# Experiences and Insights Using A Virtual Emergency Operations Center

**Cynthia Nikolai**
**University of Notre Dame**
**cnikolai@nd.edu**

**Michael Prietula**
**Emory University**
**prietula@bus.emory.edu**

**Gregory Madey**
**University of Notre Dame**
**gmadey@nd.edu**

**Irma Becerra-Fernandez**
**Florida International University**
**becferi@fiu.edu**

**Troy Johnson**
**Miami-Dade County Emergency Management**
**troy.johnson@miamidade.gov**

**Matthew Mooney**
**University of Notre Dame**
**mmooney3@nd.edu**

**Rahul Bhandari**
**Florida International University**
**rbhan001@fiu.edu**

**Keywords:** virtual Emergency Operations Center, Exercise, Training, Emergency Management

**Abstract**

Hurricane Katrina was one of the most expensive and devastating natural disasters in American history. Over half a million people were affected by the hurricane, and the US energy infrastructure was severely damaged. In fact, parts of the Gulf are still recovering from Hurricane Katrina to this day. Hurricane Katrina and other natural disasters clearly show the need for improvements in crisis management, especially in training and collaboration among federal, state, and local governments. Stemming from this need, in 2007, the National Exercise Division within FEMA's National Preparedness Directorate introduced and implemented the National Exercise Program. a socio-cognitive technical simulator and training facility for emergency managers and a tool for cognitive scientists to study the process of critical decision-making in emergency conditions. Specifically, we are creating a virtual Emergency Operations Center (vEOC). In this paper, we describe our experiences and insights using a virtual vEOC.

## 1. INTRODUCTION

One area in which training is critical is at the Emergency Operations Center (EOC). An EOC is a secure location where upper-level emergency managers and elected officials gather to prepare for, manage, and coordinate the response to an disaster (tsunamis, earthquakes, hurricanes, pandemics, etc). See Figure 1.

Activating an EOC is a rare occasion, but because of their location and experience with hurricanes, the EOC in Miami-Dade County, Florida, has a significant number of activations. It also makes Miami-Dade County an ideal location for emergency preparedness training and research.

Thus, in this research, we have been working with Miami-Dade County to design and develop a socio-cognitive technical simulator and training facility for emergency managers and a tool for cognitive scientists to study the process of critical decision-making in emergency conditions. Specifically, we are creating a virtual Emergency Operations Center (vEOC).

**Figure 1.** An Emergency Operations Center. This photograph was taken during an annual EOC exercise

## 2. THE MIAMI-DADE EOC

In day-to-day operations, emergency management staff at Miami-Dade are involved in preparedness and mitigation strategies for future crises [7]. They are organized into 5 functional groups: Health and Human Services, Systems, Planning and Preparedness, Infrastructure and Recovery, and Personnel and Administration.

When a disaster strikes, however, the emergency management staff drop their day-to-day roles and take on the role assigned to them by the Incident Commander. This role usually involves leading a section or branch of the incident command system or ICS [16]. There are four main groups in accordance with ICS: operations, planning, logistics, and finance/administration. Operations at Miami-Dade is further organized into four branches: Public Safety, Human Services, Infrastructure, and Municipal. Planning consists of Geographic Information Systems (GIS), the 311 Public Information Call Center, and three units to aid in incident planning and documentation. Finally, Logistics is divided into EOC Support and Disaster Resources. The operations, planning, logistics, and finance/administration sections constitute the general staff. Leading the general staff and assuming responsibility for the incident is the Incident Commander. The Incident Commander has additional support staff as well, called the command staff, which includes a public safety officer, a public information officer, and a liaison officer. [15].

