groups of professionals to contribute to the same scenarios at different times. Recently there has been an evolving set of capabilities for direct community involvement in emergencies but one will note in these scenarios created by a class in Emergency Management there was nothing significant put in about how community involvement might have modified either the blue or red scenario. It is hoped the use of a system like this will allow very different professional communities to collaborate about the same problem.

Finally, it is quite clear that scenarios are used in executive level planning in organizations as a common planning tool. There is nothing in the software that inhibits Collario from being used for normal activities in any type of organizational planning. However, this application has not been explicitly explored in this research.

6.3 Contributions to the Information Systems Field

In addition, this dissertation also contributes to the Information Systems field in several ways. First, this dissertation is a successful example of conducting design science research as a Ph.D. dissertation. Although the Information Systems field has called loudly for design science research in recent years, only a very small portion of IS research has been seen targeted to develop innovative information systems. This dissertation proves that this is doable as a Ph.D. dissertation. However, the Ph.D. candidate believes that there are several important things to be considered before deciding to take this direction:

Technical Background: Sound technical background in Information Systems design and development is critical. Otherwise, it might take a much longer time, or might

not be finished at all. Also, Information Technologies are moving forward quickly. It is necessary to survey the newest technologies, since they might make some of the development work much easier.

Choosing the Problem Carefully: To conduct design science research can be a huge investment, which might take a long time before its benefits are realized. It would be a disaster after all the years of hard work, you finally find that the problem is not a problem, or there have already been more advanced solutions. Therefore, a comprehensive literature review is important in the early stage. Besides, be aware that some technologies might not be recorded in the literature, so talks with domain experts can be very useful.

User-Centered Design, not Technology-Centered: It is important to remember that the objective of design science research is to develop new artifacts that users are willing to use. This is different than research in other fields like Computer Science, where objective measurements are available to determine the success of a new algorithm. For the success of design science research, understanding potential users' needs is the first step. Taking this dissertation as an example, the turning point was when the Ph.D. candidate was sent to a large-scale face-to-face tabletop exercise hosted at the New Jersey Institute of Technology (NJIT) by one of his co-advisors. After that, the advisor also sent the Ph.D. candidate to three other face-to-face tabletop exercises. From observing these exercises, it became clearer what was missing and what was needed by practitioners. Without observing these exercises, finishing this dissertation would not have been possible.

Another thing that this dissertation contributes to the Information Systems field is that it realizes a new way of collaboration, called Knowledge Structure Based Collaboration. Currently, many collaboration systems like wiki and Blackboard don't have deep collaboration support. As a result, not many ways are provided to users for joint content development. By employing a Feedback table, this dissertation introduces an easy approach to provide much finer grained capabilities for a group of people to jointly work on a group task. Furthermore, this approach can be easily adapted by any existing collaboration system, as long as they use databases to store the data.

Retrospectively, the author views the processes of this dissertation following the design science paradigm as both challenging and enjoyable. It brought great pleasure to the researcher when the subjects told him that the system would be very useful for them and that they would be looking forwarding to seeing and using the final product. When hearing such comments, the researcher felt that all the hard work has paid off.

6.4 Future Work

In the future, the author plans to extend this research in several ways. Some of the efforts have actually been underway already. First, it is planned to recruit more subjects from the Emergency Management community to use Collario. As pointed out in the previous chapter, the major limitation of this dissertation is the small sample size in the field study. By recruiting more subjects, the results will be more reliable and generalizable.

Second, several insufficiencies in the measurements have been identified and are planned to be fixed in the future studies. One important variable that should have been measured is scenario quality. Questionnaires to measure perceived quality improvement

should be added in the post survey. Expert judges should also be used to judge the quality of the scenarios before and after using Collario.

Third, another interesting and important future research direction is to conduct asynchronous scenario-based exercises in large virtual groups using Collario.

Fourth, it is also planned to improve the system continuously. The current iteration of system development and evaluation is the end of this dissertation, not Collario. From this dissertation, a lot of suggestions and comments on how to improve Collario have been collected. These suggestions and comments will be integrated into Collario gradually in the future. Opening Collario for Open Source development communities such as Sahana has also been discussed and is surely the right direction to pursue.

Fifth, the research team is planning to help local emergency management communities create exercise scenarios and conduct on-line exercises based on Collario. Local communities, such as local voluntary groups and human services agencies, are the first-line emergency responders. Such groups are in need of convenient and effective ways to provide training to their members, and to facilitate sharing experiences among members. It is hoped that Collario will be a useful tool for them.

Last but not least, the research team is also planning to apply the design methodology for deep collaboration support to other types of collaborative work and other collaborative systems. For example, in Software Engineering, scenarios can be used to describe system requirements. In an era of IT outsourcing, users and developers might not be in the same city, or even not in the same country. A system like Collario might help end users and developers communicate system requirements more effectively.

Besides, the design methodology to build deep collaboration support upon knowledge structures can be used to develop other collaborative systems. In this dissertation, the knowledge structure was hardcoded. In the future, ideally, users will have the ability to define knowledge structures and an interpreter can automatically create deep collaboration support based on the knowledge structures. This is another direction that the research team would like to explore.

APPENDIX A

COLLARIO DATABASE DESIGN DETAILS

Entity-Relationship (ER) diagrams to model the data used by Collario are introduced in Section 3.2. This appendix supplements the ER diagrams with more details.

A.1 Tables for Scenario Elements

Five tables have been designed to model scenario data. They are SCENARIO_OVERVIEW, SCENARIO_DETAIL, EVENT, RESOURCE, and EVENT_RESOURCE. The following list summarizes table structures for these five tables, with primary keys underlined and foreign keys in italic fonts. Details of the table structures are provided in the next several sections.

- **SCENARIO_OVERVIEW**(ScenarioID, ScenarioName, ScenarioDesc, Objective, *Creator*, CreateTime, *Modifier*, LastModified, IsDeleted)
- **SCENARIO_DETAIL**(ScenarioDetailID, *ScenarioID*, SequenceID, MSELID, OccurringTime, EventID, EventName, EventDesc, Response, *Creator*, CreateTime, *Modifier*, LastModified, IsDeleted)
- **EVENT**(EventID, EventName, EventDesc, Response, *Creator*, CreateTime, *Modifier*, LastModified, IsDeleted)
- **RESOURCE**(ResourceID, ResourceName, ResourceDesc, Usage, *Creator*, CreateTime, *Modifier*, LastModified, IsDeleted)
- **EVENT_RESOURCE**(EventID, ResourceID, *Creator*, CreateTime, *Modifier*, LastModified, IsDeleted)

A.1.1 SCENARIO_OVERVIEW

The SCENARIO_OVERVIEW table contains summary information about all the scenarios. Table A.1 illustrates the structure of the SCENARIO_OVERVIEW table.

Table A.1 Structure of the SCENARIO_OVERVIEW Table

Field Name	Type	Note
ScenarioID	Integer (PK)	Unique identifier of a scenario
ScenarioName	Varchar(200)	Name of the scenario
ScenarioDesc	Varchar(2000)	Description of the scenario
Objective	Varchar(2000)	Objective of the scenario
Creator	Integer	Creator of the scenario
CreateTime	DateTime	Time the scenario is created
Modifier	Integer	The last person who changes or deletes this scenario
LastModified	DateTime	The last time when this scenario is changed or deleted
IsDeleted	Boolean	A flag indicating whether the scenario is deleted or not

A.1.2 SCENARIO_DETAIL

The SCENARIO_DETAIL table contains detailed information about each scenario. Table A.2 illustrates the structure of the SCENARIO_DETAIL table.

Table A.2 Structure of the SCENARIO_ DETAIL Table

Field Name	Type	Note
ScenarioDetailID	Integer (PK)	Unique identifier of a scenario event or response
ScenarioID	Integer (FK)	Unique identifier of a SCENARIO_OVERVIEW record representing a scenario
SequenceID	Integer	Sequential number of a scenario event or response
MSELID	Integer	Master Scenario Event List (MSEL) number
OccurringTime	Varchar(30)	The occurring time of a scenario event or response
EventID	Integer (FK)	Unique identifier of an EVENT record, referring to the EVENT table
EventName	Varchar(200)	Name of the scenario event
EventDesc	Varchar(2000)	Descriptions of a scenario event
Response	Varchar(2000)	Descriptions of a scenario response or an expected response
Creator	Integer	Creator of the scenario event
CreateTime	DateTime	Create time of the scenario event
Modifier	Integer	The last person who changes or deletes this scenario event
LastModified	DateTime	The last time when this scenario event is changed or deleted
IsDeleted	Boolean	A flag indicating whether the scenario event is deleted or not

A.1.3 EVENT

The EVENT table contains information about the details of all the stand-alone events. A stand-alone event can be reused to create new scenario events. Table A.3 illustrates the structure of the EVENT table.

Table A.3 Structure of the EVENT Table

Field Name	Type	Note
EventID	Integer (PK)	Unique identifier of an event
EventName	Varchar(200)	Name of the event
EventDesc	Varchar(2000)	Detailed description of the event
Response	Varchar(2000)	Expected response for the event
Creator	Integer	Creator of the event
CreateTime	DateTime	Create time of the event
Modifier	Integer	The last person who changes or deletes this event
LastModified	DateTime	The last time when this event is changed or deleted
IsDeleted	Boolean	A flag indicating whether the event is deleted or not

A.1.4 RESOURCE:

The RESOURCE table contains information about the details of all the stand-alone resources. A stand-alone resource can be reused to create new stand-alone events or new scenario events. Table A.4 illustrates the structure of the RESOURCE table.

Table A.4 Structure of the RESOURCE Table

Field Name	Type	Note
ResourceID	Integer (PK)	Unique identifier of a resource
ResourceName	Varchar(200)	Name of the resource
ResourceDesc	Varchar(2000)	Detailed descriptions of the resource
Usage	Varchar(2000)	Usages of the resource
Creator	Integer	Creator of the resource
CreateTime	DateTime	Create time of the resource
Modifier	Integer	The last person who changes or deletes this resource
LastModified	DateTime	The last time when this resource is changed or deleted
IsDeleted	Boolean	A flag indicating whether the resource is deleted or not

A.1.5 EVENT_RESOURCE:

The EVENT_RESOURCE table contains information regarding which resources are attached with which events. Table A.5 illustrates the structure of the EVENT_RESOURCE table.

Table A.5 Structure of the EVENT_RESOURCE Table

Field Name	Type	Note
EventID	Integer (PK, FK)	Unique identifier of an event, referring to the EVENT table
ResourceID	Integer (PK, FK)	Unique identifier of a resource, referring to the RESOURCE table
Creator	Integer	Creator of the event resource
CreateTime	DateTime	Create time of the event resource
Modifier	Integer	The last person who changes or deletes this event resource
LastModified	DateTime	The last time when this event resource is changed or deleted
IsDeleted	Boolean	A flag indicating whether the event resource is deleted or not

A.2 Tables for Collaboration Support

As explained in Section 3.5, there are five tables designed in Collario to provide collaboration support. They are: FEEDBACK, FEEDBACK_TYPE, ENTITY, ENTITY_FIELD, and HISTORY_RECORD:

- **FEEDBACK**(FeedbackID, *FeedbackTypeID*, *TableID*, Content, RecordID, *FieldID*, *Contributor*, ContributeTime)
- **FEEDBACK_TYPE**(FeedbackTypeID, FeedbackTypeDesc)
- **ENTITY**(TableID, TableName)
- **ENTITY_FIELD**(TableID, FieldID, FieldName)
- **HISTORY_RECORD**(TrackingID, *TableID*, RecordID, *FieldID*, FieldValue, *Contributor*, ContributeTime)

A.2.1 FEEDBACK

The FEEDBACK table stores feedback contents. It utilizes table identifier, field identifier, and record identifier to locate the table record or the record field to which a feedback is given, and feedback type identifier to distinguish feedback type. Identifiers for tables, fields, and feedback types are stored in auxiliary dictionary tables: ENTITY, ENTITY_FIELD, and FEEDBACK_TYPE, which will be introduced later in this appendix. Record identifiers are the unique identifiers of the corresponding scenario element tables.

Table A.6 shows the structure of the FEEDBACK table.

Table A.6 Structure of the FEEDBACK Table

Field Name	Type	Note
FeedbackID	Integer (PK)	Unique identifier of a feedback
FeedbackTypeID	Integer (FK)	Unique identifier of a feedback type, referring to the FEEDBACK_TYPE table
TableID	Integer (FK)	Unique identifier of a scenario element table, referring to the ENTITY table
Content	Varchar(2000)	The content of a feedback
RecordID	Integer	Unique identifier of the corresponding scenario element table
FieldID	Integer (FK)	Unique identifier of the table field the feedback is given to, referring to the ENTITY_FIELD table
Contributor	Integer	Contributor of the feedback
ContributeTime	DateTime	Contributing time of the feedback

A.2.2 FEEDBACK_TYPE

The FEEDBACK_TYPE table is a dictionary table containing feedback types. Its structure is shown in Table A.7.

Table A.7 Structure of the FEEDBACK_TYPE Table

Field Name	Type	Note
FeedbackTypeID	Integer (PK)	Unique identifier of a feedback type
FeedbackTypeDesc	Varchar(100)	The description of a feedback type

In Collario, the FEEDBACK_TYPE table is populated with pre-defined values. The values are shown in Table A.8.

Table A.8 Values of the FEEDBACK_TYPE Table

FeedbackTypeID	FeedbackTypeDesc
1	Comment
2	Suggestion

A.2.3 ENTITY

The ENTITY table is a dictionary table containing the mapping information of the table identifiers and the scenario element tables. The structure of the ENTITY table is shown in Table A.9.

Table A.9 Structure of the ENTITY Table

Field Name	Type	Note
TableID	Integer (PK)	Unique identifier of a scenario element table
TableName	Varchar(100)	The name of the table

Like the FEEDBACK_TYPE table, the ENTITY table is pre-populated. Values of the ENTITY table are shown in Table A.10.

Table A.10 Values of the ENTITY Table

Table ID	Table Name
1	RESOURCE
2	EVENT
3	VARIABLE (not used)
4	SCENARIO_OVERVIEW
5	SCENARIO_DETAIL

A.2.4 ENTITY_FIELD

The ENTITY_FIELD table is a dictionary table containing the mapping information of the field identifiers and the table fields. Structure of the ENTITY_FIELD table is shown in Table A.11.

Table A.11 Structure of the ENTITY_FIELD Table

Field Name	Type	Note
TableID	Integer (PK)	Unique identifier of a scenario element table
FieldID	Integer (PK)	Unique identifier representing a table field
FieldName	Varchar(100)	The name of the table field

Like the FEEDBACK_TYPE and the ENTITY tables, the ENTITY_FIELD table is pre-populated. Values of the ENTITY_FIELD table are shown in Table A.12.

Table A.12 Values of the ENTITY_FIELD Table

Table ID	Field ID	Field Name
1	1	Resource Name
1	2	Resource Description
1	3	Resource Usage
1	4	Resource Record
2	1	Event Name
2	2	Event Description
2	3	Event Objective
2	4	Event Resource
2	5	Expected Response
2	6	Event Record
4	1	Scenario Name
4	2	Scenario Description
4	3	Scenario Objective
4	4	Scenario Sequence
4	5	Scenario Element
4	6	Scenario Record
5	1	Occurring Time
5	2	Scenario Event Description
5	3	Scenario Situation
5	4	Expected Response
5	5	Scenario Detail Record

A.2.5 HISTORY_RECORD

The HISTORY_RECORD table keeps all the changes made to all data fields. Like the FEEDBACK table, the HISTORY_RECORD table utilizes the dictionary tables like ENTITY and ENTITY_FIELD to uniquely identify the data field that historical values are attached to. The structure of the HISTORY_RECORD table is shown in Table A.13.

Table A.13 Structure of the HISTORY_RECORD Table

Field Name	Type	Note
TrackingID	Integer (PK)	Unique identifier of a historical value
TableID	Integer (FK)	Unique identifier of a scenario element table, referring to the ENTITY table
RecordID	Integer	Unique identifier of the corresponding scenario element table
FieldID	Integer (FK)	Unique identifier of the table field the feedback is given to, referring to the ENTITY_FIELD table
FieldValue	Varchar(2000)	The "old" value of the data field
Contributor	Integer (FK)	Contributor who makes the change
ContributeTime	DateTime	The date/time when the change is made

APPENDIX B

COLLARIO TUTORIALS

This appendix includes the tutorials provided to subjects attending the field trial to help them learn the Collario system. The tutorials explain Collario's key concepts first and then walk the users through its major operations. Collario can be access through http://www.collario.org. Anybody interested in Collario can contact its creator, Xiang Yao (xiang.yao@gmail.com) for further information.

B.1 Key Collario Concepts

Three key concepts are used in Collario to create emergency/disaster scenarios. They are resource, event, and scenario. In Collario, they are defined as:

- **Resources**: Resources are roles, equipment, tools, and financial resources to realize attacks (man-made or natural) and/or to launch defenses.
- **Events**: Events are offensive and defensive activities. Offensive events can be any activity that might lead to or facilitate a disastrous outcome. Defensive events can be any activity that might be executed to respond to any potential disastrous outcome.
- **Scenarios**: Scenarios are a series of events to describe an emergency/disaster.

Collario supports users to create elements for these concepts using textual descriptions. Quantitative information such as probabilities and losses has not been implemented yet, but is possible in the future. In the remaining parts of this document, the term component (or scenario component) refers to an element of any concept above. Collario allows users to create and discuss scenario components.

B.2 Tutorials for Collario

Collario's operations can be divided into the three key scenario element types (scenario, event, resource). The operations are summarized in table B.1.

Table B.1 Summary of Collario's Operations

	Scenario	**Event**	**Resource**
The following 5 operations apply to a component as a whole			
New	X (Tutorial 1)	X	X
Browse	X (Tutorial 2)	X	X
Mark Read	X (Tutorial 3)	X	X
Comment	X (Tutorial 4)	X	X
Delete	X (Tutorial 5)	X	X
The following 4 reviewing operations apply to data fields inside a component.			
Update	X (Tutorial 6)	X	X
Comment	X (Tutorial 7)	X	X
Suggestions	X (Tutorial 8)	X	X
Historical Values	X (Tutorial 9)	X	X
The following 3 operations only apply to scenarios			
Add Events (to a scenario)	X (Tutorial 10)	N/A	N/A
Browse Scenario Event List (in a scenario)	X (Tutorial 11)	N/A	N/A
Review a Scenario Event (in a scenario)	X (Tutorial 12)	N/A	N/A

In Table B.1, X means the operation is provided in Collario. This set of tutorials only covers the operations for scenarios. However, because of the similarity of the operations across different scenario element types, it would not be difficult for the users to figure out the remaining operations by referring to the scenario operations.

B.2.1 Tutorial 1, Add a New Scenario

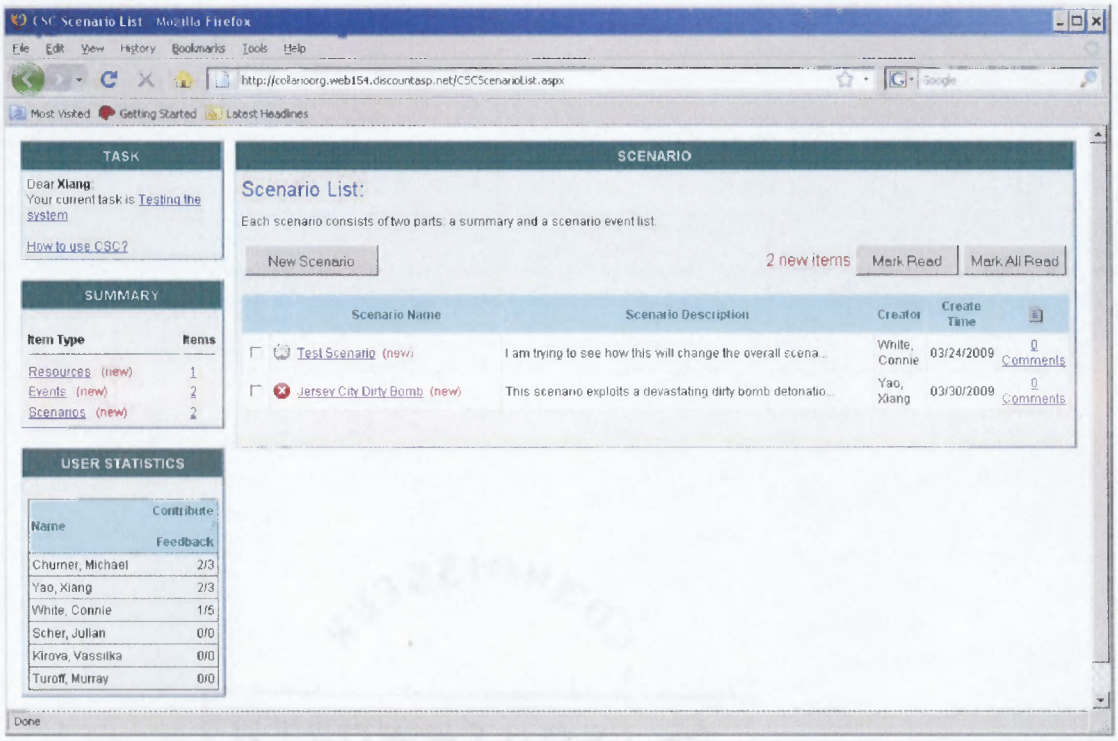

Figure B.1 Screenshot for adding a new scenario.

