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ABSTRACT

Simulation is perhaps the most widely used method for training emergency management workers. Despite its wide application, traditional simulation suffers from several constraints and limitations, which motivate us to pursue a different way – virtual simulation, as an alternative and supplement for the traditional training method. Utilization of groupware, network, and other information technologies makes virtual simulation more flexible and easier to prepare. Although virtual simulation can overcome some of the constraints related to physical simulation, so far there are little evidences that this new method can achieve similar or even better training effects compared with traditional simulation training method. To test the effects of this new training approach and the methodology to run it, several pilot trials have been conducted in the U.S. and Europe. This article is an exploratory study of a pilot emergency preparedness planning virtual simulation conducted in NJIT in late 2004. This study will help us understand the nature of virtual simulation, and help us improve the theories and designs of virtual simulation for emergency preparedness.

Keywords

Emergency Management, Training, Virtual Simulation

INTRODUCTION

Emergency management training is highly challenging work. Traditional simulations use physical fidelity methods such as using fire, bandage, and casualties. These methods cannot catch up with the new requirements of "creative" and extreme disasters like the 9-11 attack and the East Asia Tsunami. It is urgent and necessary to break through the intrinsic deficiencies in traditional simulation. These deficiencies, include rigid scenario design, lack of active participant involvement, difficulty including all key players, the expense to conduct, etc.. To design a new training method, Information Technologies provide an excellent platform. Groupware software like Webboard and WebCT provide both synchronous and asynchronous communication approaches. Threaded discussions can organize and record team discussions for later review. Networks connect dispersed users through the Internet, so physical attendance won't be necessary. Based on the new information technical platform, Turoff proposes a new kind of simulation – Virtual Simulation (Turoff, Chumer, Walle, Konopka, & Yao, 2005). A big difference between virtual simulation and traditional simulation is that there is no pre-established model or rule in virtual simulation. Participants play the virtual simulation through discussion and imagination. These researchers want to show that the new method can provide benefits such as flexibility, easy to conduct, and fostering critical and creative thinking.

Since this is a totally new training method, there is no existing empirically confirmed methodology for utilizing it. The authors attempt to provide a preliminary justification based on research on different domains such as planning, cognitive psychology, and social psychology. This methodology includes four components: information seeking, scenario composing, mental rehearsal, and critical thinking. It is expected to guide our following trials of the virtual simulation training.

CHALLENGES OF TRADITIONAL EMERGENCY MANAGEMENT SIMULATION TRAINING

Simulation is probably the most widely used and the most effective method to train emergency management workers. Its fidelity can create tensions and stimulate emotions similar to real emergency/disasters. This is thought useful to practice skills and reveal potential problems in real situations (Kleiboer, 1997). However, the effects of simulation training are not unquestionable. Borodzicz distinguish psychological fidelity from physical fidelity (Borodzicz & Haperen, 2002). It is not easy to reproduce very similar emergency/disaster scenes and it is even harder for participants to produce similar feelings. Simulation with high fidelity is costly and time-consuming to prepare. It is not unusual for some simulation training to be practiced only once a year. Furthermore, both Borodzicz and Robert have noticed the same problem of improper simulation design in compromising training effects (Borodzicz et al., 2002; Robert 2002). The rigidity of scenario design cannot keep up with the more creative threats like the 9-11 attack. On the other hand, it is possible that some emergency/disaster handling instructions may be wrong, or not suitable in specific conditions. Investigation of AA587, which took off from New York City in 2001, and crashed only 103 second later in Queens, shows that the first officer overreacted in dealing with wake turbulence caused by a Boeing 747. Ironically the pilot did follow the instructions, and applied rudder inputs below design maneuvering speed. The disaster occurred partly because instructions provided for handling wake turbulence provided by the airliner's pilot training program are good at low-speed, but devastating when applied at high-speed (Garvey, 2002; Ivey, 2004). With these constraints, traditional simulation training method seems not enough to prepare emergency workers. We need more flexible training method to empower our responders.