## 3. TRAINING AND EXERCISE

Training and exercise are critical to the success of emergency management at the EOC: "Building essential response capabilities nationwide requires a systematic program to train individual teams and organizations – to include governmental, nongovernmental, private-sector, and voluntary organizations – to meet a common baseline of performance and certification standards. Professionalism and experience are the foundation upon which successful response is built. Rigorous, ongoing training is thus imperative." [5]

### 3.1. State of the Crisis Management Training

In the current crisis management arena, much of the training is conducted via live or face-to-face exercises. [1] There are a number of limitations, however, to current training solutions. First, crises, by definition, are rare events, and therefore they do not enable extensive training. Moreover, in the middle of a crisis, few organizations have the time or resources to train new personnel; Their foremost concern is on stabilizing the crisis, not on training individuals. [22] Another limitation of face-to-face solutions is that there are few experts available, and each expert is inherently constrained by limited time, experience, and perspective. [22] In addition, there is the difficulty of training teams, training selective components of the incident command hierarchy, and training upper-level managers. [13,22] In fact, while there are multiple computer-based solutions available for first responders, current research identifies a general lack of computer-based training that targets upper-level emergency managers. [1] Moreover, the training that does take place can be ineffective because most instructors use subjective measures and usually end up emphasizing outcomes over decision management processes. Finally, in face-to-face and instructor-centric solutions, there are usually inherent time delays in the feedback as experts analyze the student's progress, compare the student's actions and outcomes to the expected actions and outcomes, and tailor the feedback to the individual. [22]

### 3.2. Simulation-Based Computer Solutions to Emergency Management Training

Simulation-based computer solutions to training, on the other hand, can adequately address these limitations. simulation-based training allows emergency managers to train new personnel without being in the middle of a disaster. Moreover, simulation-based training allows personnel to train more frequently than they otherwise would be able to in live and face-to-face exercises. In addition, they enable distributed access to data, resources, communication, and even the training itself. Computer simulations also enable teams to train selective portions of the emergency management hierarchy. Finally, whereas feedback has delays in non-computer solutions, feedback can be immediate in a computer-based simulation system.

### 3.3. Crisis Information Management and Training Systems

Recognizing the need for computer-aided training and incident management, Miami-Dade, along with several other counties in the region and throughout the state of Florida, began using Crisis Information Management Systems. In fact, many state EOCs have begun using CIMS as well. [10]

One feature incorporated into many CIMS is a training simulator. The main problem, however, with these simulators is that they typically are cumbersome to set up and run exercises. Setup involves going through hundreds or thousands of entries from various logs and modifying them to create a simulation.

## 4. ENSAYO: A VIRTUAL EMERGENCY OPERATIONS CENTER

In our research, we have designed and developed a socio-technical simulator and training facility for upper-level emergency managers. There are several key features of this software. First, it targets upper-level emergency managers, hereafter referred to as emergency managers. Second, it allows emergency managers to access databases and resources, to coordinate emergency response, and to train in a virtual environment. Since our system is web-based and distributed, it allows mangers to train from location from any computer that has a web browser. Third, this system has special feedback mechanisms that tell the emergency manager the effects of his/her decisions. These mechanisms are called dashboards, and they take the form

of charts and graphs of critical data that vary depending on decisions made. See Figure 2. Finally, another aspect that makes this system unique is that individuals are still able to train even if all personnel are not present at the EOC. In particular, we augment the environment with artificially intelligent agents to facilitate training even if all of the trainees are not available.

## 5. vEOC DESIGN

We designed the vEOC using the agile software development methodology [2]. In particular, the development to data has included 4 major cycles. First, we began with a proof-of-concept prototype. After receiving positive feedback on this prototype [16], we began production development. In the first iteration, we began with the trainee console (See Figure 3). We decided to model it as a windows based user interface approach because of the resemblance to WebEOC, a system with which many EOCs are familiar. [10]. This was followed by development of an Exercise Developer Console, which in turn was followed by development of an Exercise Controller (See figure 4). Next we integrated Geographic Information Systems (GIS), Logistics, and administrator functionality. Finally, we concluded with a researcher console. All in all, so far, there are 18 different modules in the vEOC. At each step along the way, we had validation points with Miami-Dade, and after 2 years, we were ready to have an exercise.