The following lists the steps to add a new scenario:

1. If you are not in the above page, press the "Scenarios" link in the "SUMMARY" pane.
2. Press "New Scenario" button.
3. In the next page, input the following information:
   a. In the field of Scenario Name, input "[a location] Dirty Bomb Attack"
   b. In the field of Description, input "This is a dirty bomb attack scenario that occurred in [a location] around [time] on [a future date]."
   c. In the field of Objective, input "We are seeking to identify as many potential after-attack events as possible, so that they can be used to test existing emergency plans or train emergency responders."
4. Click "Add Scenario" button. You will see the new scenario added to the scenario list.

B.2.2 Tutorial 2, Browse Scenarios

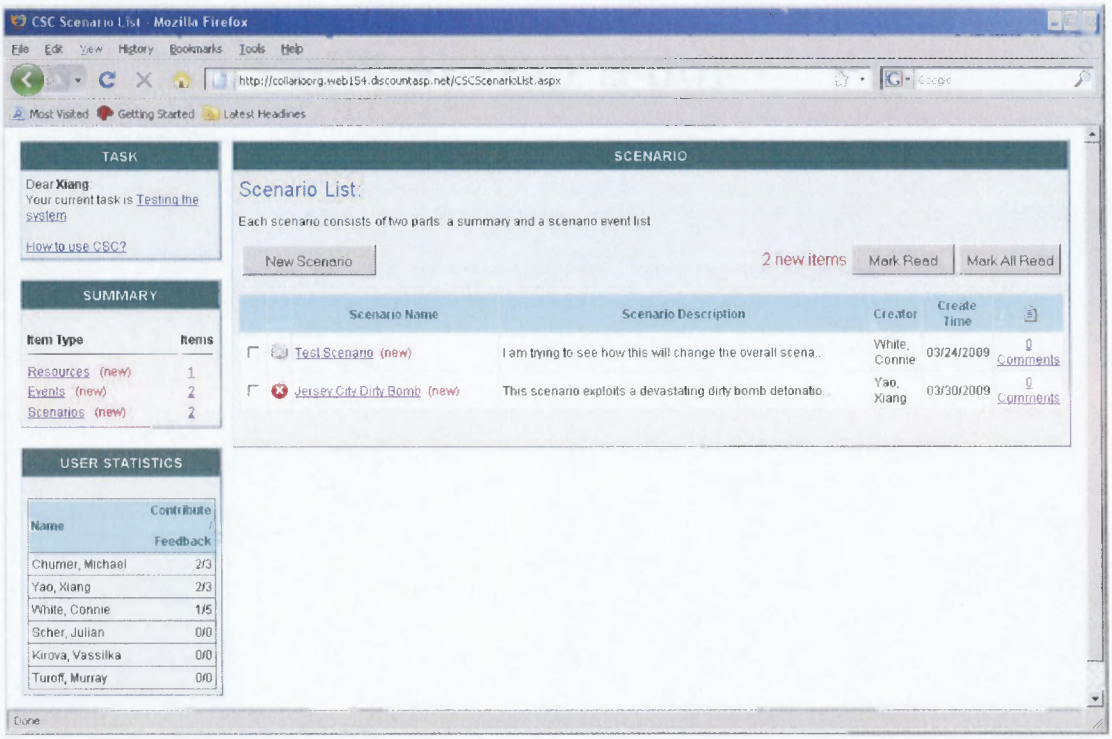

Figure B.2 Screenshot for browsing team scenarios.

The following lists the steps to browse scenarios:

1. If you are not in the above page, click the "Scenarios" link in the "SUMMARY" pane.
2. Click the "Jersey City Dirty Bomb" hyperlink under the "Scenario Name" column.
3. You will be routed to the review page of this scenario. (Refer to tutorial 7-11 for how to review a scenario.)

B.2.3 Tutorial 3, Mark Read Scenarios

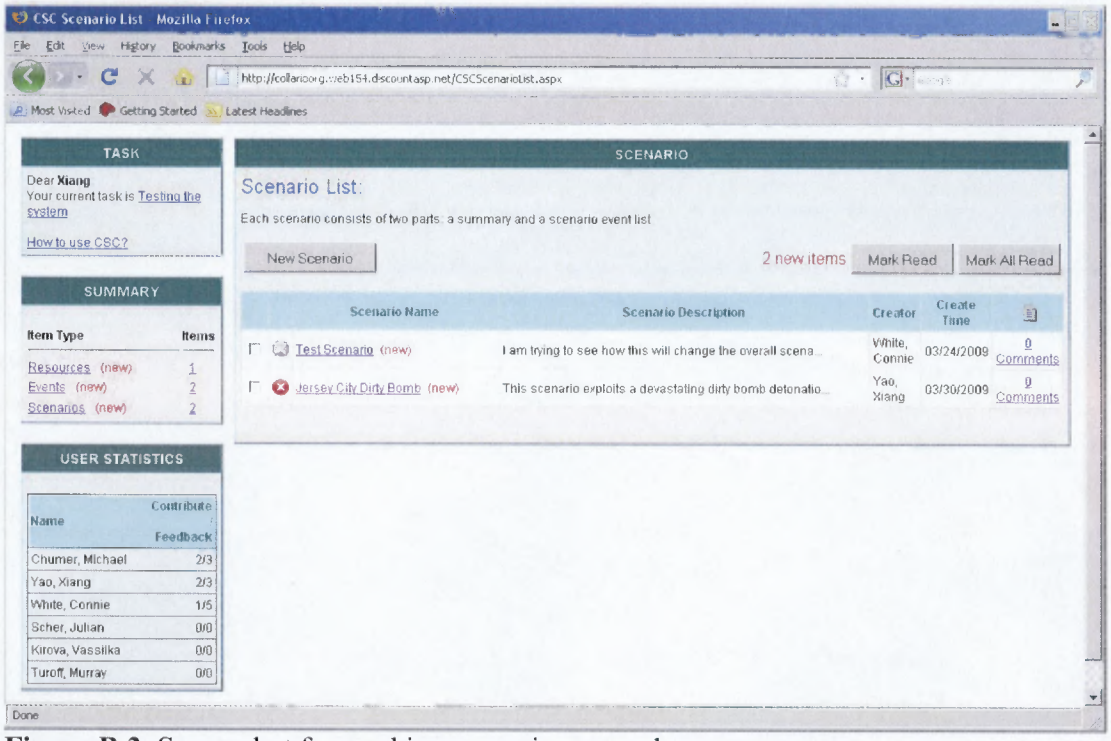

Figure B.3 Screenshot for marking scenarios as read.

The following lists the steps to Mark scenarios read:

1. If you are not in the above page, click the "Scenarios" link in the "SUMMARY" pane.
2. All the scenarios will be marked as new (with red new enclosed in parenthesis), until you "Mark Read" them.
3. To mark an individual scenario read, first check the checkbox in the left most column of a scenario. Then click the "Mark Read" button.
4. To mark all scenarios read, just click the "Mark All Read" button

B.2.4 Tutorial 4, Comment on a Scenario

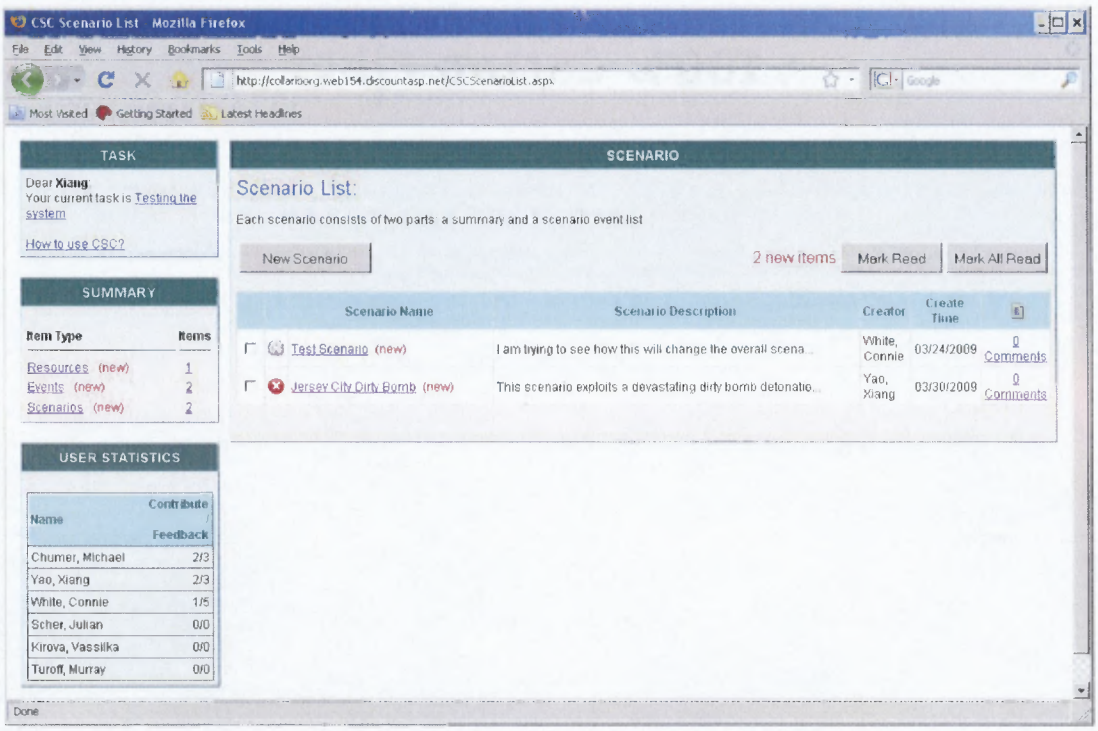

Figure B.4 Screenshot for commenting on a scenario.

The following lists the steps to comment on a scenario:

1. If you are not in above page, press the "Scenarios" link in the "SUMMARY" pane.
2. Click on any hyperlink under the last column, which says "?? Comments."
3. In the **next page**, you can see comments to this scenario, if there are any.
4. Press the "Add a Comment" button on the upper right corner.
5. Input your comments in the textbox.
6. Press the "Add" button to add the comment.
7. Press "Return to Scenario List" button to return to the above page.

B.2.5 Tutorial 5, Delete a Scenario

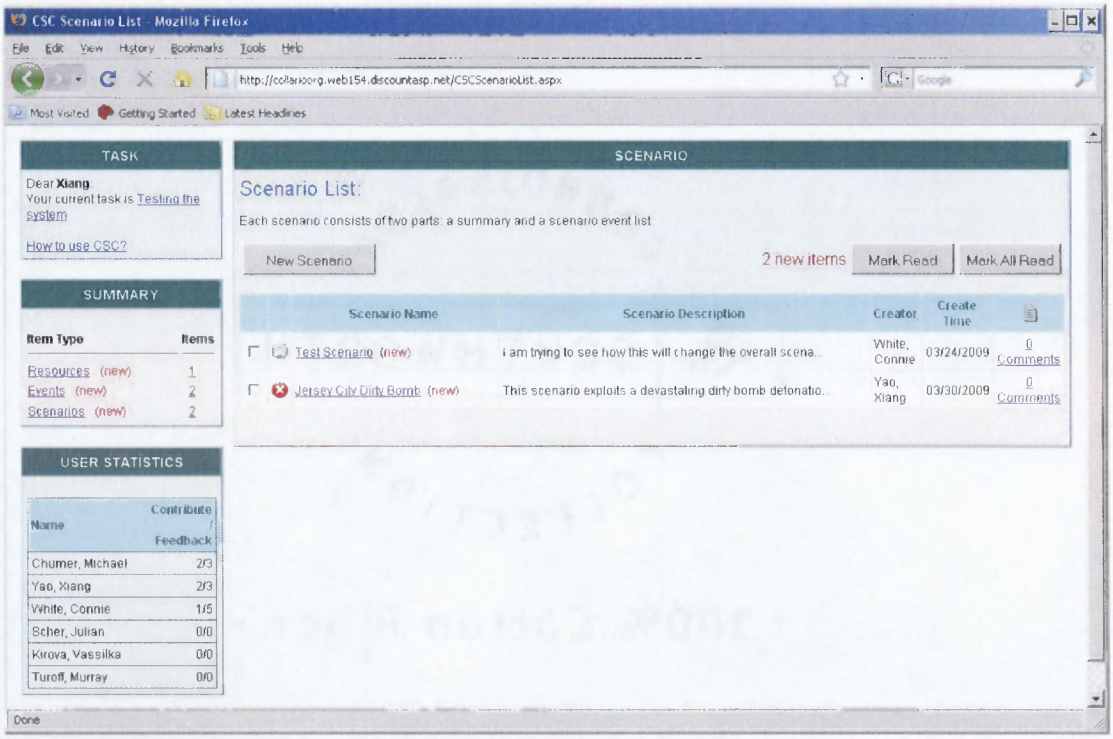

Figure B.5 Screenshot for deleting a scenario.

The following lists the steps to delete a scenario:

1. If you are not in the above page, press the "Scenarios" link in the "SUMMARY" pane.
2. You can only delete a scenario you created.
3. If you see a button under the second column, it means you are the creator and you can delete the scenario if you want.
4. If you see a sign under the second column, it means you are not the creator and you cannot delete the scenario.
5. Click on a button to delete a scenario.

B.2.6 Tutorial 6, Update a Data Field in a Scenario

(Tutorial 6 through 9 requires a user enter the scenario overview page, as shown below.)

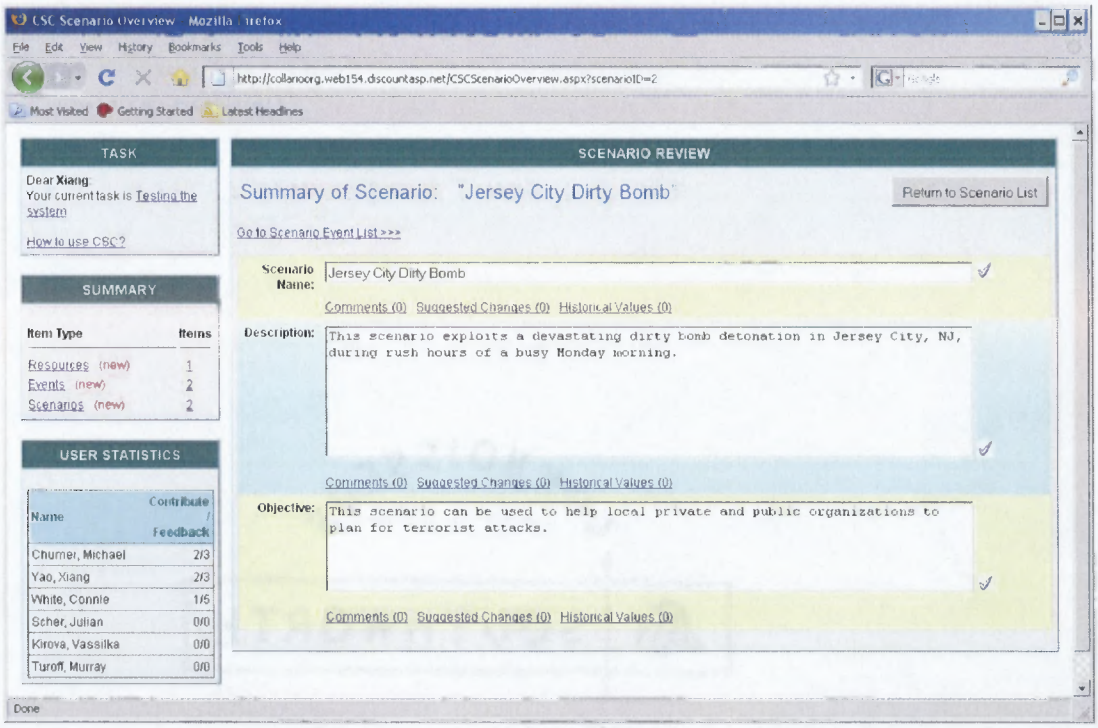

Figure B.6 Screenshot for updating scenario data fields.

The following lists the steps to update a data field in a scenario:

1. Following Tutorial 2, you will enter the above page.
2. If you are creator of the scenario, you will see ✓ beside the data fields.
3. If you are not creator of a scenario, you can also see ✓ beside some data fields, if they are empty. In this case, you are "filling in" empty fields.
4. Change the Scenario Name field to "[Another Location] Dirty Bomb."
5. Click the ✓ button beside.
6. The scenario name will be changed. You will notice the number of historical values will be increased by 1 (Refer to tutorial 9 for how to view historical values.)
7. Click on the "Return to Scenario List" button on the upper right corner to return to the scenario list page.

B.2.7 Tutorial 7, Comment on Scenario Data Fields

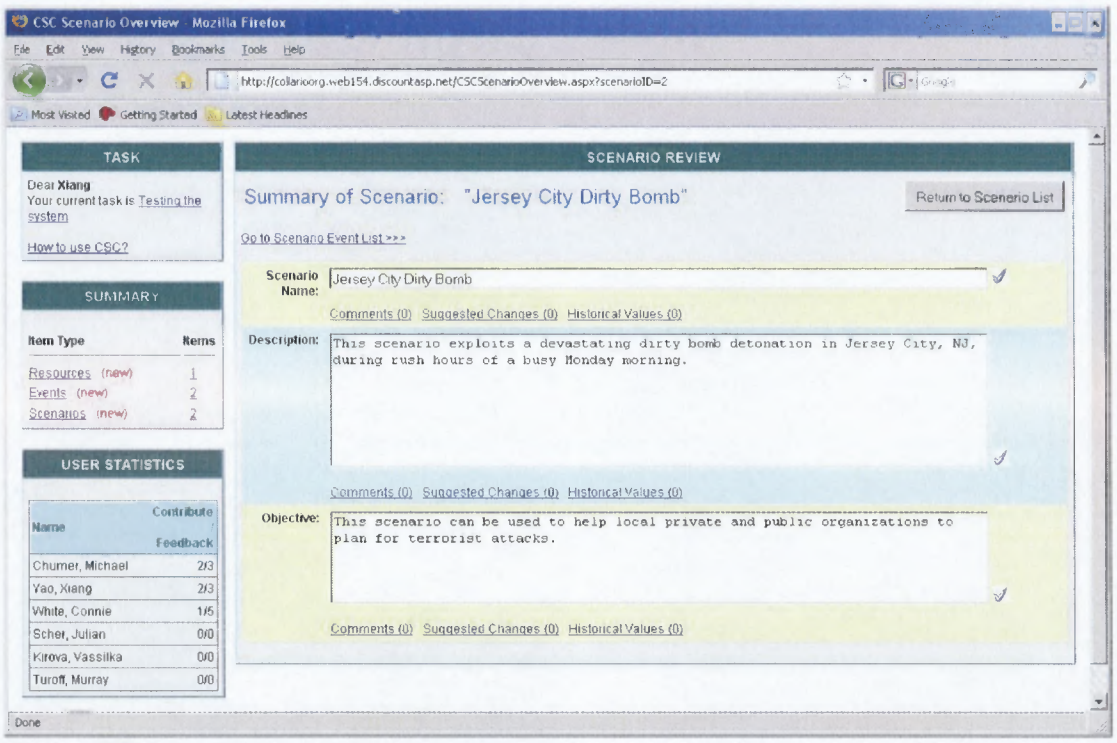

Figure B.7 Screenshot for commenting on scenario data fields.