NEW APPROACH

Virtual Emergency Planning Simulation

Addressing the problems and challenges of traditional emergency management training methods, Turoff et al. began to pursue new training approaches (Turoff, Chumer, Van de Walle, and Yao 2004; Turoff et al., 2005). They wanted to renovate emergency management training so that it can be: 1. flexible; 2. easy to deliver; 3. steering critical thinking; 4. fostering creativity.

The result is a virtual emergency planning simulation that can be played with group collaboration software such as Webboard and WebCT (Turoff et al., 2005). (Detailed introduction of the game is in the next section) It is called "virtual" because 1) participation in the simulation occurs in virtual space. No physical participation is necessary. 2) No scenario is pre-determined. Attack scenarios are a byproduct of this virtual simulation. 3) No modality is pre-defined. Virtually any possibility is acceptable in this simulation. The play of this simulation is somewhat like what is depicted in the Chinese movie "Hero": There is a dueling scene between two Gong Fu wizards, who both stand still for a long time with violent fighting in their minds and then finish their stalemate with only one real attack. In the proposed EM preparedness simulation, all the attack and defense between the opposite teams occur in their imagination without real destruction or damage. This kind of simulation has the potential to release any constraint imposed on traditional training methods.

1. It is flexible. Such simulation can accommodate virtually every emergency/disaster type. No specific scenario is needed at the beginning of the simulation. No specific model is needed.

2. It is easy to deliver. The only required pieces of equipment are a PC, an Internet connection, and an appropriate groupware server package. People do not need to be on-site; they do not even need to attend the simulation at the same time. There is also no limitation of the location of the participants and no constraint on when they individually participate.

3. In addition to the two obvious benefits, as a feasible training method, virtual simulation has to provide added value to trainees. Theoretically, this is possible. Virtual simulation is an on-line collaborative learning environment. Dillenbourg summarizes three social theories for collaborative learning. According to social-constructivism theory, conflicts of viewpoints during group discussion can stimulate learners to correct wrong concepts and improve mental models. According to social-cultural theory, the feeling of peer support can help individuals to study difficult materials

and accomplish complex tasks (Dillenbourg, Baker, &O'Malley, 1996). Both of these are useful to help participants to think deeply, critically, and creatively.

Mechanism to Play the Virtual Emergency Planning Simulation

Since this is unconventional simulation, it is necessary to understand mechanism its use. Turoff's article, "Scenario Composing", introduces the method as a useful planning tool (Turoff et al., 2005). The article is a good start, but this is not enough (Turoff et al., 2005). A broader study of literature shows that "Mental Rehearsal" and "Critical Thinking" can be critical in *imagery* game playing. We will discuss these three methods and at the end of this section, give a synthesized mechanism model for playing the on-line emergency preparedness simulation.

Scenario Composing:

Scenario is a set of activities or events related to "what-if" situations (Fahey, 2000). Scenarios are used in a wide range of applications, especially in planning. Information system analysts use scenarios to gather requirements by writing use cases. Decision-makers use scenarios to prepare for future possibilities (Duncan & Wack, 1994). Fahey found that scenario learning is one useful way for managers to anticipate future trend and make use of it in fast-changing markets (Fahey, 2000). For the emergency management domain, Turoff mentions: "The way we understand and try to analyze a real crisis situation is by investigating and relating series of events." (Turoff et al., 2005)

The literature shows that scenarios are a good approach to solve complex, unstructured problem within a structured environment (Kavakli, Loucopoulos, & Filippidou 1996). It also creates a systematic solution to the problem set (Kavakli et al. 1996). It has these effects because scenarios provide a way to decompose and decrease the complexity of difficult problems to a manageable level. Through scenarios we can prioritize the opportunities or threats and put our scarce and valuable resources to producing the greatest return.