## 6. EXERCISE METHODOLOGY

Now that the software was complete, the next step in our research was to put the software to use in an exercise. For the exercise, we invited Troy Johnson, from Miami-Dade County to Notre Dame for a vEOC off-site. In addition, we invited 5 volunteers from the Cyber-informatics Laboratory at Notre Dame, 5 volunteers from an Engineering Projects in Community Service (EPICS) class, and 2 remote individuals (one in Miami, FL and one in Tampa, FL). The individuals fulfilled one of four roles, the exercise developer, the exercise controller, the trainee, and the researcher, as described below.

**Exercise Developer:** This is the individual who develops, player handbooks, status reports, target capabilities, exercise objectives, and scripts.

**Exercise Controller:** This is the individual who moderates the flow and pace of the exercise.

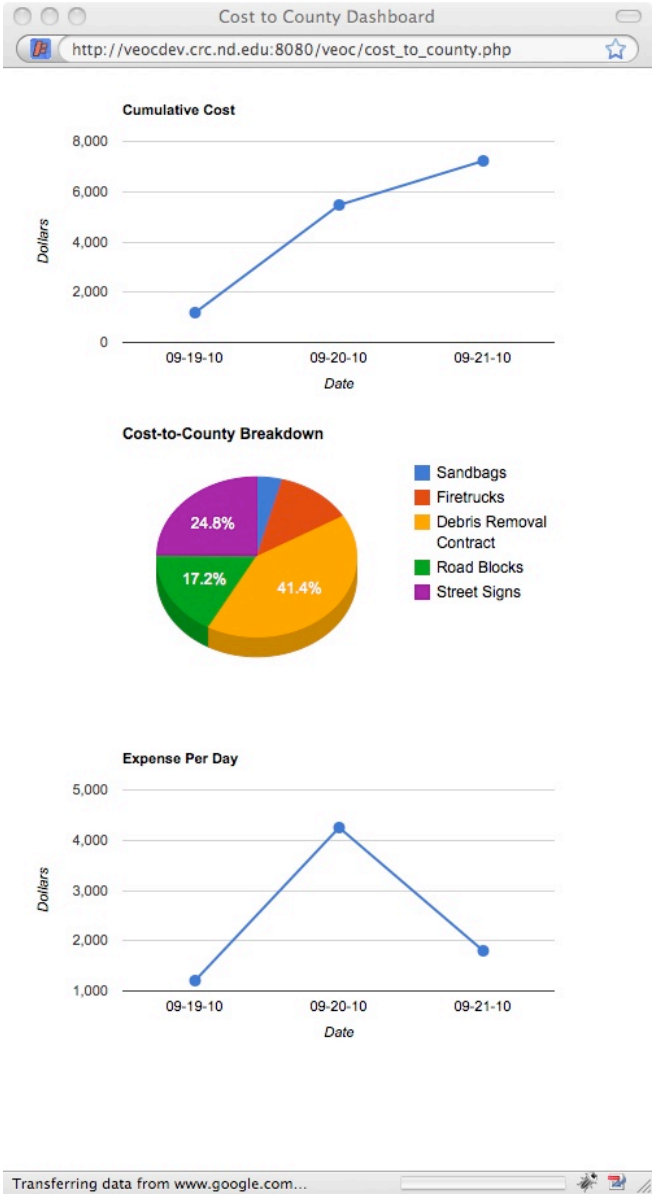


**Figure 2.** A Dashboard. This dashboard aids logistics in making decisions by showing the amount a resource would cost to the county.

**Trainee:** This is the individual who is being trained. These include Unit Liaisons, Branch Directors, Section Chiefs, and the Incident Command.

**Researcher:** This is the individual who is interested in studying emergency management and critical decision-making in emergency situations. She/he also is able to see the results and make queries about player's actions and the exercise following completion of the exercise.