The following lists the steps to comment on scenario data fields:

1. Following Tutorial 2, you will enter the above page.
2. Under the Scenario Name field, you can see a "Comments" hyperlink (The number in the parenthesis reflects the number of comments given to this field).
3. Click the hyperlink.
4. You will see a list of comments given to this field, if there are any.
5. Click on "Add a Comment" button.
6. Input comments in the text box.
7. Click the "Add" button.
8. Your comment will be on the top of the comment list.
9. Click on "Hide Comments" button to hide the comments.
10. Click on the "Return to Scenario List" button on the upper right corner to return to the scenario list page.

B.2.8 Tutorial 8, Suggest Changes to Scenario Data Fields

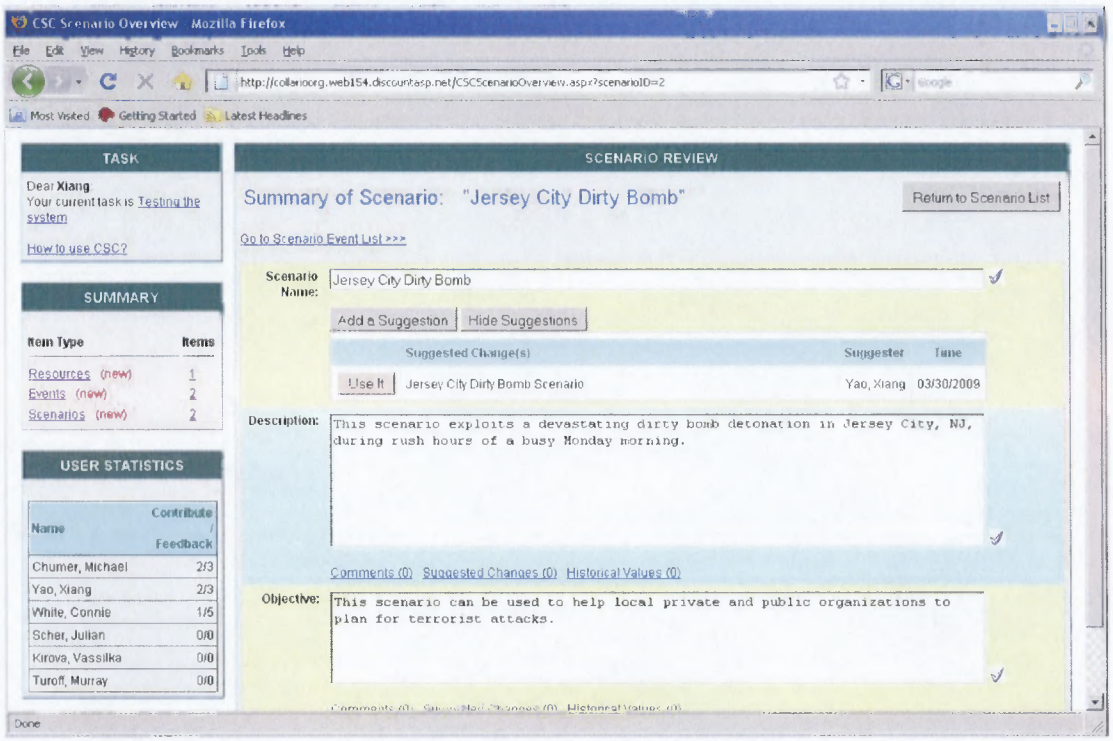

Figure B.8 Screenshot for suggesting changes to scenario data fields.

The following lists the steps to suggest changes to scenario data fields:

1. Following Tutorial 2, you will enter the above page.
2. When you do not see ✓ to change content of a field, Collario allows you to suggest changes.
3. Under the Scenario Name field, click the "Suggested Changes" hyperlink.
4. A screen like the one above will be shown to you.
5. You might see a list of suggestions for the name of the scenario, if there are any.
6. Click on the "Add a Suggestion" button to suggest a change.
7. Input your suggestion for the scenario name in the text box shown to you.
8. Click the "Add" button.
9. You will see your suggestion on the top of the suggested changes list.
10. If you are the creator of this scenario, you can see a "Use it" button enabled. Others will see this button disabled.

11. If "Use it" buttons are enabled, click one to replace the scenario name using the suggestion.

12. The number of historical values will be increased by 1.

13. Click on the "Hide Suggestions" button to hide the suggestions.

14. Click on the "Return to Scenario List" button on the upper right corner to return to the scenario list page.

B.2.9 Tutorial 9, Viewing Historical Values of Scenario Data Fields

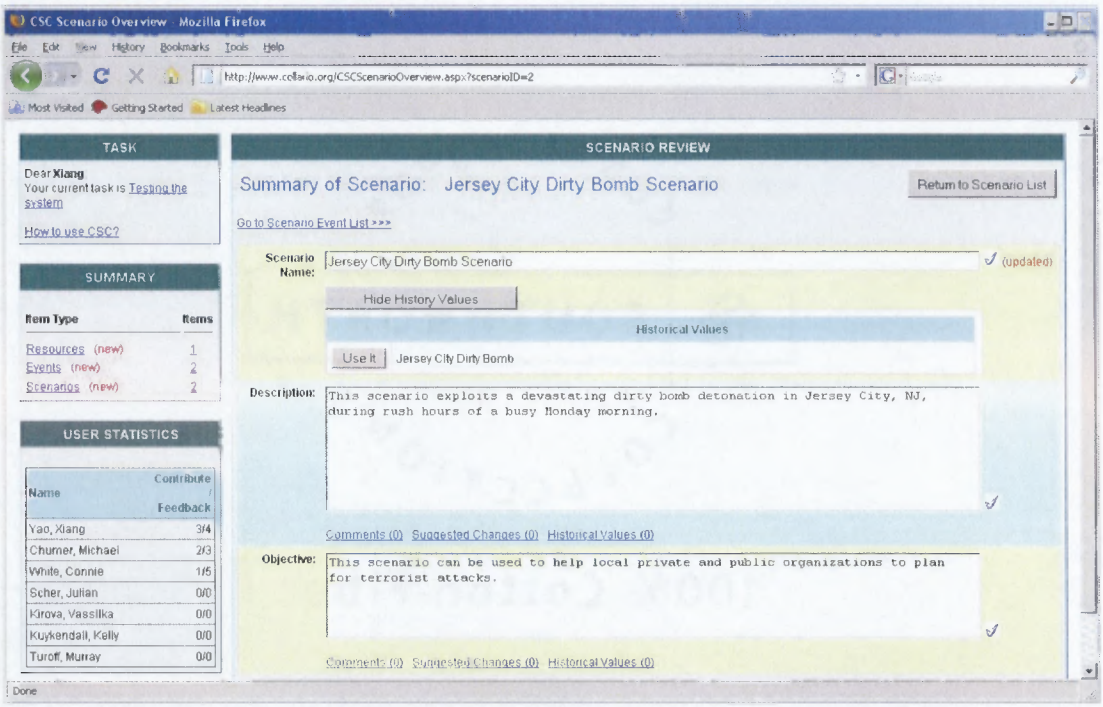

Figure B.9 Screenshot for viewing historical values of scenario data fields.

The following lists the steps to view historical values of scenario data fields:

1. Following Tutorial 2, you will enter the review page for scenario overview.
2. Under the Scenario Name field, click the "Historical Values" hyperlink.
3. A screen like the one above will be shown to you.
4. You will see a list of historical values of this field, if there are any.
5. If you are creator of this scenario, you will see a "Use it" button enabled beside each value.
6. If "Use it" buttons are enabled, click one to restore a historical value.
7. Click the "Hide Historical Values" button to hide the historical values.
8. Click the "Return to Scenario List" button on the upper right corner to return to the scenario list page.

B.2.10 Tutorial 10, Add an Event to a Scenario

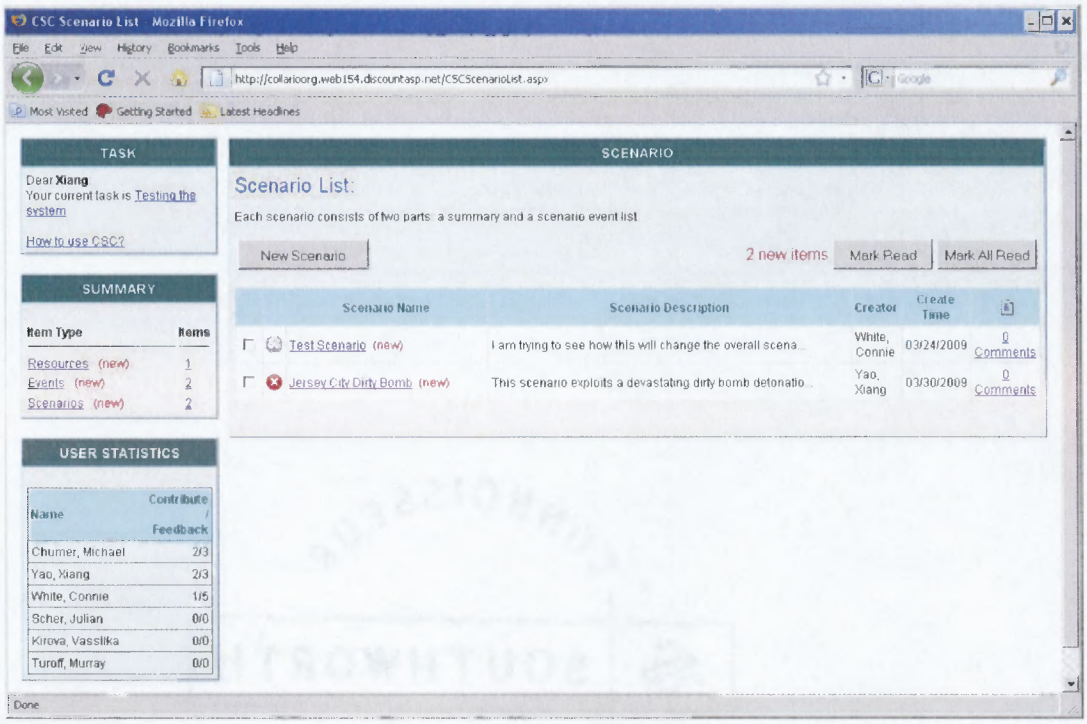

Figure B.10 Screenshot for adding an event to a scenario (1).

The following lists the steps to add an event to a scenario:

1. Go to the Scenario List page. (Refer to Tutorial 4 if you don't know how to do it.)
2. Click on the hyperlink representing a scenario ("Jersey City Dirty Bomb").
3. A Scenario Overview page like the one above will be shown to you.

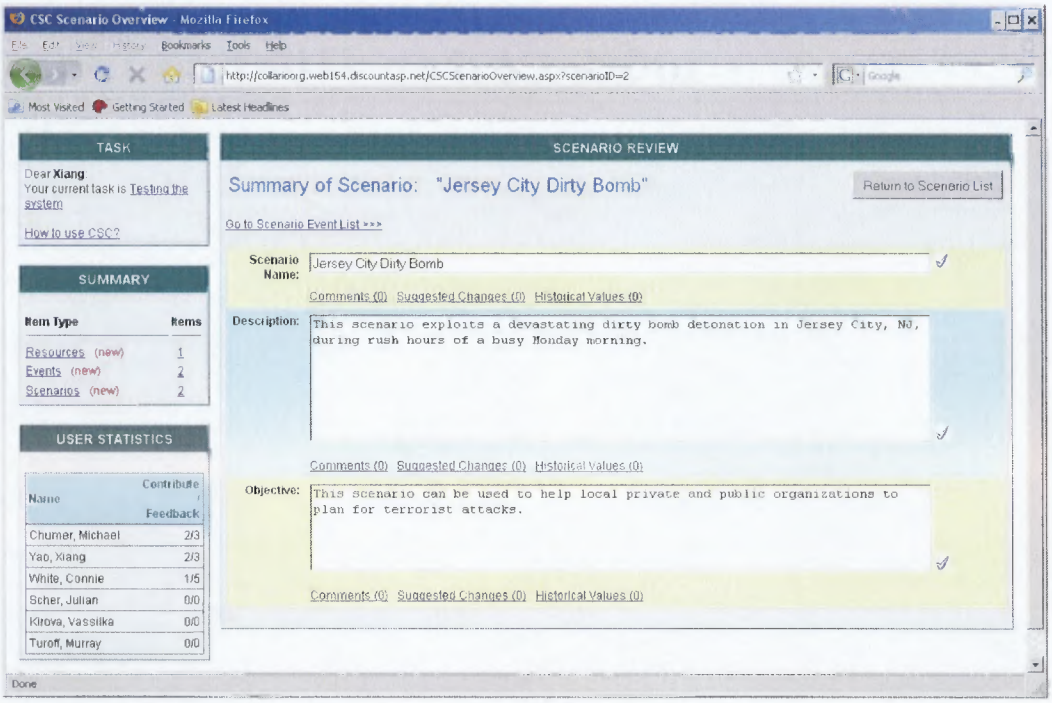

Figure B.11 Screenshot for adding an event to a scenario (2).

4. Click the "Go to Scenario Event List >>>" link on the top.
5. A Scenario Event List page like the following one will be shown to you.

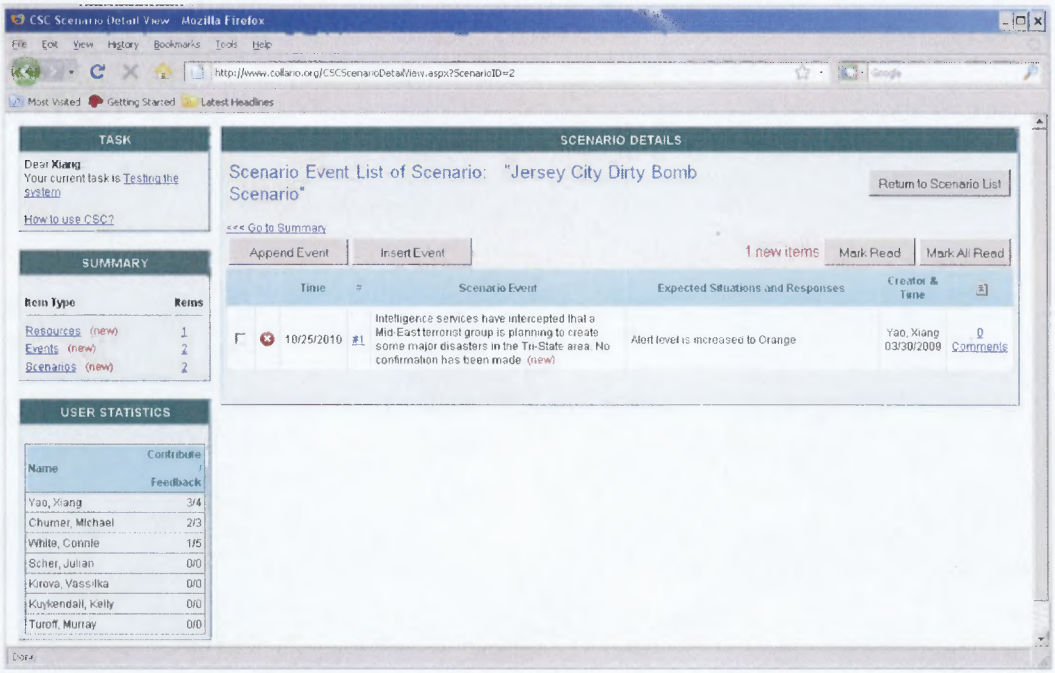

Figure B.12 Screenshot for adding an event to a scenario (3).

6. If there are events in this scenario, you will see a sequential list (In this one, you can see one).
7. You have two options to add a new event to a scenario:
8. To append will add a new event at the end of this list. (by clicking the "Append" button)
9. To insert will add a new event after a selected event. (by clicking the "Insert" button)
10. Click the "Append" button; you will a template to define scenario event.
11. Input "8:25-9:00 10-17-07" for the Time field.
12. Input "A Lehman Brothers employee on the way to work calls her supervisor & tells of a large explosion on Christopher Columbus Drive. She is stuck in traffic in the vicinity of Brunswick Street" for the Description field.
13. Leave the Expected Results (Responses) field empty.
14. Click the "Add Scenario Event" button.
15. You will see the new event added at the end of the scenario event list.

B.2.11 Tutorial 11, Browse Scenario Event List

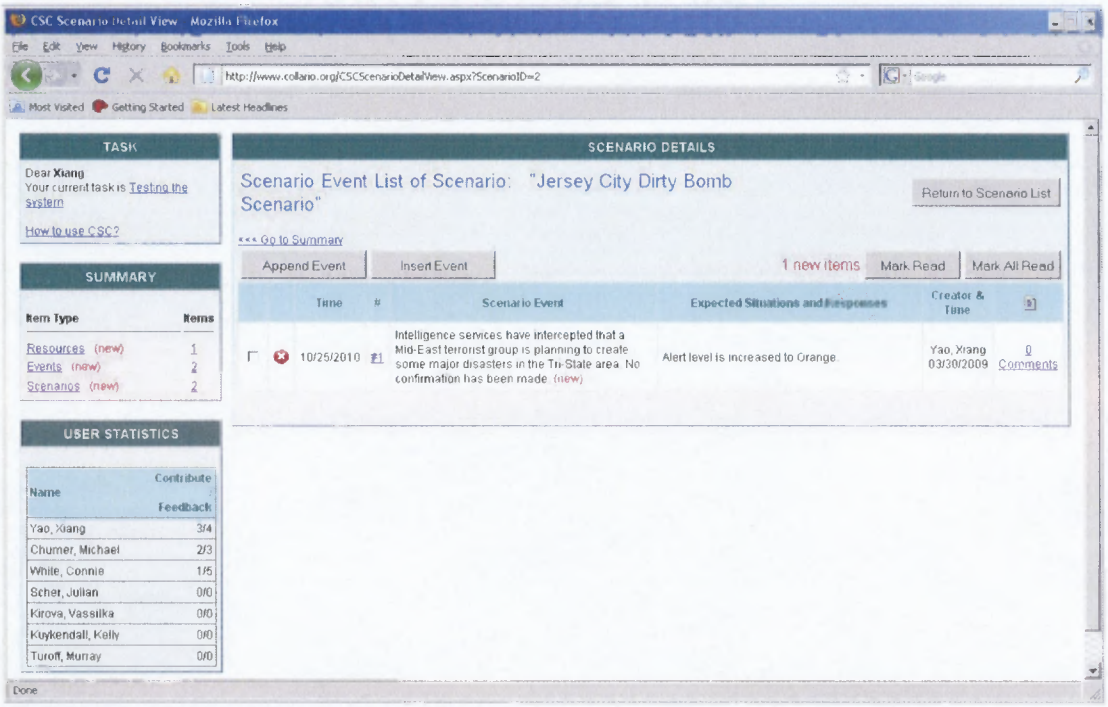

Figure B.13 Screenshot for browsing scenario event list.

The following lists the steps to browse scenario event list:

1. First, go to the scenario event list page (Please Refer to Tutorial 10, step 1-4 for how to do so.).
2. In this page, you can browse, mark read, give comments to, and delete a scenario event. Please refer to tutorial 2-5 for how to do so.
3. Click the "Return to Scenario List" button to go back to the scenario list page.

B.2.12 Tutorial 12, Review a Scenario Event

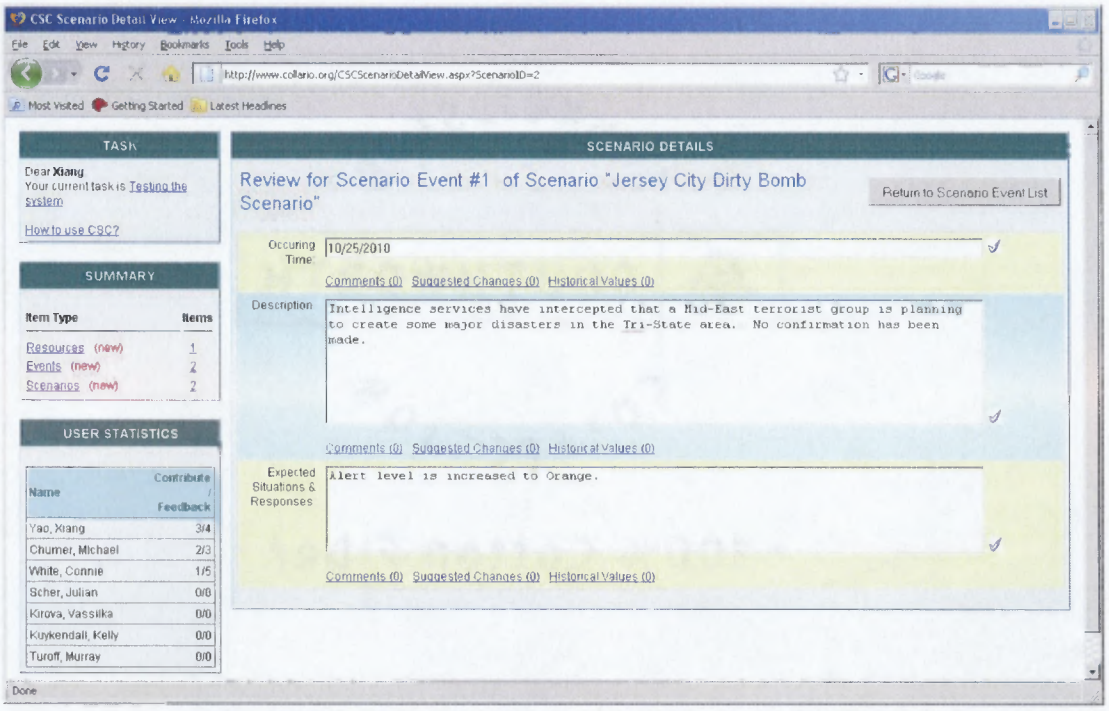

Figure B.14 Screenshot for reviewing a scenario event.