Mental Rehearsal

Mental rehearsal is widely used in training athletes, preparing for speech or job interviews, playing chess, etc.. It is the key approach for mental practice, a method using mental exercise to improve performance. Driskell does a comprehensive literature review on mental practice and provides the definition as "the cognitive rehearsal of a task in the absence of overt physical movement" (Driskell, Copper, & Moran, 1994). We use the term of mental rehearsal, not mental practice, in considering that practice implies the purpose of improving specific skills. We emphasize mental walkthroughs for the attack scenarios and defense plans to judge the feasibility and identify the pitfalls of each. Diskell's research focus on mental practice is to determine individual performance improvement (Driskell et al., 1994). Our emphasis is in finding a method suitable for use in group collaboration.

Previous studies showed mixed effects of mental practice on performance (Driskell et al., 1994; Shanks & Cameron, 2000; Smith & Collins, 2004). This mixed result intrigued Driskell enough to study when mental rehearsal takes effect. Driskell found task type, retention interval, experience, duration, and type of control as factors affecting performance of mental practice. It was confirmed that cognitively complex tasks prefer mental rehearsal (Driskell et al., 1994). Our simulation requires lots of cognitive activities where it is likely that mental rehearsal will increase learning.

Critical Thinking:

Critical thinking is a scrupulous learning method. It is also a questioning attitude. People adopting this method tend to use their own judgment in determining what to believe and what not to believe. This seems important for emergency management, since during emergencies, we are surrounded by a huge amount of information that may or may not be correct. Critical judgment is necessary for emergency managers to discern truth from "noise." Douglas found two greatest enemies for critical thinking: gullibility and rigidity (Douglas, 2000). Things are far more complex. Emergency management is collaborative work, involving many people in many different departments and organizations. We may not fully understand what other people do and how they come to a conclusion. Under the high pressure of emergencies or disasters, there will be no time for clarification of every concern. Sometimes we will have to trust other people blindly.

Synthesized Model:

As a synthesis of the previous discussion, we can now present a preliminary methodology for imagery on-line emergency preparedness simulation training. The methodology is illustrated in figure 1. Solid lines represent flow of information or thoughts. Dotted lines mean the effect of supporting or affecting of one component on another component.

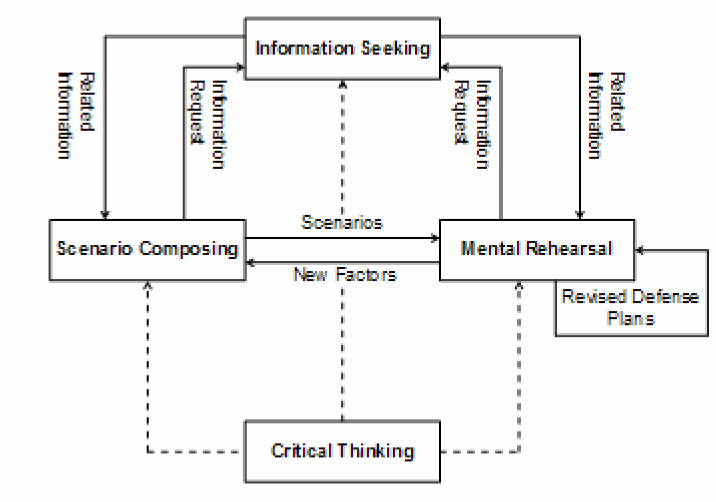

Figure 1: Methodology to Play Emergency Preparedness Simulation

CASE STUDY

The first emergency preparedness simulation-training program in NJIT was conducted from October to December, 2004. There were 23 undergraduate students initially participated in the experiment, and 19 in the end. In this section, we are going to introduce this trial of the virtual simulation-training program, summarize the observations, and give discussion to the observations. The insights we obtain from this pilot trial will be able to help us improve the design and the methodology of the virtual emergency preparedness simulation training.

Brief Introduction

Participants

The participants were divided into three groups: attack team, defense team, and intelligence team. The teams are comprised as shown in table 1:

	Attack Team	Defense Team	Intelligence Team
Beginning	7	8	8
End	7	4	8

Table 1: Constitution of the Teams

In addition to the 23 participants, there was a Overall Game Director (OGD), monitoring the progress of the simulation gaming. Since there was no spy role and evaluation team in this trial, the Overall Game Director was also responsible for information leaking and resource application approval.