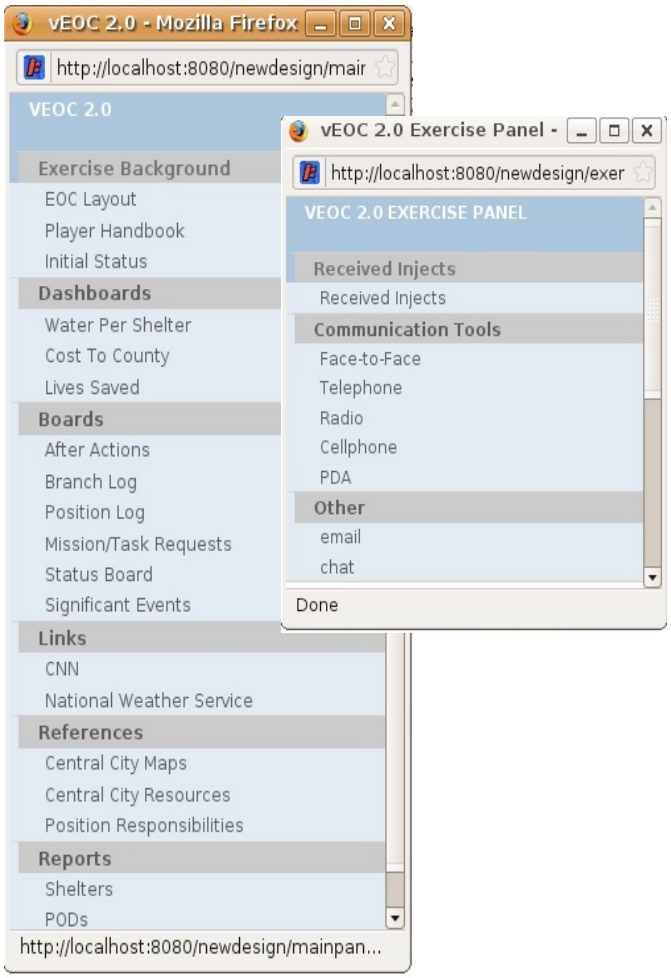


**Figure 3.** The Trainee Console. This is how trainees interact with each other in the simulation.

Troy Johnson was the exercise controller. Rahul Bhandari was the researcher, and the remaining individuals were unit liaisons. Next we set up a small script containing at least 6 injects for each of the trainees. The exercise lasted an hour in length. At the conclusion of the exercise, we conducted a follow-on survey of the user experiences using the vEOC.

## 7. EXPERIENCES AND INSIGHTS

The most valuable insight we garnered from this exercise was the validation that the vEOC is a practical simulation-based computer solution to face-to-face exercises. We also were able to validate additional parts of the software, including the dashboards and researcher evaluation metrics. Another valuable insight we gained was feedback on our vEOC, both on the design and the user interface. Finally, we also learned from this exercise that there is a need for standards when it comes to computer-based simulations and exercises.

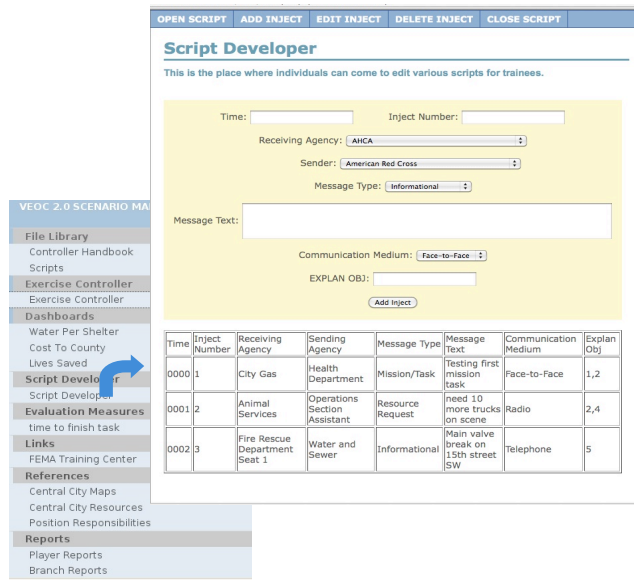


**Figure 4.** The Exercise Developer Console. This is where individuals develop player handbooks, select target capabilities, and develop exercise scripts.