1. In tutorial 11, if you click the hyperlink under the column of "#", you will enter the above scenario event review page.

2. In this page, you can give/view comments, give/view suggestions, and view historical values of the data fields. If you are the creator of this scenario event, you can also update data fields and accept suggestions. Please refer to tutorial 6-9 for how to do this.

APPENDIX C

SCENARIOS CREATED IN THE FIRST FIELD TRIAL

This appendix uses eight figures to show the scenarios created in the first field trial, both before and after using Collario. Typos in the original data are kept as they were.

- Figure C.1: Initial red team scenario before using Collario
- Figure C.2: Initial blue team scenario before using Collario
- Figure C.3: The red team scenario after using Collario
- Figure C.4: The blue team scenario after using Collario
- Figure C.5: Stand-alone events created by both teams after using Collario
- Figure C.6: Stand-alone resources created by both teams after using Collario
- Figure C.7: Discussions of the red team in using Collario
- Figure C.8: Discussions of the blue team in using Collario

Figure C.1 and Figure C.2 show initial team scenarios before using Collario.

Method: Since the Red team submitted their original plan in Powerpoint format, creation of this document needed extracted contents from the Powerpoint file. The extraction only kept the contents directly related with the scenario. Other contents such as the team composition, how to conduct TTX, what questions to discuss, and participating agencies were not related with the scenario, thus were taken out.

Initial Conditions

Three days ago a retired Cesium-137 radiation therapy source was stolen from the basement of the Medical College of Georgia (MCG) with one person killed and two injured, one of the injured being an assailant.

Local authorities immediately notified the FBI with an intense investigation to follow, however the device was not recovered nor any of the other assailants captured.

The captured assailant did confess to authorities the source would be used with a bomb but a lie detector test proved he did not know when or where the device would be detonated.

Figure C.1 Initial red team scenario before using Collario.

All local law enforcement agencies were briefed of the current situation. The Homeland Security Advisory System threat level for both the states of Georgia and South Carolina were changed to High Condition (Orange) based on the current situation and the terrorist group already proving they were willing to kill in order to carry out their mission.

Phase 1- Detonation of Device

05:00 P.M on March 30th, a device was detonated within 50 feet of the upper level food court inside the Augusta Mall. The ceiling is a glass structure in this area of the mall, which was shattered during the explosion thereby giving a release path to the environment for the radiological plume to disperse.

The weather outside was conducive for a maximum effect of ground deposition around the mall and surrounding areas given there was a stable atmosphere with little change in wind direction and a wind speed of ~ 1.0 mph.

Individuals able to exit the mall immediately ran away from the blast and gathered in parking lots outside the mall. Multiple 9-1-1 calls were made to alert authorities of the bomb being detonated.

There are 30 severely injured and possibly dead people in the food court. Those within 100 feet of the blast are highly contaminated with radioactive Cs-137.

Damage to Facility

The entire food court has been highly contaminated by the dirty bomb with dose rates reaching upwards of 5000 Rem/hr (~83 Rem/minute) near ground zero.

Approximately 4% of the radioactive plume has escaped through the exploded glass holes in the ceiling of the mall and is being carried in a NW direction from the mall.

Some light structural damage has occurred in the food court but not enough to effect the structural integrity to the building or floor.

Approximately 5% of the radioactive plume has escaped through the exploded glass holes in the ceiling of the mall and is being carried in a NW direction from the mall.

The initial 9-1-1 calls come into both Richmond and Columbia county 9-1-1 centers.

Phase 2 - Response

As ambulances and fire trucks arrive, some of the victims have been removed from the mall and are lying in the south parking lot awaiting treatment.

Some victims are dying even though there injuries are not life threatening while the persons who helped the injured are throwing up and feeling extremely sick.

Someone decides to call Plant Vogtle and SRS to see if they could send some radiation protection personnel to the mall for surveys as a precaution.

Both GEMA and SC EPD activate their radiological branches to go to the scene and decide to activate their respective EOC's in Columbia SC and Atlanta, Ga.

Figure C.1 Initial red team scenario before using Collario. (Continued)

Plant Vogtle and SRS personnel arrive within a half hour and realize the extent of the radioactivity is very high and endangering those in the immediate vicinity of the mall.

Radiological surveys are taken all around the mall and the plume is discovered on the NW side. Everyone on the NW side is highly contaminated but not life threatening.

Phase 3 – Recovery

The area has been quarantined and posted properly with all personnel removed from the immediate vicinity for decontamination.

Figure C.1 Initial red team scenario before using Collario. (Concluded)

Date: April 25, 2009

Time: 1800 hours

Location: Naperville, IL

Population: 150,000

Weather: Sunny, winds W 30

National DHS Threat Level: Elevated

Background: Since 2001 major cities in the U.S. have been concerned about hazardous chemicals be transported via railway through their cities. 60 major cities in the U.S. still allow hazardous materials to be transported through their core. Recently, Chicago has attempted to make a deal with CN Rail that will see rail traffic bypass Chicago en route to Aurora, IL. One of the results of this bypass would be a tripling of the amount of rail traffic in smaller centers between Chicago and Illinois. Residents of Naperville, 28 miles west of Chicago, object to this proposal. One local group, the NEM (Naperville Environmental Movement) led by a radical extreme environmentalist, has been particularly active in their objections, and has had several run ins with police so far. A major railway accident that occurred on April 25, 1946 killing 43 and the likelihood of it being repeated is often mentioned by this group.

Event: On April 25, 2009 the terrorist group NEM detonated a bomb at the Manchester Road railway crossing. The bomb exploded as a CN Railway train carrying hazardous cargo, including several tankers of chlorine and propane, passed over the tracks. The initial propane explosion has killed and injured several people who had recently debarked from the Metra public transportation system at this park and ride station. There are numerous casualties, several people with serious injuries, and many people trapped under wreckage tossed about by the huge explosion. Additionally, it appears that the chlorine tankers may be damaged. Winds blowing eastward will carry any contaminants directly into a densely populated residential district. Of note, one chlorine tank car can produce a toxic, lethal gas cloud 15 miles long and four miles wide.

Figure C.2 Initial blue team scenario before using Collario.

Figure C.3 and Figure C.4 show team scenarios after using Collario.

05:00 PM: A device was detonated within 50 feet of the upper level food court inside the Augusta Mall. The ceiling is a glass structure in this area of the mall, which was shattered during the explosion thereby giving a release path to the environment for the radiological plume to disperse. **Expected Action:** Individuals able to exit the mall immediately ran away from the blast and gathered in parking lots outside the mall. Multiple 9-1-1 calls were made to alert authorities of the bomb being detonated.

05:00 PM: The weather outside was conducive for a maximum effect of ground deposition around the mall and surrounding areas given there was a stable atmosphere with little change in wind direction and a wind speed of ~ 1.0 mph.

05:00 PM: There are 30 severely injured and possibly dead people in the food court. Those within 100 feet of the blast are highly contaminated with radioactive Cs-137.

05:00 PM: The entire food court has been highly contaminated by the dirty bomb with dose rates reaching upwards of 5000 Rem/hr (~83 Rem/minute) near ground zero. NOTE:LD 50/30 for radiation dose is ~500-600 Rem without medical treatment.

05:03 PM: The initial 9-1-1 calls come into both Richmond and Columbia county 9-1-1 centers. **Expected Action:** 9-1-1 dispatchers will start the notification process to pertinent reponse units. Fire Department Police Department Local EMA's Georgia Highway Patrol

05:05 PM: Approximately 4% of the radioactive plume has escaped through the exploded glass holes in the ceiling of the mall and is being carried in a NW direction from the mall.

05:05 PM: FBI, GBI, GEMA and SC EPD - Are notified a bomb has been detonated inside the Augusta Mall **Expected Action:** The following team are immediately dispatched to the event scene: - Civil Support Team out of Atlanta Ga. - GEMA Department of Natural Resources radiological team is mobilized. - SC Dept. of Health and Environmental Control radiological team is mobilized.

05:05 PM: FBI office in Atlanta, GA dispatches a specially trained and equipped Evidence Response Team and Hazardous Material Response Unit to provide expertise and coordination of the evidence collection. **Expected Action:** These FBI teams arrive and take over the evidence collection effort and manage the crime scene.

Figure C.3 Final red team scenario after using Collario.

05:10 PM: EMT's,paramedics with BLS and ALS (basic life support & Advanced Life support) are arriving on scene.They begin to assist victims in the parking lot but are unable to get inside the hot zone inside and around the building until the hazmat teams arrives. While assisting the "walking wounded" first responders are discovering they are having a hard time communicating with the local dispatch and hospitals due to the overload of traffic on the local 800MHZ channels used by the local police and fire departments. The IC on scene informs the IC at the Augusta EOC and he requests the MCV (Mobile Command Vehicle)and personnel to assist with dispatching and call taking on the scene. **Expected Action:** Amateur Radio will be in place to assist in communications for the first responders from Richmond and Columbia counties, and will "shadow" the IC on scene to free up channels on the system between the scene and IC at the Augusta EOC.

05:15 PM: As ambulances and fire trucks arrive, some of the victims have been removed from the mall and are lying in the south parking lot awaiting treatment.

05:15 PM: Some victims are dying even though there injuries are not life threatening while the persons who helped the injured are throwing up and feeling extremely sick. **Expected Action:** Suspected WMD

05:20 PM: EMS identify the need for on-scene triage. After identifying a safe distance, the set-up procedures begin in order to assist the "walking wounded." **Expected Action:** Victims see that help is available and move to the site to be assisted by EMS.

05:20 PM: Law enforcement and first responders scan the areas around the incident site for any indication of a secondary device.

05:20 PM: Both Richmond and Columbia county EOC's are activated.

05:25 PM: The MCV arrives and communications begin to run more smoothly. Just as it look like things might under control, some citizens have been able to get in what is now a crime scene. The already stressed first responders are having to tend to these people as well as some are going into shock over what they have seen and some are complaining of chest pains. The IC on scene informs the IC at the Agusta EOC of the situation and the EM director realize the resources and man-power are stretched to the limit. A conference call is placed to the SEOC and Richmond and Columbia Counties to request assistance through the local EMAC's. Help is promised within the hour, as they have no idea how many will wander on scene and what to expect when the hazmat team gets inside the mall. **Expected Action:** The EMAC's will allow for assistance of the other counties with resources and personnel.

05:27 PM: As events escalate, the IC on scene coordinates with the Augusta EOC in the formation of a press release. The media has become aware of the situation. In order to keep the media and public informed in a timely fashion and with reliable information, a press release is necessary.

Figure C.3 Final red team scenario after using Collario. (Continued)

05:25 PM: Someone decides to call Plant Vogtle and Savannah River Site (SRS) to see if they could send some radiation protection personnel to the mall for surveys as a precaution. **Expected Action:** Both facilities dispatch health physics (radiation protection) personnel to the response site.

05:30 PM: Both GEMA and SC EPD activate their radiological branches to go to the scene and decide to activate their respective EOC's in Columbia SC and Atlanta, Ga.

05:40 PM: A press release is issued from the Augusta EOC. The media and public are updated on the response. Press releases will continue to be issued on a regular basis.

05:45 PM: Plant Vogtle and SRS personnel arrive and realize the extent of the radioactivity is very high and endangering those in the immediate vicinity of the mall.

05:55 PM: Radiological surveys are taken all around the mall and the plume is discovered on the NW side. Everyone on the NW side is highly contaminated but not life threatening. **Expected Action:** Contaminated individuals are removed from the plume exposure area and place in a low radiation area for decontamination. Initially those highly contaminated to the extent of receiving considerable exposure from their contamination are hosed down immediately.

06:00 PM: The assistance from Richmond and Columbia Counties begin to arrive to help the first responders already on scene. Upon trying to talk to the local dispatch, they are not being heard as they have different radio systems. A represenative from one of the agencies approaches the IC on scene who then request the EDICS (Emergency Deployable Interoperable Communications system) to patch all the responders together to talk to one another. The IC at the Augusta EOC requests Amateur Radio at the EOC and on scene to release some of the channels being used between IC on scene and at the EOC and to assist with communications until the EDICS is up and running. **Expected Action:** EDICS will allow all agencies to talk to one another by "patching" them together with radio equipment. Amateur Radio will free up channels being used by the IC on scene and at the EOC.

06:00 PM: The first responders from the county jurisdictions help local EMS with on-scene triage. They expect more victims as the response continues.

06:15 PM: Georgia Highway Patrol setup road blocks to stop all incoming traffic within a 1 mile radius of the Augusta Mall.

06:15 PM: A press release is issued with updates including the establishment of road blocks within a one mile radius of the Augusta Mall.

06:15 PM: Tent designed to house the media is erected to keep media safely away from the incident site while controlling the flow of information. Periodic press briefings will be given at this site by the designated media officer.

Figure C.3 Final red team scenario after using Collario. (Continued)

06:30 PM: One radio Operator has arrived at the EOC and 2 on scene,one for Richmond County teams and one for Columbia County, and have begun a emergency net. Net control at the EOC has also started checking availabilty of other radio operators as evacuation orders for residents living in a 5 mile radius of the "warm zone" are expected to come out within the hour and the Red Cross will be opening shelters to house those leaving their homes, and one special needs shelter will open for those with medical conditions that require help of a nurse or caregiver,which will involve the health department. The radio operators who are available are asked to stand by for further instructions. **Expected Action:** The radio operators will assist in communications for the shelters between the facilities and EOC.

07:00 PM: The local officals have declared a local state of emergency for Augusta and the evacutions orders have come out through radio and televison. At the moment there has been no decision made as to how long the shelters will have to remain open and the Red Cross has been advised that the incident could create the need for them to be active 3-5 days out,depending on the situation .The names and address of open shelters are released and residents are advised to stay away from the scene and given alternate traffic routes to avoid getting exposed to the chemical release that occured when the explosion shattered the glass celings in the food court.Those not asked to evacuate have been advised to keep the windows and air venelation systems off until hazmat can determine exposure levels and not to venture outside unless absolutetely neccesary. **Expected Action:** The open shelters will house and feed the evacuees until they can return home.

07:00 PM: Two Search and Rescue Teams are being formed and briefed for entry into the mall. **Expected Action:** Unknown

07:05 PM: Prior to the Hazmat teams entering the incident site, the Radiological Decontamination Team begins setting up their mobile decontamination site. They choose the southeast parking lot as it is downwind of the radiological cloud. The decon team sets up two mobile shower trailers, one for response personnel and one for victims. Water source is via a hookup to a nearby fire hydrant and drums are utilized to capture the contaminated shower water. Victims are required to remove clothing and belongings which are then catalogued and placed in sealed bags for later disposition. Paper scrubs are supplied as victims exit the shower trailer and victims are checked for radiation before being cleared to move to another collection area. **Expected Action:** Decontamination of personnel and victims as they exit the incident site. Allows some clearance of victims from the site.

07:15 PM: IC on scene requests counslers and psychologists to be available to assist first responders deal with the situation they are working in. **Expected Action:** The first responders have not worked in such a disaster with so many deaths. The toll on the workers' mental health is expected to be a problem.

Figure C.3 Final red team scenario after using Collario. (Continued)

07:15 PM: In response to requests, the Red Cross contacts volunteer psychologists and counselors who are sent to the scene to offer assistance to responders and victims.

07:20 PM: An Incident Command Center is established outside of the affected areas.

07:20 PM: The Richmond County EMA brings to the site two industrial generators to supply power to additional equipment. **Expected Action:** Additional power will be available for communication equipment, computers, shower trailers, and lighting.

07:30 PM: Two search and rescue teams enter the mall. One team enters from the south end and the other the north end to the food court area. Teams are briefed and teamed up with radiation protection technicians from SRS and Plant Vogtle. SCBA's are required for respiratory protection along with plastic suits to protect against becoming contaminated. The briefing the teams receive set radiation dose rate limits at 10Rem/hr, which equates to 166 mRem/min. No team member is allowed to receive more than 5Rem WB for the search phase of the entry unless the determination is made that a saving a life is at stake ,upon which the dose limit is raised to 50 Rem WB for the rescue stage. The health physics technician must survey any area entered and perform a stay time dose calculation estimate based on the radiological conditions to be entered. **Expected Action:** The search and rescue teams are deployed to look for survivors. What they will find is not known.

08:00 PM: The area has been quarantined and posted properly with all personnel removed from the immediate vicinity for decontamination.

08:00 PM: Contaminated personnel are required to undress after a make-shift tent is set-up near the buffer zone boundary and put on paper suits Plant Vogtle employees brought from the plant. In addition, local hospitals have donated patience gowns for when the paper suits ran out. ~250 people need decontaminated and processed through a portable decontamination unit. The contaminated clothing was placed in plastic bags and moved into a designated area away from any people for distance factor to reduce radiation exposure. The bags of clothing will remain in the hot zone until clean-up efforts start and will be disposed of at that time. **Expected Action:** Reduce a major source term of radiation exposure to those exposed to the radioactive plume.

08:00 PM: Contaminated individuals have been segregated based on contamination levels with the most highly contaminated people >500K dpm/100 cm2 scheduled to go first to reduce radiation exposure. Personal Decontamination Techniques • Wash well with soap and water and monitor skin • Do not abrade skin, only blot dry **Expected Action:** Reduce exposure to external contamination

Figure C.3 Final red team scenario after using Collario. (Continued)

08:00 PM: GEMA and the National Guard units out of Atlanta set-up two gender specific mobile decontamination units which includes a shower compartment on the boundary of the buffer zone. The shower compartment has a shower head and a drain located therein. There is a means for providing water to the shower head. There is a storage tank connected to the drain to store contaminated water from the shower compartment. There is a means for maintaining the shower compartment at a negative air pressure via a 500 CFM HEPA unit with HEPA filter for radiological airborne concerns during decon. The shower compartment has a shower head and a drain located therein. There are means for providing water to the shower heads and means for heating the water before it reaches the shower heads. A storage tank is connected to the drains for storing contaminated water. the entire structure is inside a berm for total containment of any liquids. **Expected Action:** Decontaminate personnel out of the hot zone.

08:00 PM: Reporters,family members, and other agencies are calling non stop wanting information. **Expected Action:** A Joint Information Center is established and a Chief Information Officer is appointed. This is where all calls are refered to for current information.

08:15 PM: Personnel start to be processed through the decontamination unit. They are required to shower with tepid water and mild soap to remove the gross contamination. A step off pad configuration is set-up to designate the clean area (<100dpm/100cm2 and <100cpm/area under probe of frisker). If personnel are under the contamination limits they are transported to a local hospital for blood work to determine the amount of radiation exposure during the event. Victims will also be given Prussian blue which has been used to treat people who have been internally contaminated with radioactive cesium (mainly Cs-137)Doctors must prescribe Prussian blue at any point after they have determined that a person who is internally contaminated would benefit from treatment. Prussian blue will help speed up the removal of cesium from the body. **Expected Action:** Individuals are released from the buffer zone after being deconned to acceptable levels.

Cesium-137: Characteristics: Cesium-137 is a dangerous radioisotope to the environment in terms of it's long-term effects. It's intermediate half-life of about 30 years suggests that it is not only highly radioactive but that it has a long enough halflife to be around for hundreds of years. Besides its persistence and high activity, cesium-137 has the further insidious property of being mistaken for potassium by living organisms and taken up as part of the fluid electrolytes. This means that it is passed on up the food chain and reconcentrated from the environment by that process.