Tasks & Roles:

The targets of this experiment were museums, art galleries, and historical landmarks in New York City. The attack team was asked to design attack scenarios to discredit the institutes. The defense team was asked to make defense plans to protect them from attack. The intelligence team received an attack spy report (made by OGD in this trial) and made a defense intelligence report, which was sent back to the defense team by the Overall Game Director.

Processes:

The first week is a socialization week. From the second week to the fourth week, for each week, there was a round of competing between the defense team and the attack team. Monday through Friday during these four weeks is discussion time for the defense team and the attack team. Both of these two teams were required to submit a report by Friday midnight. On Saturday morning, the OGD (spy in general design) would prepare a spy report and post it in the intelligence team's private conference. By Sunday midnight, the intelligence team would post its intelligence report in their private conference, which would be transferred by the OGD into the private conference of the defense team.

Platform:

Webboard was the only information-exchanging platform in this simulation game. Webboard is an asynchronous web-based threaded discussion system, which allows administrator to define private and public conferences. Private conferences can only be accessed by some participants, and not by others, so they can be used for inter-group discussion for the different groups in this simulation. The participants were assigned pen names. None of them knew the real identities of their peers. They were not allowed to use email systems, chat, or messenger. In the beginning of the game, the OGD creates different private conferences for the defense team, the attack team, and the intelligence team. Nobody in one group can view another group's discussion, except the "public defense plans". All in the group can view the defense team's private conference.

Observation & Analysis

A. Observation about team activity:

A.1 Attack team is more active than intelligence team; and intelligence team is more active than defense team.

A comparison of the individual contributions (number of postings) shows this difference:

Attack Team		**Defense Team**		**Intelligence Team**	
Mars11	36	Jupiter11	0	Mercury11	8
Mars12	28	Jupiter12	27	Mercury12	15
Mars13	22	Jupiter13	0	Mercury13	39
Mars14	42	Jupiter14	6	Mercury14	4
Mars15	10	Jupiter15	13	Mercury15	3
Mars16	11	Jupiter16	0	Mercury16	6
Mars17	41	Jupiter17	0	Mercury17	5
		Jupiter18	10		
Total	190	Total	56	Total	80

Table 2: Contributions in Different Teams

Attack team members from the beginning of the experiment showed higher degree of involvement. They were more active in volunteering for jobs. They were more reactive to their peers' postings. They were more supportive. The intelligence team had a responsive team leader. Although not all the participants jointed the discussion frequently, they could still post weekly intelligence report in time. Defense team had the most students withdraw from the experiment and didn't post weekly defense plans until the third week.

Analysis: The different level of involvement is from a variety of reasons. Leadership definitely is one. A deeper study shows that the task characteristic may be another factor. Daft & Lengel uses two-force framework (uncertainty vs. ambiguity) to analyze organizational information processing features (Daft & Lengel, 1984). Here, we use this framework to study task complexity of the three roles. In our emergency preparedness simulation, uncertainty represents the degree of unpredictability about where the attack will be, and ambiguity stands for the level of unsureness about how a specific attack will be conducted. We can match three teams' information processing characteristics into this framework and get the following result.

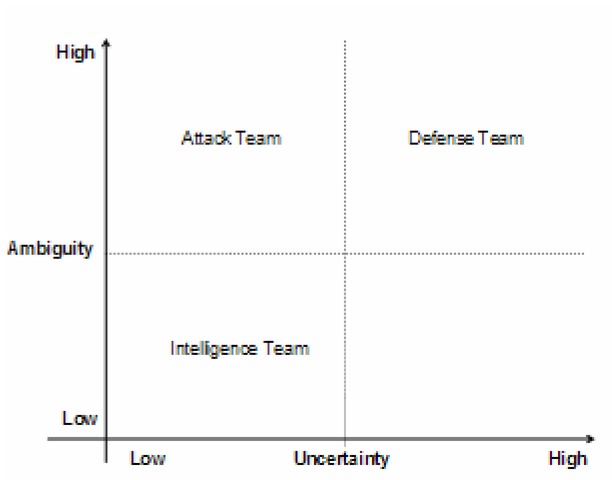

Figure 2: Two-Force Framework on Information Requirement in Emergency Simulation

From this diagram, relative task complexity of the three roles can be illustrated as below:

Defense Team > Attack Team > Intelligence Team

With this framework, we can then explain the different levels of activity:

The defense team is faced with the most complex work. Not only they did not exactly know what the threats were, but they were not sure how to handle each threat. Considering the large number of possibilities, what the defense team did is really difficult. This makes the participants feel frustrated in the lack of progress, thus choosing an avoidance strategy.

The intelligence team is faced with the least complex work having access to both defense plans and partial attack plans. The availability of specific information decreases the uncertainty, the ambiguity and the complexity of the information requirements. The less challenging work made some students feel less motivated. The good thing is that even if the contributions of this team were dominated by the team leader, he/she could still handle it.

The attack team is different from the other two as the work was neither too complex, nor too simple. The expectation to make other people busy and to show off their intelligence makes this team highly self-motivated. Medium complexity makes them comfortable doing their job.

B. Observations about the platform

B.1 Pre-defined discussion threads were not favorable.

To help participants organize their discussion, we created several root items in Webboard in advance. The attack team members did not to like this arrangement. They were the most active team. They felt the rigidity of the pre-defined root items did not help to fulfill their discussion requirements. Table 3 shows this situation:

	No. of pre-defined root items	No. of used pre-defined root items	No. of newly created root items
Attack Team	12	6 (with 3 used by OGD)	8
Defense Team	17	11 (with 3 used by OGD)	17 (The team leader didn't make a good arrangement)
Intelligent Team	12	9	10

Table 3: Discussion root items distribution

This phenomenon may be explained with AST (Adaptive Structuration Theory) that on-line discussion groups choose the best coordination structure for themselves, instead of following that determined by the designers (DeSanctis, 1991). This result gives us good hints in the optimization of the discussion threads.

B.2 Webboard

In this experiment, a large proportion of students complained about the inconvenience of Webboard in supporting their group discussion. Some students had not used Webboard before. One student said he/she didn't know how to mark read messages. This is not a unique case because several other students had similar problems.

A lesson from this pilot experiment is that we cannot assume that the users have Webboard experience. We should make tutorials for the students who are not familiar with it.

B.3 other tools

Some students mentioned they wanted other collaboration tools such as messenger or chat. Some students said e-mail or a face-to-face meeting would be very useful. Although the last two approaches are not what we want, the integration of chat or messenger into our game should be very useful. Webboard provides chat function. MSN messenger can record the discussion history. Both of them are good candidates for further experiments.

C. Observations about the participant perception

C.1 Attack team members tend to feel the task is simple; while defense team members tend to feel the task is difficult.

From the complexity analysis in the previous section, we have shown that compiling defense plans is hard work. Compared with the attack team, the defense team was confronted with more options and option combinations. For N possible ways to inflict damage, attack team can pick up any one or several ways. In contrast, the defense team needs to prepare for all combinations. This is an asymmetrical situation. The perception of the participants reflects this situation.

We need a differential treatment of the teams. The differential treatment can be assigning more people into the defense team, power them with better tools, and give more advanced training in emergency preparedness. The methodology should be told to the defense team at the beginning of the simulation. Such treatment will help make the defense task easier and let the teams have a fairer play.

C.2 Information Overload

Students in this experiment generally felt information overload. Although we expected them to work around three hours per week, many of the students reported they work three to six hours a week. Reading through all the postings is time-consuming. Additionally, they had to do research on the Internet. Of all three teams, the defense team felt the highest level of information overload.

Dealing with information overload is an important skill for emergency workers. Proper collaboration can leverage the efforts of each team member. Also, visualization techniques, such as concept maps, can help decrease information overload (Kremer & Gaines, 1994). There already exists groupware with concept mapping tools supporting on-line asynchronous discussions (Kremer & Gaines, 1996). It would be interesting to apply such visualization tools to help lower information overload and task complexity.