Figure C.3 Final red team scenario after using Collario. (Continued)

08"30 PM: Unified command becomes active as fire chiefs from Columbia and Richmond counties are arriving on scene,and the health department director arrives as well. Staff from the local Red Cross have arrived in a local ERV to offer assistance with feeding the first responders. One of the volunteers happens to be a grief counlser and offers their help to survivors and the first responders. This was not planned but works out well as the IC on command had requested counslers and pyschologists be available to help with the metal stress occuring from this sort of response. An information hotline has been opened at Augusta Emergency Management. The telephone personnel will have information about shelter openings, general information about the incident, and school closing for the next day, and they will take people's name if someone calls stating they are looking for someone that might have gone to the mall. There is a Red Cross liaison in the information center who will try to cross reference an **Expected Action:** Unified command allows for all the management of reponse personnel be in one place for the incident rather than scattered about" doing their own thing". The Red Cross ERV will provide meals and related support to response personnel.

08"30 PM: The EDICS has finally arrived in Augusta but it has taken time to get to the county, but it is still not close to the scene yet. The agency host of the system for the region is actually a couple of hours away. The responder with the EDICS reports to their own agency that they have been slow to arrive because of the traffic tie ups that are occuring all over the place. The EDICS is a large and cumbersome vehicle and trailer and does not move anywhere fast. Citizens are also becoming panicky because of all the media reports from the scene and even those who do not need to leave the area have begun to evacuate Augusta to go stay with other family members so traffic problems are only worsening. Amatuer Radio is still in place at the EOC and on scene at the command post so the arrival of the EDICS is not a issue at the moment. Once the EDICS does arrive response will not begin immediately. It will take time to setup the equipment which can take up to an hour or more,depending on whether the responder has assistance setting it up. **Expected Action:** The EDICS will allow all the responding agencies to talk to one another even though they have different radio systems. Amateur Radio is providing the communications support until the EDICS arrrives and is setup.

8:40: Things are going smoothly, but the radios that the first responders showed up on scene with are starting to fail as they are losing battery power. Personnel are trying to charge them but it is taking too long and some of the battery chargers are not working correctly. IC on scene has notified IC in the August EOC of the situation. The IC on scene is assuming the EDICS will have a cache of radios with it when it arrives. **Expected Action:** There will be a failure of communications between first responders and dispatch if the problem is not solved.

Figure C.3 Final red team scenario after using Collario. (Continued)

8:50: The EDICS has arrived on scene and has started setup of the equipment. The EDWARDS satelite downlink will be setup to have internet access as well. The IC on scene speaks to the radio specialist that arrived with the EDICS about the using the cache of radio and chargers that usually are in a EDICS, but the cache of radios is not with the EDICS as the radios have not undergone rebanding requirements to meet the new standards for use of frequencies. **Expected Action:** The specialist recommends requesting the use of the MARC (Mutal Aid Radio Cache)from the county.

8:55: The IC on scene has notified the IC at the Augusta EOC that the cache of radios is not with the EDICS and is requesting the use of MARC. The MARC tower will not be needed since the EDICS has arrived but someone from the county will have to retrieve the radios from the storage area. The person who normally maintains the cache is out of town and will be unable to bring them out to the scene. **Expected Action:** The MARC will provide the relief needed since the radios that the response personnel are using are beginning to use up battery life. The ham radio operators remain on scene to assist with the communications.

8:55: Portable refrigerated trailer designed for temporary storage of bodies is brought to the site. **Expected Action:** Most of the deceased will be contaminated and will need to be deconned or handled as potential raidation hazards due to the high amount of contamination from the Cs-137

Figure C.3 Final red team scenario after using Collario. (Concluded)

17:30: It is a beautiful spring day in Naperville, Illinois. The sun is shining and the wind is lightly out of the west at 20 mph. The local population of 150,000 is returning from work and looking forward to firing up the barbeque. The DHS National Threat Level is elevated for the State of Illinois as a result of recent activities and threats from a local environmental group.

17:55: Local police are receiving calls about a large truck abandoned on a grassy area alongside the Manchester Road railway crossing. There does not appear to be anyone in the truck. **Expected Action:** Event entered for dispatch to check out suspicious vehicle.

18:00: There has been a large explosion at the Manchester Road railway crossing. The explosion has resulted in the derailment of a passing CN train carrying hazardous cargo. The fireball from the explosion is obscuring most of the scene but it appears that several cars are tipped over on their sides.

Figure C.4 Final blue team scenario after using Collario.

18:02: Emergency Communication Officers for Fire, EMS and Police are overwhelmed with phone calls reporting a large explosion, derailed tanker cars turned on their sides and possibly several casualties who had just debarked from the Metra public transportation system at this park and ride station. **Expected Action:** Dispatchers will immediately alert first responders of a large explosion following mass-casualty incident protocols. Appropriate notifications will be made. Dispatchers across Police, Fire & EMS will share information to form a complete picture of the incident. Someone will connect the previously reported suspicious vehicle with this incident and advise first responders.

18:05: Naperville Police Department arrives onscene. They begin scene assessment. A large crowd has developed due to the explosion. Multiple victims are scattered all over the area. **Expected Action:** Officers begin first aid on victims until EMS arrive. They request community service officers for traffic control and public works to bring baracades for crowd control. They also set up a scene perimeter to protect the crime scene. Traffic has backed up on either side of the tracks. Police close off access to the area. Police request Communications to notify CN Rail

18:06: Police onscene advise dispatch of the possibility that this event is a result of a bomb and request the bomb squad to respond. They also advise dispatch to update other responders with this information and caution them to be aware of the possibility of a secondary device. **Expected Action:** Bomb squad is paged by dispatch. Evidence of explosive device prompts considerations of a terrorist attack. Police advise Communications to notify FBI.

18:06: EMS arrives onscene. There are multiple victims with a large array of injuries. Some massive and some minor. **Expected Action:** A triage area is set up in a safe zone. EMS personnel begin locating and treating victims. They request back up and mutual aid to assist with the numerous victims. They also call Edward Hospital to notify them of incident, victim numbers, and treatments

18:07: First EMS personnel to respond and bystanders in the immediate area are experiencing adverse affects, in particular, coughing, chest tightness, burning sensation in the nose, throat and eyes, nausea and vomitting. The responders back out of the area and advise all people in the area to move out of the area. **Expected Action:** EMS recognizes the symptoms of chlorine exposure and pulls back to a cold zone until appropriate PPE can be delivered.

18:07: Fire Department and the Chief on Duty arrive on scene. They observe several residual fires and possible hazardous materials on the ground. **Expected Action:** The COD sets up a incident command. The engines begin to control the fires. The Hazmat team is called out to identify the material and contain it.

18:17: The Fire department has staged outside the effected area. They immediately relay to the HAZ-MAT team they have a potential IDLH environment surrounding the scene.

Figure C.4 Final blue team scenario after using Collario. (Continued)

18:17: EMS have evaluated the scene and requested all available units to respond, as well as the shift supervisor. The first unit on scene begins to establish a staging area for EMS units and equipment. **Expected Action:** Shift supervisor acknowledges and is en route to the scene. Additional units have been dispatched to the incident.

18:20: Naperville Bomb Squad arrives on scene. **Expected Action:** The team does an assesment of the scene and the device used. They also check for secondary devices.

18:20: EMS Shift Supervisor arrives on-scene and determines that this incident will overwhelm their capabilities. He contacts dispatch and requests an all call for additional personnel from his service and requests units from neighboring services. **Expected Action:** Dispatch performs an all call out for additional available personnel. Dispatch contacts neighboring EMS agencies and requests available units for response to this incident and provides them with instructions on where to report to and who to report to when they arrive on-scene.

18:20: Due to the overwhelming need of EMS mutual aid needs to be utilized. **Expected Action:** Communications contacts Plainfield, Warrenville, Bolingbrook, Lisle Woodridge, and Downers Grove are contacted for mutual aid. Communications assigns a specific channel to the mutual aid units. A second dispatcher is called to fire side to operate that channel while the original dispatcher continues to handle the incident. Also a second dispatcher is handling the routine calls for service on the police side and the original dispatcher is handling the incident. The communications supervisor sends out a page to off duty dispatchers to come in for back up.

18:30: HAZMAT team arrives on scene and sets up zones. They suit up and begin testing for different types of hazardous material. **Expected Action:** HAZMAT team identifies chlorine gas and notifies COD (incident commander). They also communicate via telephone with CN's Emergency Response Team to attempt to get manifest information and other details of the cargo.

18:30: A Command Post is established upwind of the incident and the Incident Command System is implemented with the local Fire Chief assuming the role of Incident Commander. **Expected Action:** ICS is appropriately implemented given the size and scope of the incident. The Commander takes into account the resources that are required not only to deal with this incident but to respond to other "routine" events that may be occuring in this area. Implementation of ICS is providing smoother communications although the lack of interoperable radio systems in the area is hindering tri-services communication.

18:30: HAZMAT team also sets up a decontamination area in the warm zone. **Expected Action:** To decontaminate all persons exiting the hot zone. This includes workers and victims. Patients must be decontaminated prior to transport by EMS to the hospital.

18:40: the Haz-Mat team has detected large readings of Chlorine gas as well as detectable amounts of phosgene gas.

Figure C.4 Final blue team scenario after using Collario. (Continued)

18:45: Communications Center reports that they are overwhelmed with calls from residents who are trapped on the other side of the tracks from their residences. A daycare and a seniors' nursing home have both called in seeking instructions. **Expected Action:** Has the public warning system been activated? What message is being provided? Was a PIO appointed upon implementation of the ICS?

18:50: the haz-mat team has referenced the Emergency response guide book and determined that there needs to be a one mile isolation zone surrounding the haz-mat scene. The chlorine gas and phosgene gas are both heavier than air and therefore will effect low lying areas to include the potential for ground contamination and water sources. **Expected Action:** Has the HAZMAT team contacted CHEMTRECH who can provide detailed information about the chemical agents and can assist in contacting shippers and transporters for more details.

18:50: The IC contacts dispatch to notify CN Rail to stop all rail traffic to this area. **Expected Action:** Dispatch contacts CN Rail with the exact location of the incident and advised them to stop all rail traffic through this location.

18:50: CN Rail's Emergency Response Team is notified. The National Response Team is notified as required by law. **Expected Action:** Trained members from CN's award-winning REACT team that has trained over 5,000 rural responders in incidents involving dangerous goods are notified and en route. Has someone notified CN Rail to stop all rail traffic into the area?

18:50: Naperville's Community Emergency Response Team (CERT) has been activated. The team is knowledgeably in hazmat incidents, transportation incidents, and terrorist events.

18:50: A large cloud of greenish, yellowish gas has begun to form and is moving slowly to the east towards a residential area. **Expected Action:** Incident Command will address the issue of evacuating or sheltering in place and how to best communicate to diverse populations in a timely manner. Has specialized equipment been requested from mutual aid partners to predict cloud dispersal. Should some people be told to shelter-in-place. How will this message be delivered? Should people farther out evacuate?

18:55: Local news media arrives on scene. **Expected Action:** News media is trying to get as close as possible. LE attempts to contain them and sets up a staging area for the media. Has PIO been appointed? Are messages going out to media consistent? Have police, Fire and EMS communications centers been updated so that they are providing callers with consistent, accurate information?

Figure C.4 Final blue team scenario after using Collario. (Continued)

18:56: The Emergency Manager contacts the public services officer and asks him to be in charge of media contact. **Expected Action:** Public services officer responds to scene and holds a press conference. The officer also advises media personnel that he is the point of contact for all information. He asks that the media and public stay away from the area due to the hazardous material. He asks all citizens looking for loved ones to please be patient, they police and hospital will be working together to contact family memebrs as soon as possible. A 1-800 number is given out for people to call with any information about the incident. If they saw anything or anyone that will help catch the bomber.

18:56: EMS Shift Supervisor contacts dispatch and requests that all hospitals within a 100 mile radius be notified of this incident and placed on standby to receive patients. Also, requests that air medical be notified and on standby pending a landing zone setup and staging area for helicopters. **Expected Action:** Dispatch notifies hospitals and air medical. EMS Shift Supervisor communicates with fire department Chief on Duty and LE and begins planning for a staging area for air medical and to try to locate personnel to man the LZ. Radio traffic at this time is very heavy, creating a hazardous situation for any responding helos.

18:57: North Central College administration and security is notified. They are advised that they should be on stand by for evacuation and notify students to stay away from the area. **Expected Action:** Security helps to maintain order on campus and also be prepared to start evacuating if necessary. Administration will be prepared to handle calls from students and the students families. They will be given the current information to disiminate and the number to give out for people to call.

18:57: The Dupage Children's Museum supervisor is notified. This museum is only a couple of blocks away from the explosion. **Expected Action:** The museum should report any illnesses. If none, it should be evacuated and closed down.

19:00: EOC is activated. **Expected Action:** Expected that there is a callout list for EOC activation and that senior personnel from support agencies arrive.

19:00: FBI office in Atlanta, GA dispatches a specially trained and equipped Evidence Response Team and Hazardous Material Response Unit to provide expertise and coordination of the evidence collection. **Expected Action:** These FBI teams arrive and take over the evidence collection effort and manage the crime scene.

19:15: The EOC is trying to bring order. There is already widespread evacation in progress. There is a lot of work to be done with the multiple injures and death. They must conduct a door to door search to help people who cant help themselves and those who may be stuck. Police have received updated risk models from EPA and begin door-to-door evacuations in some areas and advise others to shelter-in-place.

Figure C.4 Final blue team scenario after using Collario. (Continued)

19:30: CN Rail's Emergency Response Team is now on the scene they are try to figure out what happen and the point of orgin. They are having a very difficult time due to the fact that everything is qurantined off. Since this is a serious issue everyone has mask on for there potection and the news team is asked to leave for their own safety. The Emergency response team are still getting all the resident out of harms way. everything is coming together and most of the resident are evacuted.

19:30: Additional EMS units and personnel have arrived, a group of EMS personnel along with a group of LE have arranged an LZ for air medical upwind and a safe distance away from the incident to prevent rotor wash from worsening the cloud. **Expected Action:** An LZ is in place with good communications directly to the responding ships for their safety and to help prevent a collision from having multiple ships coming into or leaving from the same area.

19:45: The EOC command calls in the Red Cross for assistance. The RC arrives with food, water, and resources for a temporary shelter for those that need it. They also provide additional volunteer nurses and a liaison for the EOC. If additional help is needed the Salvation Army has agreed to step in and assist with the mass care for workers and citizens. (The RC also operates under a ICS system and can expand as needed so more can happen if we need it to.)

19:45: Edward's Hospital has plenty of doctors and nurses on hand to handle the sick and injured so they are waiting for EMS to bring people in.

19:45: Central Dupage Hospital is notified. They are asked to be on stand by for an over flow of victims. **Expected Action:** CDH calls in extra staff, sets up a decontamination area, and prepares for arrival of victims.

20:00: IC contacts dispatch and requests the Department of Public Utilities be notified of the potential for contamination of the watershed area around the incident. **Expected Action:** Dispatch contacts the City of Naperville Department of Public Utilities and they are sending a representative to the command post.

20:00: IC also determines that the Illinois Environmental Protection Agency should be notified. **Expected Action:** Dispatch contacts the Illinois EPA.

20:00: the hazardous material technicians have taken air sample readings 1/4 mile from the impact site and determined the air safe from harmful contaminates. they have also used PH Strips to take readings from nearby streams and have deemed them safe and uncontaminated. The hazmat team has deduced that the gas cloud has dissipated enough for it not to effect anything greater than a 1/4 mile distance down wind.

20:30: Dukes Oil Serv Inc has just voulunteered to help with the clean up.

21:00: Environmental Protection Agency has now been notified and are on there way. this willl help out a lot

Figure C.4 Final blue team scenario after using Collario. (Continued)

23:00: with all the agency in place and try to work toward clean u this disater things are looking better. Everyone is still keeping in touch with the evaluation post and we have recieved word of great progress. The EOC has really got everything flowing great

23:00: Department of Public Utilities worker checking the water.

23:00: The public water system has tested negative for contamination. Local streams and ponds have tested negative for contamination. The EOC and Naperville Hazardous materials teams has reduced the effected area to the immediate area of the blast radius itself.

23:00: Winds have dissipated the cloud contaminate throughout the day. The hazardous material technicians have taken air sample readings at the blast site. The blast site no longer contains and IDLH atmosphere. the blast area has been deemed safe to begin triage of effected victims and scene clean-up.

Figure C.4 Final blue team scenario after using Collario. (Concluded)

Figure C.5 and Figure C.6 list the stand-alone events and stand-alone resources created by the two teams.

1. **Ambulances**: Multiple ambulances will be necessary for the transporation of victims to local hospitals.

2. **Atmospheric Testing Equipment to detect Oxygen levels**: 50-ITX Multi-Gas Monitor or Equivalent with trained personnel to use them. **Usage:** The iTX multi Gas Monitor is used to sample the atmosphere for oxygen (O2) and flammable gases (%LEL)

3. **CAMEO II**: Graphic database that allows files to be built to support disaster plans including air modelling to predict air plumes of hazardous materials into the atmosphere. http://cool-palimpsest.stanford. **Usage:** Haz tech officers to predict impact of release of hazardsous substances.

4. **Cellular jamming unit**: Unit designed to block cellular phone traffic in the immediate area. **Usage:** Jamming unit designed to prevent the use of cellular phones in the immediate area until it can be searched and cleared of any possible secondary devices.

5. **Compressor to refill SCBA bottles**: 2-Compressors to refill SCBA bottles.

6. **Containers for contaminated materials**: Sealable, identified containers for the storage and disposal of any contaminated materials from the incident scene.

Figure C.5 Stand-alone resources.

7. derailment causes: Usually, train accidents and toxic train derailments include causes from: Collisions with other trains Improper switch alignment Improper or Inadequate Track Inspections or Track Maintenance.

8. Dosimeters: Radiation exposure monitors utilized to ensure no personnel working in and around the scene is exposed to too much radiation.

9. DRAEGER MULTI GAS DETECTOR/MSA QUICK DRAW SAMPLING: 50-DRAEGER MULTI GAS DETECTORS AND MSA QUICK DRAW SAMPLING PUMP WITH TRAINED PERSONNEL TO USE THEM. **USAGE:** DETERMINE THRESHOLD LIMIT VALUES (TLV) FOR CHLORINE GAS

10. Edward Hospital: This is the local hospital in Naperville that can take care of the wounded and sick.

11. Emergency Power Generator Trailer: Emergency Power Generator Trailer manufactured by TVI Corporation, each with 650 kilowatt capacity powered by a Volvo Engine. **Usage:** Utilized to run the command center, decontamination trailers, additional communication equipment, computers, lighting, etc.

12. Flood Lights: Portable Tripod 750watt flood lights which can be moved around the incident scene where necessary.

13. HAZMAT Decon Unit: This unit maintained by the HAZMAT team (fire department) contains all necessary equipment to set up a decontamination area. This includes privacy shelters, run-off catch basins (pools), decon showers. **Usage:** Used to set up the decontamination area at an incident.

14. Lifefight Helicopters: To move the most critical patients to hospitals more than 90 miles away from the scene. **Usage:** Frequent

15. MCI Equipment Trailer: A Mass Casualty Incident trailer maintained by EMS. Contents would include extra equipment such as long back boards, cervical collars, triage kit (flags and vests, triage tags, etc.), trauma pads, bur. **Usage:** To be used at any incident that exceeds the resources readily available on the units responding.

16. Mobile Forensics Trailer: Towable trailer designed for use as a forensic evidence collection, documentation, evaluation, and storage site. **Usage:** Used as a central point to collect, catalog, evaluate, and store and evidence related to the incident.

17. Mobile Kitchen/ Dining/ Break Area: Temporary shelter used to prepare food or feed responder crews working the incident scene. Would also contain water, sport drinks, and refreshments to minimize dehydration among workers. Shelter wou.

18. Portable temporary morgue trailer: Refrigerated trailer designed for use as a temporary morgue. Temporary morgue contains necessary equipment such as body bags, body tags, and supplies for documentation. **Usage:** Used for collection, cataloging, and storage of bodies from the incident scene

Figure C.5 Stand-alone resources. (Continued)

19. Radiation Detection Equipment: The following will be needed for radiological surveys: - GEMA mobile lab with germanium gamma spectroscopy detectors - 10 ion chambers for dose rate readings - 10 teletectors with GM detectors for

20. Red Cross: After the first responders (fire and police)get to the scene at the RR: They realize that they need assistance with so many things. The first group they call for assistance is the local Red Cross chap

21. Self Contained Breathing Appartus (SCBA): 100 - Only NIOSH approved SCBAs and the approved replacement parts designated for these SCBAs shall be used. **Usage:**

Temporary Hospital Shelter: Temporary Hospital Shelter set up on site inside the hot zone containing emergency medical supplies, stabilization equipment, gurneys, etc.

22. Temporary Hospital Shelter: Temporary Hospital Shelter set up on site inside the hot zone containing emergency medical supplies, stabilization equipment, gurneys, etc. **Usage:** Utilize to treat immedate life threatening injuries and serious wounds prior to a victim being decontaminated and mobilized to a hospital.

23. Temporary Media Tent: Temporary Tent designed to house media safely away from the scene with access to phone, fax, and internet. **Usage:** The tent will be used to safely house the media and also be the location of periodic press briefings designed to control the flow of information about the event, proper evacuation and precaution information and prevent inaccurate information and rumors from exacerbating the situation.

Figure C.5 Stand-alone resources. (Concluded)

1. Communications response: 5:10 P.M.- EMT's,paramedics with BLS and ALS (basic life support & Advanced Life support) are arriving on scene.They begin to assist victims in the parking lot but are unable to get inside the hot zone inside and around the building until the hazmat teams arrives. While assisting the "walking wounded" first responders are discovering they are having a hard time communicating with the local dispatch and hospitals due to the overload of traffic on the local 800MHZ channels used by the local police and fire departments. The IC on scene informs the IC at the Augusta EOC and he requests the MCV (Mobile Command Vehicle)and personnel to assist with dispatching and call taking on the scene. **Expected Situation/Response:** Amateur Radio will be in place to assist in communications for the first responders from Richmond and Columbia counties, and will "shadow" the IC on scene to free up channels on the system between the scene and IC at the Augusta EOC.

Figure C.6 Stand-alone events.

2. Communications response 2: 5:25-The MCV arrives and communications begin to run more smoothly. Just as it look like things might under control, some citizens have been able to get in what is now a crime scene. The already stressed first responders are having to tend to these people as well as some are going into shock over what they have seen and some are complaining of chest pains. The IC on scene informs the IC at the Agusta EOC of the situation and the EM director realize the resources and man-power are stretched to the limit. A conference call is placed to the SEOC and Richmond and Columbia Counties to request assistance through the local the local mutal aid agreements. Help is promised within the hour, as they have no idea how many will wander on scene and what to expect when the hazmat team gets inside the mall. **Expected Situation/Response:** The EMAC's will allow for assistance of the other counties with resources and personnel.

3. Communications response 3: 6 P.M.- The assistance from Richmond and Columbia Counties begin to arrive to help the first responders already on scene. Upon trying to talk to the local dispatch, they are not being heard as they have different radio systems. A represenative from one of the agencies approaches the IC on scene who then request the EDICS (Emergency Deployable Interoperable Communications system) to patch all the responders together to talk to one another. The IC at the Augusta EOC requests Amateur Radio at the EOC and on scene to release some of the channels being used between IC on scene and at the EOC and to assist with communications until the EDICS is up and running. **Expected Situation/Response:** EDICS will allow all agencies to talk to one another by "patching" them together with radio equipment. Amateur Radio will free up channels being used by the IC on scene and at the EOC.

4. communications repsonse 4: 6:30 p.m.- One radio Operator has arrived at the EOC and 2 on scene,one for Richmond County teams and one for Columbia County, and have begun a emergency net. Net control at the EOC has also started checking availabilty of other radio operators as evacuation orders for residents living in a 30 mile radius of the "warm zone" are expected to come out within the hour and the Red Cross will be opening shelters to house those leaving their homes, and one special needs shelter will open for those with medical conditions that require help of a nurse or caregiver,which will involve the health department. The radio operators who are available are asked to stand by for further instructions. **Expected Situation/Response:** The radio operators will assist in communications for the shelters between the facilities and EOC.

Figure C.6 Stand-alone events. (Continued)

5. communications repsonse 5: 7 p.m.- The local officals have declared a local state of emergency for Augusta and the evacutions orders have come out through radio and televison. At the moment there has been no decision made as to how long the shelters will have to remain open and the Red Cross has been advised that the incident could create the need for them to be active 3-5 days out,depending on the situation .The names and address of open shelters are released and residents are advised to stay away from the scene and given alternate traffic routes to avoid getting exposed to the chemical release that occured when the explosion shattered the glass celings in the food court.Those not asked to evacuate have been advised to keep the windows and air venelation systems off until hazmat can determine exposure levels and not to venture outside unless absolutetely neccesary. **Expected Situation/Response:** The open shelters will house and feed the evacuees until they can return home.

6. 07:15 - Initial Sweep of Inside the Mall looking for Survivors: The hazmat teams enter the mall from the south end to the food court area. Teams are briefed and teamed up with radiation protection technicians from SRS and Plant Vogtle. SCBA's are required for respiratory protection along with plastic suits to protect against becoming contaminated. The briefing the teams receive set radiation dose rate limits at 10Rem/hr, which equates to 166 mRem/min. No team member is allowed to receive more than 5Rem WB for the search phase of the entry unless the determination is made that a saving a life is at stake ,upon which the dose limit is raised to 50 Rem WB for the rescue stage. The health physics technician must survey any area entered and perform a stay time dose calculation estimate based on the radiological conditions to be entered. **Expected Situation/Response:** The search and rescue teams are deployed to look for victims and survivors. What they will find is not known.

7. communications repsonse 7: 7:15- IC on scene requests counslers and psychologists to be available to assist first responders deal with the situation they are working in.

8. contact list: POLICE Above Board Remediation Technologies 10S059 Schoger Dr Naperville, IL 60564 Map (630) 692-1039 City of Naperville 1350 Aurora Ave Naperville, IL 60540 Map (630) 305-5477 City of Naperville - Police Department 1350 Aurora Ave Naperville, IL 60540 Map (630) 305-5477 Geese Police 5S439 Columbia St Naperville, IL 60563 Map (630) 548-9781 Naperville Police Department - Traffic Unit 1350 Aurora Ave Naperville, IL 60540 Map (630) 420-6197 Lisle Police Department 4907 Yackley Ave Lisle, IL 60532 Map (630) 271-4200 Dupage County Sheriffs Dept 511 S County Farm Rd Wheaton, IL 60187 Map (630) 407-2382 Police Dept to The Police PO Box 727 Wheaton, IL 60189 Map (630) 260-2161 Dupage County Sheriffs Dept 501 N County Farm Rd Wheaton, IL 60187 Map (630) 407-2000 City of Wheaton Public Works Dept 821 W Liberty Dr Wheaton, IL 60187 Map (630) 260-2161 Dupage County Sheriffs Dept. **Expected Situation/Response:** The first responders have not worked in such a disaster with so many deaths. The toll on the workers' mental health is expected to be a problem.

Figure C.6 Stand-alone events. (Continued)

9. Deconning Efforts of the Mall and Surrounding Areas: One material affected by Cs + ion transport and contamination are aqueous solutions, concrete and cement. The Cs-137 contamination interacted strongly with cement which will hinder decontamination efforts of the affected areas.

10. Cesium-137 Characteristics: Cesium-137 is a dangerous radioisotope to the environment in terms of it's long-term effects. It's intermediate half-life of about 30 years suggests that it is not only highly radioactive but that it has a long enough halflife to be around for hundreds of years. Besides its persistence and high activity, cesium-137 has the further insidious property of being mistaken for potassium by living organisms and taken up as part of the fluid electrolytes. This means that it is passed on up the food chain and reconcentrated from the environment by that process.

10. Radiological Decontamination Teams begin to set up. : 7:05 pm. Prior to the Hazmat teams entering the incident site, the Radiological Decontamination Team begins setting up their mobile decontamination site. They choose the southeast parking lot as it is downwind of the radiological cloud. The decon team sets up two mobile shower trailers, one for response personnel and one for victims. Water source is via a hookup to a nearby fire hydrant and drums are utilized to capture the contaminated shower water. Victims are required to remove clothing and belongings which are then catalogued and placed in sealed bags for later disposition. Paper scrubs are supplied as victims exit the shower trailer and victims are checked for radiation before being cleared to move to another collection area. **Expected Situation/Response:** Decontamination of personnel and victims as they exit the incident site. Allows some clearance of victims from the site.

11. Additional power sources brought to area: The Richmond County EMA brings to the site two industrial generators to supply power to additional equipment. **Expected Situation/Response:** Additional power will be available for communication equipment, computers, shower trailers, and lighting.

12. Portable Morgue arrives on scene and is set up for use.: Portable refrigerated trailer designed for temporary storage of bodies.

13. FBI Evidence Response Team and Haz Mat Response Unit arrive: FBI office in Atlanta, GA dispatches a specially trained and equipped Evidence Response Team and Hazardous Material Response Unit to provide expertise and coordination of the evidence collection. **Expected Situation/Response:** These FBI teams arrive and take over the evidence collection effort and manage the crime scene.

14. Temporary Media Tent is erected.: Tent designed to house the media is erected to keep media safely away from the incident site while controlling the flow of information. Periodic press briefings will be given at this site by the designated media officer.

Figure C.6 Stand-alone events. (Concluded)

Figure C.7 and Figure C.8 show the details of the two team scenarios after using Collario, together with the discussions.

S#	Time	Event	ID	Create Time
1	05:00 PM 03/30/2009	A device was detonated within 50 feet of the upper level food court inside the Augusta Mall. The ceiling is a glass structure in this area of the mall, which was shattered during the explosion thereby giving a release path to the environment for the radiological plume to disperse. **Expected Action:** Individuals able to exit the mall immediately ran away from the blast and gathered in parking lots outside the mall. Multiple 9-1-1 calls were made to alert authorities of the bomb being detonated.	11	4/10 17:44
2	05:00 PM 03/30/2009	The weather outside was conducive for a maximum effect of ground deposition around the mall and surrounding areas given there was a stable atmosphere with little change in wind direction and a wind speed of ~ 1.0 mph.	11	4/10 17:49
3	05:00 PM 03/30/2009	There are 30 severely injured and possibly dead people in the food court. Those within 100 feet of the blast are highly contaminated with radioactive Cs-137.	11	4/10 17:48
4	05:00 PM 03/30/2009	The entire food court has been highly contaminated by the dirty bomb with dose rates reaching upwards of 5000 Rem/hr (~83 Rem/minute) near ground zero. NOTE:LD 50/30 for radiation dose is ~500-600 Rem without medical treatment.	11	4/10 17:49
5	05:03 PM 03/30/2009	The initial 9-1-1 calls come into both Richmond and Columbia county 9-1-1 centers. **Expected Action:** 9-1-1 dispatchers will start the notification process to pertinent response units. Fire Department Police Department Local EMA's Georgia Highway Patrol	11	4/10 18:19
	#1 Comment	*I have added Unified Command to the communications part. I have included the IC on scene, the fire chiefs from the Richmond and Columbia counties, and the director of the health department.* <u>Confirm related issues regarding comments #2 and #3.</u>	17	4/13 06:04

Figure C.7 Scenario creation and discussion details of the red team.

	#2 Comment	*Both Agencies are responding. The Augusta Mall is right on the border of the two counties and the amount of response needed will overwhelm them both.* Clarify an issue.	11	4/11 05:24
	#3 Comment	*Has jurisdiction been established? Are both agencies responding or just one?* Raise a new issue.	14	4/10 20:18
6	05:05 PM 03/30/2009	Approximately 4% of the radioactive plume has escaped through the exploded glass holes in the ceiling of the mall and is being carried in a NW direction from the mall.	11	4/10 17:50
7	05:05 PM 03/30/2009	FBI, GBI, GEMA and SC EPD - Are notified a bomb has been detonated inside the Augusta Mall **Expected Action:** The following team are immediately dispatched to the event scene: - Civil Support Team out of Atlanta Ga. - GEMA Department of Natural Resources radiological team is mobilized. - SC Dept. of Health and Environmental Control radiological team is mobilized.	11	4/10 18:01
8	05:05 PM 03/30/2009	FBI office in Atlanta, GA dispatches a specially trained and equipped Evidence Response Team and Hazardous Material Response Unit to provide expertise and coordination of the evidence collection. **Expected Action:** These FBI teams arrive and take over the evidence collection effort and manage the crime scene. Reuse stand-alone event #14.	11	4/19 05:00
	#4 Comment	*If you read over our scenario you will recognize this event. I was trying the Event Repository and inserted this into our event.* Indicate a reused event.	18	4/19 11:24

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

9	05:10 PM 03/30/2009	EMT's paramedics with BLS and ALS (basic life support & Advanced Life support) are arriving on scene. They begin to assist victims in the parking lot but are unable to get inside the hot zone inside and around the building until the hazmat teams arrives. While assisting the "walking wounded" first responders are discovering they are having a hard time communicating with the local dispatch and hospitals due to the overload of traffic on the local 800MHZ channels used by the local police and fire departments. The IC on scene informs the IC at the Augusta EOC and he requests the MCV (Mobile Command Vehicle)and personnel to assist with dispatching and call taking on the scene. **Expected Action:** Amateur Radio will be in place to assist in communications for the first responders from Richmond and Columbia counties, and will "shadow" the IC on scene to free up channels on the system between the scene and IC at the Augusta EOC.	11	4/11 05:37
	#5 Comment	*When does the media find out about the emergency? Has the event been shown to the public by now?* Raise new issues.	15	4/13 20:38
10	05:15 PM 03/30/2009	As ambulances and fire trucks arrive, some of the victims have been removed from the mall and are lying in the south parking lot awaiting treatment.	11	4/10 18:02
	#6 Comment	*It would be a good idea to have a triage area created so that all victims are routed to one area and EMS can respond accordingly.* Suggest new content, addressed by scenario event #12.	14	4/10 20:19
11	05:15 PM 03/30/2009	Some victims are dying even though there injuries are not life threatening while the persons who helped the injured are throwing up and feeling extremely sick.	11	4/10 18:02
	#7 Comment	*By this time the FD should be putting 2 and 2 together and seeing that there is something different about this bomb.* Assess the situation.	13	4/15 20:57

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

12	05:20 PM 03/30/2009	EMS identify the need for on-scene triage. After identifying a safe distance, the set-up procedures begin in order to assist the "walking wounded." **Expected Action:** Victims see that help is available and move to the site to be assisted by EMS. Content added addressing comment #6	15	4/17 23:03
13	05:20 PM 03/30/2009	Law enforcement and first responders scan the areas around the incident site for any indication of a secondary device.	11	4/19 04:53
14	05:20 PM 03/30/2009	Both Richmond and Columbia county EOC's are activated. Content added addressing comment #8.	11	4/19 05:04
15	05:25 PM 03/30/2009	The MCV arrives and communications begin to run more smoothly. Just as it look like things might under control, some citizens have been able to get in what is now a crime scene. The already stressed first responders are having to tend to these people as well as some are going into shock over what they have seen and some are complaining of chest pains. The IC on scene informs the IC at the Agusta EOC of the situation and the EM director realize the resources and man-power are stretched to the limit. A conference call is placed to the SEOC and Richmond and Columbia Counties to request assistance through the local EMAC's. Help is promised within the hour, as they have no idea how many will wander on scene and what to expect when the hazmat team gets inside the mall. **Expected Action:** The EMAC's will allow for assistance of the other counties with resources and personnel.	11	4/11 05:38
	#8 Comment	*Should we include a time when the EOC is activated?* Point out a missing part, addressed by scenario event #14.	15	4/18 00:28
16	05:27 PM 03/30/2009	As events escalate, the IC on scene coordinates with the Augusta EOC in the formation of a press release. The media has become aware of the situation. In order to keep the media and public informed in a timely fashion and with reliable information, a press release is necessary.	15	4/17 23:35
	#9 Comment	*The PIO should probably be mentioned here as the one coordinating with the media.* Suggest missing information. Suggest new resource. However, it had never being addressed further.	15	4/18 00:22

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

17	05:25 PM 03/30/2009	Someone decides to call Plant Vogtle and Savannah River Site (SRS) to see if they could send some radiation protection personnel to the mall for surveys as a precaution. **Expected Action:** Both facilities dispatch health physics (radiation protection) personnel to the response site.	11	4/10 18:04
	#10 Comment	*I would assume that at this point the 4th Weapons of Mass Destruction – Civil Support Team would be called in for help. The unit falls under the George Department of Defense's Directorate of Joint Operations. The unit is equipped with chemical, biological and radiological protective and monitoring equipment, along with advanced satellite communications and computer systems. When requested by emergency officials, the unit can rapidly respond to any nuclear, chemical, biological or radiological incident occurring within a five sate region.* Assess the situation and suggesting a new resource. Regretfully, this comment was not addressed further.	13	4/15 21:04
18	05:30 PM 03/30/2009	Both GEMA and SC EPD activate their radiological branches to go to the scene and decide to activate their respective EOC's in Columbia SC and Atlanta, Ga.	11	4/10 18:05
19	05:40 PM 03/30/2009	A press release is issued from the Augusta EOC. The media and public are updated on the response. Press releases will continue to be issued on a regular basis.	15	4/17 23:37
20	05:45 PM 03/30/2009	Plant Vogtle and SRS personnel arrive and realize the extent of the radioactivity is very high and endangering those in the immediate vicinity of the mall.	11	4/10 18:06
21	05:55 PM 03/30/2009	Radiological surveys are taken all around the mall and the plume is discovered on the NW side. Everyone on the NW side is highly contaminated but not life threatening. **Expected Action:** Contaminated individuals are removed from the plume exposure area and place in a low radiation area for decontamination. Initially those highly contaminated to the extent of receiving considerable exposure from their contamination are hosed down immediately.	11	4/10 18:09
	#11 Comment	*These surveys are going to take some time to complete especially given the area they are going to have to cover.* Assess the situation.	13	4/15 21:13

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

22	06:00 PM 03/30/2009	The assistance from Richmond and Columbia Counties begin to arrive to help the first responders already on scene. Upon trying to talk to the local dispatch, they are not being heard as they have different radio systems. A representative from one of the agencies approaches the IC on scene who then request the EDICS (Emergency Deployable Interoperable Communications system) to patch all the responders together to talk to one another. The IC at the Augusta EOC requests Amateur Radio at the EOC and on scene to release some of the channels being used between IC on scene and at the EOC and to assist with communications until the EDICS is up and running. **Expected Action:** EDICS will allow all agencies to talk to one another by "patching" them together with radio equipment. Amateur Radio will free up channels being used by the IC on scene and at the EOC.	11	4/11 05:39
23	06:00 PM 03/30/2009	The first responders from the county jurisdictions help local EMS with on-scene triage. They expect more victims as the response continues.	15	4/17 23:18
24	06:15 PM 03/30/2009	Georgia Highway Patrol setup road blocks to stop all incoming traffic within a 1 mile radius of the Augusta Mall.	11	4/10 18:22
25	06:15 PM 03/30/2009	A press release is issued with updates including the establishment of road blocks within a one mile radius of the Augusta Mall.	15	4/17 23:53
26	06:15 PM 03/30/2009	Tent designed to house the media is erected to keep media safely away from the incident site while controlling the flow of information. Periodic press briefings will be given at this site by the designated media officer.	11	4/19 05:01

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

27	06:30 PM 03/30/2009	One radio Operator has arrived at the EOC and 2 on scene, one for Richmond County teams and one for Columbia County, and have begun a emergency net. Net control at the EOC has also started checking availability of other radio operators as evacuation orders for residents living in a 5 mile radius of the "warm zone" are expected to come out within the hour and the Red Cross will be opening shelters to house those leaving their homes, and one special needs shelter will open for those with medical conditions that require help of a nurse or caregiver, which will involve the health department. The radio operators who are available are asked to stand by for further instructions. **Expected Action:** The radio operators will assist in communications for the shelters between the facilities and EOC.	11	4/16 17:31
28	07:00 PM 03/30/2009	The local officials have declared a local state of emergency for Augusta and the evacuations orders have come out through radio and television. At the moment there has been no decision made as to how long the shelters will have to remain open and the Red Cross has been advised that the incident could create the need for them to be active 3-5 days out, depending on the situation .The names and address of open shelters are released and residents are advised to stay away from the scene and given alternate traffic routes to avoid getting exposed to the chemical release that occurred when the explosion shattered the glass ceilings in the food court. Those not asked to evacuate have been advised to keep the windows and air venelation (venting) systems off until hazmat can determine exposure levels and not to venture outside unless absolutely necessary. **Expected Action:** The open shelters will house and feed the evacuees until they can return home.	11	4/16 17:34
29	07:00 PM 03/30/2009	Two Search and Rescue Teams are being formed and briefed for entry into the mall. **Expected Action:** Unknown	11	4/16 18:47