D. Other Observation

D.1Creativity

Creativity is what we want to see through the team's competitive interactions. This goal was not achieved in this experiment, because the defense team didn't submit defense plans during the first two weeks. The anticipated competitive interaction did not occur. Despite this, the attack team became smarter in preparing their attacks in the following ways:

1. Knowing there was leak of their attack scenario, the attack team posted a fake plan on the day they were required to submit their real plan. They posted their real one on the day of an actual "attack".

2. They continually changed attack targets, to confuse the defense team as to their real purpose.

With these sparks in the game, we can expect more creative ideas in future experiments as we improve the design and the tools.

D.2 Focus

In this trial, we gave the attack team a broad range of targets in New York City and asked them to create attack scenarios against them. We did not restrict the choice of institutions nor the type of attack. The attack team tried different "victims" using different approaches in the four weeks of play. This confused the intelligence team and the defense team creating extra work to catch up with changes.

A better way is to get the goals more focused. We can ask the attack team to attack a specific institute. We can also express in advance the criteria for judging the effects of the attack. This will benefit all the teams by expending less energy leaking information and performing deeper research.

D.3 Feedback

In this experiment, the students generally thought feedback was a problem that needed to be improved. Some students thought there was too little involvement by the Overall Game Director, while some students thought there were too much. The role of the Overall Game Director needs more careful design.

Timely feedback is a very important ingredient to make the game interesting. This feedback has two levels:

1. Reports must be delivered to proper parties on time.
2. Evaluation of the weekly attack and defense reports must be given to the participants in a timely manner.

Level one feedback is operational. Feedback in this level guarantees a smooth, on-going game. Level-two feedback is motivational. This kind of feedback can give players an impression of how good their job is compared to their competitors, and thus stimulate them to improve their plans. Only with this level of feedback can our emergency response training be called a game.

Such kind of feedback can give players an impression of how good their job is compared to their competitors. This can stimulate them to improve their plans. Only with this level of feedback can our emergency response training be called a game.

In our pilot trial, we only facilitated the operational feedback. This is a major shortcoming of this round of the experiment. In an ideal situation, we should have a group of experts as judges, who score defense effectiveness every week along several dimensions. All the teams can see the scores and in this way know their advantage or disadvantage.

IMPLICATION

The exploration of the pilot virtual simulation provides several hints for those who would like to try virtual simulation for their training purposes. First, it is necessary to carefully design the simulation tasks. The tasks should be neither too flexible, nor too strict. Second, simulation director should take into consideration planning experience of the participants. If the participants have little related experiences, it is necessary to provide them guidance to make plans. Pre-simulation lecture and plan templates are all good forms of help. Third, it is necessary to carefully choose groupware for the virtual simulation. Webboard has limitation in functionality and usability, making it hard to be proper tool. Ideally, specially designed virtual simulation platform, like the one we are developing which integrates brainstorm, planning process support, scenario-composing, and scenario-playing is recommended.

FUTURE WORK

We will continue improving our virtual simulation training method, especially the design of usable simulation programs and the development of simulation-playing software. In addition to these, we are also interested in studying the pedagogical basis and mechanisms of virtual simulation can add values to emergency planning training. Our ultimate goal is to make virtual simulation a practically useful training method.

CONCLUSION

Emergency management training is important and challenging. Virtual simulation is potentially a good alternative and supplement to traditional, physical simulation. This new form of simulation can provide flexibility, ease of preparation, and the opportunity to stimulate critical and creative thinking. Since this is a totally new type of simulation, a lot of its own challenges need to be solved before this new training method can generate expected results.. This article makes a preliminary attemp to underpin the mechanism of this new kind of training form. The four components: information seeking, scenario composing, mental rehearsal, and critical thinking, are thought to be useful in real emergency preparedness planning. With practices in these four activities in virtual simulation, the new training method can help improve participants' abilities. A case study of the pilot trial conducted in New Jersey Institute of Technology in 2004 shows a lot of other issues, such as complexity, platform, information overload, and coordination. The case study shows that there is still a long way to go for this new training method to be effective. We must continue to improve the methodology and design of this training method to get to its potential.