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

30	07:05 PM 03/30/2009	Prior to the Hazmat teams entering the incident site, the Radiological Decontamination Team begins setting up their mobile decontamination site. They choose the southeast parking lot as it is downwind of the radiological cloud. The decon team sets up two mobile shower trailers, one for response personnel and one for victims. Water source is via a hookup to a nearby fire hydrant and drums are utilized to capture the contaminated shower water. Victims are required to remove clothing and belongings which are then catalogued and placed in sealed bags for later disposition. Paper scrubs are supplied as victims exit the shower trailer and victims are checked for radiation before being cleared to move to another collection area. **Expected Action:** Decontamination of personnel and victims as they exit the incident site. Allows some clearance of victims from the site.	11	4/19 04:50
31	07:15 PM 03/30/2009	IC on scene requests counselors and psychologists to be available to assist first responders deal with the situation they are working in. **Expected Action:** The first responders have not worked in such a disaster with so many deaths. The toll on the workers' mental health is expected to be a problem.	11	4/16 17:37
32	07:15 PM 03/30/2009	In response to requests, the Red Cross contacts volunteer psychologists and counselors who are sent to the scene to offer assistance to responders and victims.	15	4/17 23:27
33	07:20 PM 03/30/2009	An Incident Command Center is established outside of the affected areas.	11	4/10 18:25
34	07:20 PM 03/30/2009	The Richmond County EMA brings to the site two industrial generators to supply power to additional equipment. **Expected Action:** Additional power will be available for communication equipment, computers, shower trailers, and lighting.	11	4/19 04:52

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

35	07:30 PM 03/30/2009	Two search and rescue teams enter the mall. One team enters from the south end and the other the north end to the food court area. Teams are briefed and teamed up with radiation protection technicians from SRS and Plant Vogtle. SCBA's are required for respiratory protection along with plastic suits to protect against becoming contaminated. The briefing the teams receive set radiation dose rate limits at 10Rem/hr, which equates to 166 mRem/min. No team member is allowed to receive more than 5Rem WB for the search phase of the entry unless the determination is made that a saving a life is at stake,upon which the dose limit is raised to 50 Rem WB for the rescue stage. The health physics technician must survey any area entered and perform a stay time dose calculation estimate based on the radiological conditions to be entered. **Expected Action:** The search and rescue teams are deployed to look for survivors. What they will find is not known.	11	4/16 18:45
36	08:00 PM 03/30/2009	The area has been quarantined and posted properly with all personnel removed from the immediate vicinity for decontamination.	11	4/10 18:10
	#12 Comment	*The triage center will be first. The national guard will take some time flying from Atlanta. Although I am not sure how long it would take in an Apache Helicopter which is what they came to the plant in for a demonstration some time back. Bad machine....* Clarify a question.	11	4/15 18:54
	#13 Comment	*Where will the contamination take place? Should the triage center be set up here or should the Hazmat team arrive first?* Raise a question.	15	4/13 20:34

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

37	08:00 PM 03/30/2009	Contaminated personnel are required to undress after a make-shift tent is set-up near the buffer zone boundary and put on paper suits Plant Vogtle employees brought from the plant. In addition, local hospitals have donated patience gowns for when the paper suits ran out. ~250 people need decontaminated and processed through a portable decontamination unit. The contaminated clothing was placed in plastic bags and moved into a designated area away from any people for distance factor to reduce radiation exposure. The bags of clothing will remain in the hot zone until clean-up efforts start and will be disposed of at that time. **Expected Action:** Reduce a major source term of radiation exposure to those exposed to the radioactive plume.	11	4/16 18:23
38	08:00 PM 03/30/2009	Contaminated individuals have been segregated based on contamination levels with the most highly contaminated people >500K dpm/100 cm2 scheduled to go first to reduce radiation exposure. Personal Decontamination Techniques · Wash well with soap and water and monitor skin · Do not abrade skin, only blot dry **Expected Action:** Reduce exposure to external contamination	11	4/16 18:19
39	08:00 PM 03/30/2009	GEMA and the National Guard units out of Atlanta set-up two gender specific mobile decontamination units which include a shower compartment on the boundary of the buffer zone. The shower compartment has a shower head and a drain located therein. There is a means for providing water to the shower head. There is a storage tank connected to the drain to store contaminated water from the shower compartment. There is a means for maintaining the shower compartment at a negative air pressure via a 500 CFM HEPA unit with HEPA filter for radiological airborne concerns during decon. The shower compartment has a shower head and a drain located therein. There are means for providing water to the shower heads and means for heating the water before it reaches the shower heads. A storage tank is connected to the drains for storing contaminated water. The entire structure is inside a berm for total containment of any liquids. **Expected Action:** Decontaminate personnel out of the hot zone.	11	4/16 18:16

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

40	08:00 PM 03/30/2009	Reporters, family members, and other agencies are calling nonstop wanting information. **Expected Action:** A Joint Information Center is established and a Chief Information Officer is appointed. This is where all calls are referred to for current information.	14	4/11 22:09
	#14 Comment	*A news release should have been sent out within an hour of the responders arriving and determining an IC. And during that release a hot line number should have been given. To my understanding GA should have something set up that would aid in the process.* Assessing situation. Suggest actions.	13	4/15 21:09
	#15 Comment	*It may be constructive to set up a hotline for family members and others to call to find out more information.* Suggest a solution.	15	4/13 20:36
	#16 Comment	*Who are they calling? emergency management? 911? or the Red Cross? And what specific information are they looking for?* Point out deficiencies. Unfortunately, this comment was not fully answered.	17	4/12 16:18
41	08:15 PM 03/30/2009	Personnel start to be processed through the decontamination unit. They are required to shower with tepid water and mild soap to remove the gross contamination. A step off pad configuration is set-up to designate the clean area (<100dpm/100cm2 and <100cpm/area under probe of frisker). If personnel are under the contamination limits they are transported to a local hospital for blood work to determine the amount of radiation exposure during the event. Victims will also be given Prussian blue which has been used to treat people who have been internally contaminated with radioactive cesium (mainly Cs-137)Doctors must prescribe Prussian blue at any point after they have determined that a person who is internally contaminated would benefit from treatment. Prussian blue will help speed up the removal of cesium from the body. **Expected Action:** Individuals are released from the buffer zone after being deconned to acceptable levels.	11	4/16 18:35

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

42	Cesium-137 Characteristics	Cesium-137 is a dangerous radioisotope to the environment in terms of its long-term effects. Its intermediate half-life of about 30 years suggests that it is not only highly radioactive but that it has a long enough half-life to be around for hundreds of years. Besides its persistence and high activity, cesium-137 has the further insidious property of being mistaken for potassium by living organisms and taken up as part of the fluid electrolytes. This means that it is passed on up the food chain and reconcentrated from the environment by that process.	11	4/16 19:40
43	08"30 PM	Unified command becomes active as fire chiefs from Columbia and Richmond counties are arriving on scene, and the health department director arrives as well. Staff from the local Red Cross has arrived in a local ERV to offer assistance with feeding the first responders. One of the volunteers happens to be a grief counselor and offers their help to survivors and the first responders. This was not planned but works out well as the IC on command had requested counselor and psychologists be available to help with the metal stress occurring from this sort of response. An information hotline has been opened at Augusta Emergency Management. The telephone personnel will have information about shelter openings, general information about the incident, and school closing for the next day, and they will take people's name if someone calls stating they are looking for someone that might have gone to the mall. There is a Red Cross liaison in the information center who will try to cross reference an **Expected Action:** Unified command allows for all the management of response personnel be in one place for the incident rather than scattered about" doing their own thing". The Red Cross ERV will provide meals and related support to response personnel.	17	4/13 05:38

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

44	08"30 PM	The EDICS has finally arrived in Augusta but it has taken time to get to the county, but it is still not close to the scene yet. The agency host of the system for the region is actually a couple of hours away. The responder with the EDICS reports to their own agency that they have been slow to arrive because of the traffic tie ups that are occurring all over the place. The EDICS is a large and cumbersome vehicle and trailer and does not move anywhere fast. Citizens are also becoming panicky because of all the media reports from the scene and even those who do not need to leave the area have begun to evacuate Augusta to go stay with other family members so traffic problems are only worsening. Amateur Radio is still in place at the EOC and on scene at the command post so the arrival of the EDICS is not a issue at the moment. Once the EDICS does arrive response will not begin immediately. It will take time to setup the equipment which can take up to an hour or more, depending on whether the responder has assistance setting it up. **Expected Action:** The EDICS will allow all the responding agencies to talk to one another even though they have different radio systems. Amateur Radio is providing the communications support until the EDICS arrives and is setup.	17	4/13 06:01
45	8:40	Things are going smoothly, but the radios that the first responders showed up on scene with are starting to fail as they are losing battery power. Personnel are trying to charge them but it is taking too long and some of the battery chargers are not working correctly. IC on scene has notified IC in the August EOC of the situation. The IC on scene is assuming the EDICS will have a cache of radios with it when it arrives.	17	4/18 13:38
46	8:50	The EDICS has arrived on scene and has started setup of the equipment. The EDWARDS satellite downlink will be setup to have internet access as well. The IC on scene speaks to the radio specialist that arrived with the EDICS about the using the cache of radio and chargers that usually are in an EDICS, but the cache of radios is not with the EDICS as the radios have not undergone rebinding requirements to meet the new standards for use of frequencies. **Expected Action:** The specialist recommends requesting the use of the MARC (Mutual Aid Radio Cache) from the county.	17	4/18 13:52

Figure C.7 Scenario creation and discussion details of the red team. (Continued)

47	8:55	The IC on scene has notified the IC at the Augusta EOC that the cache of radios is not with the EDICS and is requesting the use of MARC. The MARC tower will not be needed since the EDICS has arrived but someone from the county will have to retrieve the radios from the storage area. The person who normally maintains the cache is out of town and will be unable to bring them out to the scene. **Expected Action:** The MARC will provide the relief needed since the radios that the response personnel are using are beginning to use up battery life. The ham radio operators remain on scene to assist with the communications.	17	4/18 14:04
48	8:55	Portable refrigerated trailer designed for temporary storage of bodies is brought to the site.	11	4/19 04:58

Figure C.7 Scenario creation and discussion details of the red team. (Concluded)

Seq	Time	Event	ID	Create Time
1	17:30 4/25/2009	It is a beautiful spring day in Naperville, Illinois. The sun is shining and the wind is lightly out of the west at 20 mph. The local population of 150,000 is returning from work and looking forward to firing up the barbeque. The DHS National Threat Level is elevated for the State of Illinois as a result of recent activities and threats from a local environmental group.	18	4/11 14:10
2	17:55 4/25/2009	Local police are receiving calls about a large truck abandoned on a grassy area alongside the Manchester Road railway crossing. There does not appear to be anyone in the truck. **Expected Action:** Event entered for dispatch to check out suspicious vehicle.	18	4/11 14:12
3	18:00 4/25/2009	There has been a large explosion at the Manchester Road railway crossing. The explosion has resulted in the derailment of a passing CN train carrying hazardous cargo. The fireball from the explosion is obscuring most of the scene but it appears that several cars are tipped over on their sides.	18	4/11 14:12

Figure C.8 Scenario creation and discussion details of the blue team.

4	18:02 4/25/2009	Emergency Communication Officers for Fire, EMS and Police are overwhelmed with phone calls reporting a large explosion, derailed tanker cars turned on their sides and possibly several casualties who had just debarked from the Metro public transportation system at this park and ride station. **Expected Action:** Dispatchers will immediately alert first responders of a large explosion following mass-casualty incident protocols. Appropriate notifications will be made. Dispatchers across Police, Fire & EMS will share information to form a complete picture of the incident. Someone will connect the previously reported suspicious vehicle with this incident and advise first responders.	18	4/11 13:20
5	18:05 4/25/2009	Naperville Police Department arrives on scene. They begin scene assessment. A large crowd has developed due to the explosion. Multiple victims are scattered all over the area. **Expected Action:** Officers begin first aid on victims until EMS arrive. They request community service officers for traffic control and public works to bring barricades for crowd control. They also set up a scene perimeter to protect the crime scene. Traffic has backed up on either side of the tracks. Police close off access to the area. Police request Communications to notify CN Rail	14	4/11 16:43
	#1 Comment	*Okay, let's assume they are smrt. We'll just leave that as a question on "expected actions."* Agree on the clarification.	*18*	*4/15/ 18:35*
	#2 Comment	*I'm not sure. What do you think? As an officer I would assume the initial officers are smart and steer clear of the hazardous material (to include staying up wind of it). They should just do scene assessment, crowd control, evacuation if necessary, and treat victims that can be treated safely. Usually all officers are given hazmat training so they should know what to do. It depends on where you want to go with the scenario.* Clarify the issue.	*14*	*4/14 15:09*
	3# Comment	*Tx ...(Name deleted). Do the police consider this to me a hazmat event and approach from upwind or do the Fire department arrive and find a police officer down from the leaking gas that can't be seen yet because of all the black smoke from the propane fire?* Raise a new issue.	*18*	*4/11 17:52*

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

6	18:06 4/25/2009	Police on scene advise dispatch of the possibility that this event is a result of a bomb and request the bomb squad to respond. They also advise dispatch to update other responders with this information and caution them to be aware of the possibility of a secondary device. **Expected Action:** Bomb squad is paged by dispatch. Evidence of explosive device prompts considerations of a terrorist attack. Police advise Communications to notify FBI.	14	4/17 08:57
	4# Comment	*Has any action been taken to assess and preserve the area as a crime scene?* Raise a new issue.	*15*	*4/18* *10:59*
7	18:06 4/25/2009	EMS arrives on scene. There are multiple victims with a large array of injuries. Some massive and some minor. **Expected Action:** A triage area is set up in a safe zone. EMS personnel begin locating and treating victims. They request back up and mutual aid to assist with the numerous victims. They also call Edward Hospital to notify them of incident, victim numbers, and treatments	14	4/11 16:39
8	18:07 4/25/2009	First EMS personnel to respond and bystanders in the immediate area are experiencing adverse affects, in particular, coughing, chest tightness, burning sensation in the nose, throat and eyes, nausea and vomiting. The responders back out of the area and advise all people in the area to move out of the area. **Expected Action:** EMS recognizes the symptoms of chlorine exposure and pulls back to a cold zone until appropriate PPE can be delivered.	16	4/13 09:34
	5# Comment	*I was wondering if EMS would go to the scene without taking any precautions. Did they know the train was carrying hazardous materials?* Challenge the possibility.	*15*	4/18 00:17
	6# Comment	*Most EMS services are trained to ask what is involved, such as what is the truck carrying or what was the train carrying. Maybe following the inadequate equipment might be the way; however, there is always the possibility to just rush in without thinking.* Propose another possibility.	*12*	*4/15* *13:35*

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

	7# Comment	*I think you meant to say "bystanders." You have to be the one to make that correction, please and thanks!* Suggest correction of a typo.	*18*	*4/13 18:02*
	8# Comment	*I like this. Let's develop this one a bit. Did they race in without considering contamination or is their PPE inadequate?* Enquiry for a possibility.	*18*	*4/13 10:08*
9	18:07 4/25/2009	Fire Department and the Chief on Duty arrive on scene. They observe several residual fires and possible hazardous materials on the ground. **Expected Action:** The COD sets up a incident command. The engines begin to control the fires. The Hazmat team is called out to identify the material and contain it.	14	4/11 16:45
10	18:17 4/25/2009	The Fire department has staged outside the affected area. They immediately relay to the HAZ-MAT team they have a potential IDLH environment surrounding the scene.	16	4/13 09:38
	9# Comment	*Immediately Dangerous to Life and Health* Explain an acronym.	*11*	*4/15 19:01*
	10# Comment	*Can we spell out IDLH (for me for a start :)* Request clarification of an acronym.	*18*	*4/13 10:11*
11	18:17 4/25/2009	EMS have evaluated the scene and requested all available units to respond, as well as the shift supervisor. The first unit on scene begins to establish a staging area for EMS units and equipment. **Expected Action:** Shift supervisor acknowledges and is en route to the scene. Additional units have been dispatched to the incident.	12	4/12 17:46
12	18:20 4/25/2009	Naperville Bomb Squad arrives on scene. **Expected Action:** The team does an assessment of the scene and the device used. They also check for secondary devices.	14	4/17 08:58

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

13	18:20 4/25/2009	EMS Shift Supervisor arrives on-scene and determines that this incident will overwhelm their capabilities. He contacts dispatch and requests an all call for additional personnel from his service and requests units from neighboring services. **Expected Action:** Dispatch performs an all call out for additional available personnel. Dispatch contacts neighboring EMS agencies and requests available units for response to this incident and provides them with instructions on where to report to and who to report to when they arrive on-scene.	12	4/12 18:00
14	18:20 4/25/2009	Due to the overwhelming need of EMS mutual aid needs to be utilized.	14	4/15 08:20
15	18:30 4/25/2009	HAZMAT team arrives on scene and sets up zones. They suit up and begin testing for different types of hazardous material. **Expected Action:** HAZMAT team identifies chlorine gas and notifies COD (incident commander). They also communicate via telephone with CN's Emergency Response Team to attempt to get manifest information and other details of the cargo.	12	4/12 18:45
	11# Comment	*Good job Bob, Thanks.* Express Appreciation.	*12*	*4/16* *11:42*
	12# Comment	*Air Compressor also for both scenarios.* Provide another resource.	*11*	*4/15* *19:03*
	13# Comment	*The SCBA's are for both scenarios. The ITX's, Draeger pumps and Draeger tubes are for your scenario only. Who says I am not a team player?* Provide a resource.	*11*	*4/15* *18:58*
	14# Comment	*Can we use the same resources that the other team is putting in or should I enter the same information as what is already in there.* Request to reuse a resource.	*12*	*4/15* *13:16*
	15# Comment	*What are they using to test the air? Let's add that to the resources.* Ask for a resource.	*18*	*4/13* *19:45*

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

16	18:30 4/25/2009	A Command Post is established upwind of the incident and the Incident Command System is implemented with the local Fire Chief assuming the role of Incident Commander. **Expected Action:** ICS is appropriately implemented given the size and scope of the incident. The Commander takes into account the resources that are required not only to deal with this incident but to respond to other "routine" events that may be occurring in this area. Implementation of ICS is providing smoother communications although the lack of interoperable radio systems in the area is hindering tri-services communication.	18	4/19 10:24
17	18:30 4/25/2009	HAZMAT team also sets up a decontamination area in the warm zone. **Expected Action:** To decontaminate all persons exiting the hot zone. This includes workers and victims. Patients must be decontaminated prior to transport by EMS to the hospital.	12	4/15 13:26
18	18:40 4/25/2009	the Haz-Mat team has detected large readings of Chlorine gas as well as detectable amounts of phosgene gas	16	4/13 09:40
19	18:45 4/25/2009	Communications Center reports that they are overwhelmed with calls from residents who are trapped on the other side of the tracks from their residences. A daycare and a seniors' nursing home have both called in seeking instructions. **Expected Action:** Has the public warning system been activated? What message is being provided? Was a PIO appointed upon implementation of the ICS?	18	4/13 19:47
20	18:50 4/25/2009	the haz-mat team has referenced the Emergency response guide book and determined that there needs to be a one mile isolation zone surrounding the haz-mat scene. The chlorine gas and phosgene gas are both heavier than air and therefore will effect low lying areas to include the potential for ground contamination and water sources. **Expected Action:** Has the HAZMAT team contacted CHEMTRECH who can provide detailed information about the chemical agents and can assist in contacting shippers and transporters for more details.	16	4/16 12:51
21	18:50 4/25/2009	The IC contacts dispatch to notify CN Rail to stop all rail traffic to this area.	12	4/15 13:01

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

22	18:50 4/25/2009	CN Rail's Emergency Response Team is notified. The National Response Team is notified as required by law. **Expected Action:** Trained members from CN's award-winning REACT team that has trained over 5,000 rural responders in incidents involving dangerous goods are notified and en route. Has someone notified CN Rail to stop all rail traffic into the area?	18	4/13 19:27
23	18:50 4/25/2009	Naperville's Community Emergency Response Team (CERT) has been activated. The team is knowledgeably in hazmat incidents, transportation incidents, and terrorist events.	16	4/20
24	18:50 4/25/2009	A large cloud of greenish, yellowish gas has begun to form and is moving slowly to the east towards a residential area. **Expected Action:** Incident Command will address the issue of evacuating or sheltering in place and how to best communicate to diverse populations in a timely manner. Has specialized equipment been requested from mutual aid partners to predict cloud dispersal. Should some people be told to shelter-in-place. How will this message be delivered? Should people farther out evacuate?	18	4/13 19:14
25	18:55 4/25/2009	Local news media arrives on scene. **Expected Action:** News media is trying to get as close as possible. LE attempts to contain them and sets up a staging area for the media. Has PIO been appointed? Are messages going out to media consistent? Have police, Fire and EMS communications centers been updated so that they are providing callers with consistent, accurate information?	12	4/12 18:56
	16# Comment	*A press release may a good idea as well.* Suggest another action.	*15*	*4/18* *10:55*
	17# Comment	*Good point, Shannon beat me to it.* Applause another person's contribution.	*12*	*4/15* *13:04*
	18# Comment	*Perhaps as an expected action we could add "I/C appoints a Public Information Officer" to ensure consistent and accurate information is delivered to the media.* Suggest an action.	*18*	*4/13* *19:16*

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

26	18:56 4/25/2009	The Emergency Manager contacts the public services officer and asks him to be in charge of media contact. **Expected Action:** Public services officer responds to scene and holds a press conference. The officer also advises media personnel that he is the point of contact for all information. He asks that the media and public stay away from the area due to the hazardous material. He asks all citizens looking for loved ones to please be patient, they police and hospital will be working together to contact family members as soon as possible. A 1-800 number is given out for people to call with any information about the incident. If they saw anything or anyone that will help catch the bomber.	14	4/15 08:06
27	18:56 4/25/2009	EMS Shift Supervisor contacts dispatch and requests that all hospitals within a 100 mile radius be notified of this incident and placed on standby to receive patients. Also, requests that air medical be notified and on standby pending a landing zone setup and staging area for helicopters. **Expected Action:** Dispatch notifies hospitals and air medical. EMS Shift Supervisor communicates with fire department Chief on Duty and LE and begins planning for a staging area for air medical and to try to locate personnel to man the LZ. Radio traffic at this time is very heavy, creating a hazardous situation for any responding helos.	12	4/12 19:08
28	18:57 4/25/2009	North Central College administration and security is notified. They are advised that they should be on standby for evacuation and notify students to stay away from the area. **Expected Action:** Security helps to maintain order on campus and also be prepared to start evacuating if necessary. Administration will be prepared to handle calls from students and the students' families. They will be given the current information to disseminate and the number to give out for people to call.	14	4/15 20:40
29	18:57 4/25/2009	The Dupage Children's Museum supervisor is notified. This museum is only a couple of blocks away from the explosion. **Expected Action:** The museum should report any illnesses. If none, it should be evacuated and closed down.	14	4/15 20:44
30	19:00 4/25/2009	EOC is activated. **Expected Action:** Expected that there is a callout list for EOC activation and that senior personnel from support agencies arrive.	18	4/13 19:19

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

31	19:00 4/25/2009	FBI office in Atlanta, GA dispatches a specially trained and equipped Evidence Response Team and Hazardous Material Response Unit to provide expertise and coordination of the evidence collection. **Expected Action:** These FBI teams arrive and take over the evidence collection effort and manage the crime scene. Reuse stand-alone event #19	18	4/19
	19# Comment	*This insert comes from ... (Name was deleted) of the Red Team. I was trying out the Event Repository where you could take a previously prepared event and insert it into any scenario. Thanks Connie!!* Indicate source of the event.	*18*	*4/19* *11:23*
32	19:15 25/2009	The EOC is trying to bring order. There is already widespread evacuation in progress. There is a lot of work to be done with the multiple injuries and death. They must conduct a door to door search to help people who cannot help themselves and those who may be stuck. Police have received updated risk models from EPA and begin door-to-door evacuations in some areas and advise others to shelter-in-place.	20	4/13 22:10
33	19:30 4/25/2009	CN Rail's Emergency Response Team is now on the scene they are try to figure out what happen and the point of origin. They are having a very difficult time due to the fact that everything is quarantined off. Since this is a serious issue everyone has mask on for there protection and the news team is asked to leave for their own safety. The Emergency response teams are still getting all the resident out of harm's way. Everything is coming together and most of the resident is evacuated.	20	4/13 22:36
34	19:30 4/25/2009	Additional EMS units and personnel have arrived, a group of EMS personnel along with a group of LE have arranged an LZ for air medical upwind and a safe distance away from the incident to prevent rotor wash from worsening the cloud. **Expected Action:** An LZ is in place with good communications directly to the responding ships for their safety and to help prevent a collision from having multiple ships coming into or leaving from the same area.	12	4/16 11:52

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

35	19:45 4/25/2009	The EOC command calls in the Red Cross for assistance. The RC arrives with food, water, and resources for a temporary shelter for those that need it. They also provide additional volunteer nurses and a liaison for the EOC. If additional help is needed the Salvation Army has agreed to step in and assist with the mass care for workers and citizens. (The RC also operates under a ICS system and can expand as needed so more can happen if we need it to.)	8	4/16 22:25
36	19:45 4/25/2009	Edward's Hospital has plenty of doctors and nurses on hand to handle the sick and injured so they are waiting for EMS to bring people in.	8	4/16 23:01
37	19:45 4/25/2009	Central Dupage Hospital is notified. They are asked to be on standby for an over flow of victims. **Expected Action:** CDH calls in extra staff, sets up a decontamination area, and prepares for arrival of victims.	14	4/17 08:55
38	20:00 4/25/2009	IC contacts dispatch and requests the Department of Public Utilities be notified of the potential for contamination of the watershed area around the incident. **Expected Action:** Dispatch contacts the City of Naperville Department of Public Utilities and they are sending a representative to the command post.	12	4/17 20:08
39	20:00 4/25/2009	IC also determines that the Illinois Environmental Protection Agency should be notified. **Expected Action:** Dispatch contacts the Illinois EPA.	12	4/17 20:12
40	20:00 4/25/2009	the hazardous material technicians have taken air sample readings 1/4 mile from the impact site and determined the air safe from harmful contaminates. they have also used PH Strips to take readings from nearby streams and have deemed them safe and uncontaminated. The hazmat team has deduced that the gas cloud has dissipated enough for it not to effect anything greater than a 1/4 mile distance down wind.	16	4/20
41	20:30 4/25/2009	Dukes Oil Serv Inc has just volunteered to help with the clean up.	20	4/18 00:45
42	21:00 4/25/2009	Environmental Protection Agency has now been notified and is on their way. this will help out a lot	20	4/18 00:47

Figure C.8 Scenario creation and discussion details of the blue team. (Continued)

43	23:00 4/25/2009	With all the agency in place and try to work toward clean u this disaster things are looking better. Everyone is still keeping in touch with the evaluation post and we have received word of great progress. The EOC has really got everything flowing great	20	4/18 00:55
44	23:00 4/25/2009	Department of Public Utilities worker checking the water.	20	4/18 00:56
45	23:00 4/25/2009	The public water system has tested negative for contamination. Local streams and ponds have tested negative for contamination. The EOC and Naperville Hazardous materials teams has reduced the affected area to the immediate area of the blast radius itself.	16	4/20
46	23:00 4/25/2009	Winds have dissipated the cloud contaminate throughout the day. The hazardous material technicians have taken air sample readings at the blast site. The blast site no longer contains and IDLH atmosphere. the blast area has been deemed safe to begin triage of effected victims and scene clean-up.	16	4/20

Figure C.8 Scenario creation and discussion details of the blue team. (Concluded)

APPENDIX D

INSTITUTIONAL REVIEW BOARD (IRB) APPROVALS

NEW JERSEY INSTITUTE OF TECHNOLOGY

Institutional Review Board: HHS FWA 00003246
Notice of Approval
IRB Protocol Number: E97-07

Principal Investigators: Xiang Yao and Murray Turoff
Information Systems

Title: Investigation of a Collaborative Knowledge Exchange System for Scenario Creation

Performance Site(s): Off-Site Sponsor Protocol Number (if applicable):

Type of Review: FULL [ ] EXPEDITED [X]

Type of Approval: NEW [X] RENEWAL [ ] REVISION [ ]

Approval Date: June 28, 2007 Expiration Date: June 27, 2008

1. **ADVERSE EVENTS:** Any adverse event(s) or unexpected event(s) that occur in conjunction with this study must be reported to the IRB Office immediately (973) 642-7616.

2. **RENEWAL:** Approval is valid until the expiration date on the protocol. You are required to apply to the IRB for a renewal prior to your expiration date for as long as the study is active. Renewal forms will be sent to you, but it is your responsibility to ensure that you receive and submit the renewal in a timely manner.

3. **CONSENT:** All subjects must receive a copy of the consent form as submitted. Copies of the signed consent forms must be kept on file with the principal investigator.

4. **SUBJECTS:** Number of subjects approved: 120.

5. The investigator(s) did not participate in the review, discussion, or vote of this protocol.

6. **APPROVAL IS GRANTED ON THE CONDITION THAT ANY DEVIATION FROM THE PROTOCOL WILL BE SUBMITTED, IN WRITING, TO THE IRB FOR SEPARATE REVIEW AND APPROVAL.**

Dawn Hall Apgar, PhD, LSW, ACSW, Chair IRB June 28, 2007

NJIT NEW JERSEY INSTITUTE OF TECHNOLOGY

Institutional Review Board: HHS FWA 00003246
Notice of Approval
IRB Protocol Number: E97-07

Principal Investigators: Xiang Yao and Murray Turoff
Information Systems

Title: Investigation of a Collaborative Knowledge Exchange System for Scenario Creation

Performance Site(s): Off-Campus Sponsor Protocol Number (if applicable):

Type of Review: FULL [ ] EXPEDITED [X]

Type of Approval: NEW [ ] RENEWAL [X] REVISION [X]

Approval Date: September 26, 2008 Expiration Date: September 25, 2009

1. **ADVERSE EVENTS:** Any adverse event(s) or unexpected event(s) that occur in conjunction with this study must be reported to the IRB Office immediately (973) 642-7616.

2. **RENEWAL:** Approval is valid until the expiration date on the protocol. You are required to apply to the IRB for a renewal prior to your expiration date for as long as the study is active. It is your responsibility to ensure that you submit the renewal in a timely manner.

3. **CONSENT:** All subjects must receive a copy of the consent form as submitted. Indications of consent must be kept on file with the principal investigator.

4. **SUBJECTS:** Number of subjects approved: 120.

5. The investigator(s) did not participate in the review, discussion, or vote of this protocol.

6. **APPROVAL IS GRANTED ON THE CONDITION THAT ANY DEVIATION FROM THE PROTOCOL WILL BE SUBMITTED, IN WRITING, TO THE IRB FOR SEPARATE REVIEW AND APPROVAL.**

Dawn Hall Apgar, PhD, LSW, ACSW, Chair IRB September 26, 2008

APPENDIX E

CONSENT FORM

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Evaluate a Collaborative Knowledge Exchange System (CKES) for Scenario Generation

RESEARCH STUDY:

I,_____, have been asked to participate in a research study under the direction of Dr(s). Dr. Murray Turoff Other professional persons who work with them as study staff may assist to act for them.

PURPOSE:

The purpose of this study is to evaluate the effects of the Collario (Collaborative Scenario) system on supporting the discussion and creation of scenarios in virtual teams.

DURATION:

My participation in this study will last for 2-5 weeks with approximately 1-2 hours per week. Totally, it will take 2-10 hours, including taking tutorials and answering questionnaires.

PROCEDURES:

I have been told that, during the course of this study, the following will occur:
All the following steps will be done through web browsers.
The subject reads the study introduction before clicking on "Next" button.
The subject reads the Consent Form.
The subject needs to indicate his/her consent by clicking on "I Agree" button.
The subject fills out a pre questionnaire.
The subject goes through the on-line tutorial.
The subject finishes a small exercise about scenario creation.
The subject starts working on a specific emergency scenario using the Collario system. The subject is suggested to check the Collario system at least once a day for the new contents.

At the end of the period (two to five weeks depending on the group and task) the researchers will present the post survey, hold a debriefing with the group either face to face or online, and conduct selected interviews based upon the feedback obtained from the post surveys.

PARTICIPANTS:

I will be one of about __120__ participants to participate in this study.

EXCLUSIONS:

I will inform the researcher if any of the following apply to me:
All subjects must be 18 years old and above.

RISKS/DISCOMFORTS:

I have been told that the study described above may involve the following risks and/or discomforts:

As an online participant in this research, there is always the risk of intrusion by outside agents (i.e., hacking) and, therefore the possibility of being identified exists.

The experiment is not being run through a secure http connection, so your messages might be visible to experienced attackers.

There also may be risks and discomforts that are not yet known.
I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:

I understand confidential is not the same as anonymous. Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:

I have been told that I will receive $0 compensation for my participation in this study.

RIGHT TO REFUSE OR WITHDRAW:

I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:

If I have any questions about my treatment or research procedures, I understand that I should contact the principal investigator at:

Dr. Murray Turoff
Information Systems Department
New Jersey Institute of Technology
Newark, New Jersey 07102
Email: murray.turoff@njit.edu
Telephone: 973-361 6680

If I have any addition questions about my rights as a research subject, I may contact:

Dawn Hall Apgar, PhD, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 642-7616
dawn.apgar@njit.edu

APPENDIX F

SURVEY QUESTIONNAIRES

Pre-Survey Questionnaires

Important: Please don't forget clicking on the "Submit" button when you finish the survey. Thank you very much!

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1. Your first name is: _____ (required)
   Your last name is: _____ (required)

2. Your gender is:
   ☐ Male ☐ Female

3. Your age is: _____ years.

4. Ethnic background (check one):

   ☐ Black/Afro-American
   ☐ Hispanic
   ☐ White/Caucasian
   ☐ Asian or Asian-American
   ☐ Other , please specify _____

5. Your native language is: _____

6. Please check all the conditions applying to you.

   ☐ I am an undergraduate students. Years in undergraduate programs: _____
   ☐ I am a Gradudate student. Years in undergraduate programs: _____
   ☐ I am a part time student.
   I am employed by _____
   My job function/title is _____

My undergraduate degree is _____ in _____ (subject)

My highest graduate degree is _____ in _____ (subject)

7. I have _____ years of work experience for emergency management.

8. Check below to indicate experience related to emergency management.

- ☐ None (This scenario creation will be my first exposure to this feld.)
- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 3-5 years
- ☐ 5-10 years
- ☐ More than 10 years

9. If not obvious from your work job title/function above indicate in a very concise statement the nature of your work experience:

10. Have you been invovled in emergency scenario creation process before?

☐ Yes ☐ No

11. Have you been involved in using scenarios for planning purposes?

☐ Yes ☐ No

12. Have you been involved in using scenarios for training purposes?

☐ Yes ☐ No

For the following questions, please the one most appropriate response to each question. Fill in teh answer that best fits your immediate reaction. Do not spend a long time on each item: Your first reaction is probably the best one. Do not worry about projecting a good image. Your answers are strictly confidential.

13. My work or educational experience will aid my participation in this scenario creation task:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

14. In general, I see my primary objectives as a participant in this scenario creation task: (Rank order those that apply from 1 to N, with 1 being the most siginificant one to you, etc.
Feel free to add additional objectives if you do not see it in the list:)

Rank	Objectives for participation
☐	To learn more about planning methods.
☐	To learn more about emergency preparedness.
☐	To learn more about scenario creation.
☐	To get some extra credit in a course.
☐	To contribute to improving the scenarios.
☐	To have fun or enjoy myself.

Not see your objectives in above list, please add your own below:

☐ ☐
☐ ☐
☐ ☐

15. To create the particular scenarios is very interesting to me.
Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

16. Given my own constraints, I will put as much effort into this scenario creation as I can:
Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

17. I feel nervous to express my opinions in a team.
Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

18. I am experienced in working in teams:
Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

19. How easy/difficult did you EXPECT to create teh particular scenarios in virtual team:
Easy ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Difficult

20. I expect to be able to contribute a great deal in creating the scenarios:
Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

21. How frequently do you use email or chat:

- ☐ not at all
- ☐ less than once a week
- ☐ less than an hour a week
- ☐ one to two hours a week
- ☐ two to five hours a week
- ☐ more than five hours a week

22. How many times have you used an asynchronous conferencing (stored discussion) system such as WebBoard, WebCT, Blackboard, etc.:

- ☐ None (This is my first course)
- ☐ Once or Twice
- ☐ Three to Five times
- ☐ 5-20 times
- ☐ more than 20 times

23. I believe it is difficult to design good plans for man-made disasters.

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

24. I believe it is difficult to design high-quality scenarios for evaluating plans in emergency preparedness:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

25. This scenario creation task will motivate me to do my best work:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

26. I feel very prepared to work on this scenario creation task:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

27. Generally, I am comfortable participating in group discussions:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

28. I expect to learn much from my teammates in creating the scenario:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

29. If there is something you would like to express or comment on not covered in the above questions please feel free to included it here:

Post-Survey Questionnaires

Important: Please don't forget clicking on the "Submit" button when you finish the survey. Thank you very much!

(Your identity will be removed and replaced by a code for processing of the data)

1. Your Last Name is: _____ (required)

Your email address is: _____ (This is to send you research reports and publications in the future.)

For the following questions, please the one most appropriate response to each question. Fill in teh answer that best fits your immediate reaction. Do not spend a long time on each item: Your first reaction is probably the best one. Do not worry about projecting a good image. Your answers are strictly confidential.

2. To what degree was the collaborative scenario creation exercise enjoyable to you?

Extremely boring ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Extremely enjoyable

3. To what degree was the collaborative scenario creation exercise relevant to your job responsibilities?

Extremely irrelevant ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Extremely relevant

4. On the average I participated:

☐ less than 1 hour in a typical week

☐ 1-3 hours per week

☐ 3-6 hours per week

☐ 6-10 hours per week

☐ more than 10 hours per week with an average of _____ hours per week and _____ logins per day.

5. To what degree did the group leader make the group's roles clear?

Extremely clear ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Extremely unclear

6. To what degree did the group leader make the group's priorities and directions clear?

Extremely clear ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Extremely unclear

7. The group leader wisely anticipated workflow problems and takes necessary actions to avoid crisis?

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

8. To what degree did the group leader bring a sense of order into the group?

Very chaotic ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Very orderly

9. Overall, the group leader did an excellent job:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

10. Overall, the functions of leadership were well served:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

11. The people in my group were very trustworthy:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

12. We were usually considerate of one another's feelings on this team:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

13. The people in my group were friendly:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

14. I could rely on those with whom I worked in my group:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

15. I find Collario is useful for creating emergency scenarios:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

16. I find using Collario is useful in promoting knowledge sharing and learning from peers:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

17. I find using Collario enables groups to create emergency scenarios more quickly:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

18. I find using Collario increases a group's collaboration and group wide understandings:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

19. I find using Collario increases the amount of group discussion about the contributions of individual members:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

20. I find my interaction with the group is clear and understandable when using Collario:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

21. I find it easy for a group to become skillful for using Collario:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

22. I find it easy to discuss scenarios asynchronously using Collario:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

23. I find it easy for me to learn to use Collario to discuss scenarios asynchronously:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

24. I believe my manager would support me to try the system:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

25. I believe my professional friends would support me to use the system:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

26. My group members give me a lot of help to use the system:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

27. In general, my group has supported me trying the system:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

28. I have the resources necessary to use the system at home as well as at work:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

29. I have the knowledge necessary to use the system:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

30. I have enough training before using the system to work on the scenario:

Strongly Disagree ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Strongly Agree

For the remaining open-ended questions, please give your answers based on your experiences of using Collario.

31. What features in Collario do you think most useful? (optional)

32. What features in Collario make you most trouble? (optional)

33. Do you have any suggestions or comments on how to improve Collario? (optional)

34. Will you recommend the Collario to your colleagues? Why? (optional)

35. If there is something you would like to express or comment on not covered in the above questions please feel free to included it here: (optional)

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