REFERENCES

1. Borodzicz, E., & Haperen, K. V. (2002) Individual and group learning in crisis simulations, *Journal of Contingencies and Crisis Management* 10(3): 139-147.
2. Cannon-Bowers, J. A., & Salas, E. (2000) Individual and team decision making under stress: theoretical underpinnings, Making Decisions under Stress, J. A. Cannon-Bowers, & Salas, E. Washington D.C., American Psychological Association**:** 17-38.
3. Daft, R. L., & Lengel, R. H. (1986) Organizational information requirements, media richness and structural design, *Management Science* 32(5): 554-571.
4. Desanctis, G. P., S. (1991) Understanding the difference in collaborative systems use through appropriation analysis, *Proceedings of the Twenty Fourth Hawaii International Conference on System Sciences*, Hawaii, IEEE Computer Society Press.
5. Dillenbourg, P.; Baker, M.; Blayer, A.; and O'Malley, C. (1994) The evolution of research on collaborative learning, Learning in Human and Machines: Towards an Interdisciplinary Learning Science, D. P. Reimann, & H. Spada, Oxford: Pergamon: 189-211.
6. Douglas, N. L. (2000) Enemies of critical thinking: lessons from social psychology research, *Reading Psychology* 21(2): 129-144.
7. Driskell, J. E., Copper, C., & Moran, A. (1994) Does mental practice enhance performance? *Journal of Applied Psychology* 79: 481-492.
8. Duncan, N. E. W., P. (1994). Scenarios designed to improve decision making, *Strategy and Leadership* 22(4): 18-25.
9. Fahey, L. (2000). Scenario learning, *Management Review* 89(3): 29-35.
10. Garvey, H. F. (2002). Safety recommendation, Washington, D.C., Federal Aviation Administration
11. Ivey, D. J. (2004). NTSB board meeting AA flight 587, operational factors, Washington, D.C., National Transportation Safety Board
12. Kavakli, E., Loucopoulos, P. & Filippidou, D. (1996) Using scenarios to systematically support goal-directed elaboration for information system requirements, *In Proceedings of the IEEE symposium and workshop on engineering of computer based systems* (ECBS '96): 308-314.
13. Kleiboer, M. (1997) Simulation methodology for crisis management support, *Journal of Contingencies and Crisis Management* 5(4): 198-206.
14. Klein, G. A. (1989). Recognition-primed decisions, Advances in man-machine systems research, W. B. Rouse. Greenwich, CT, JAI Press**:** 47-92.
15. Kremer, R., & Gaines, B. R. (1994) Group concept mapping techniques, *The 12th Annual International Conference on Systems Documentation*
16. Perrow, C. (1984) Normal accidents: living with high-risk technologies, New York, Basic Books.

17. Rijpma, J. A. (2003) From deadlock to dead end: the normal accidents - high reliability debate revisited, *Journal of Contingencies and Crisis Management* 11(1): 37-45.
18. Robert, B., & Lajtha, C. (2002) A new approach to crisis management, *Journal of Contingencies and Crisis Management* 10(4): 181-191.
19. Shanks, D. R., Cameron A. (2000) The effect of mental practice on performance in a sequential reaction time task, *Journal of Motor Behavior* 32(3): 305-313.
20. Smith, D., Collins, D. (2004) Mental practice, motor performace, and the late CNV, *Journal of Sport & Exercise Psychology* 26(3): 412-416.
21. Turoff, M., Chumer, M., Van de Walle, B. V., & Yao, X. (2004) The design of a dynamic emergency response management information system, Journal of Information Technology Theory and Application.
22. Turoff, M., Chumer, M., Van de Walle, B. V., Konopka, J., & Yao, X. (2005) Crisis planning via scenario development gaming, Working paper for ISCRAM.