### 7.1. Standards for Computer-Based Simulations and Exercises

One capability that seems to be lacking in the emergency management computer-based simulation community is the ability to share exercises and simulations with other individuals in a standardized way. That is, in our findings, we needed the ability to import and export file of the simulation amongst ourselves and to share with other individuals. This would take the form of an XML-based simulation standard.

## 8. FUTURE WORK

As we continue our research, we still have a few items left to develop. First, we have to finish the planning section of the trainee console. We also have to develop consoles for the branch directors, section chiefs, and incident command. Finally, we need to create a set of XML standards for our simulations and exercises, so that we can seamlessly share our simulations with others.

## 9. CONCLUSION

In this paper, we have discussed our insights and experiences using a virtual Emergency Operations Center. We began with some background information about EOCs. Next we discussed how we have been coordinating with Miami-Dade County in the development of this training tool

for virtual training and exercise and research purposes. After this, we delved into CIMS and some of the needs with respect to training simulation tools. Following this, we discussed the vEOC design and our exercise using the vEOC. Finally, we discussed our insights and experiences and concluded with future directions for our research.

## 10. ACKNOWLEDGEMENTS

I would like to thank the Miami-Dade EOC for their generous support of this project and inviting me into their emergency management lives. I am especially grateful to Soheila Ajabshir, Roslyn Viterbo, Craig Hall, Jonathan Lord, Frank Reddish, Curtis Sommerhoff and all the personnel at the EOC. I also thank the students who contributed to developing and testing this software, in particular, Regina Ranstrom, Nathan Thomas, and Sara Aycock. Finally, I thank, the University of Notre Dame Zahm Research Travel Fund, the National Science Foundation (Award Number CNS-0855164), and the U.S. Department of Education (GAANN Fellowship Award Number P200A090044) for their support of this research as well.

**References**

[1] Agrait, R., A, English, D. Evans, T. Hammell, J. Loughran, and M. Stahl (2004). Review of Models, Simulations, and Games for Domestic Preparedness Training and Exercising: Volume III. *Office for Domestic Preparedness*. Department of Homeland Security.

[2] Anderson, D.J. Agile Management For Software Engineering : Applying The Theory Of Constraints For Business Results. Upper Saddle River, NJ: Prentice Hall Professional.

[3] Becerra-Fernandez, I., Madey, G, Prietula, M., Rodriguez, D., Valerdi, R., and T Wright. (2008) "Design and Development of a Virtual Emergency Operations Center for Disaster Management Research, Training, and Discovery", *HICSS-41*, Hawaii.

[4] Becerra-Fernandez, I., Prietula, M., Madey, G., and D. Rodriguez (2007) "Project Ensayo: a Virtual Emergency Operations Center for Disaster Management Research, Training, and Discovery." Presentation and Proceedings, *The First International Conference on Global Defense and Business Continuity (ICGD&BC 2007)*, San Jose, CA.

[5] Department of Homeland Security (2008). National Response Framework, Washington D.C.

[6] Emergency Management Institute (2008) Introduction to Incident Command System (ICS 100), *IS-00100.a,* April.

[7] Emergency Management Institute (2002) Emergency Program Manager An Orientation to the Position (ICS 1), *IS-00001,* December.

[8] Emergency Management Institute (2003) Exercise Design, *IS-00139,* March.

[9] *Emergency Management* (2009) All-Hazards, All-Stakeholders Summit, *Miami EM Summit 2009*.

[10] ESi Acquisition, Inc (2010) WebFusion Regional Meeting. February 9-10, 2010.

[11] Florida Department of Emergency Management (2009). Operation Cassandra, Full-Scale Exercise, July 29, 2009.

[12] Government Accountability Office. (2010) Hurricane Recovery. GAO Report to Congressional Requesters. July.

[13] Green, W. (2001). E-emergency Management in the U.S.A.: A Preliminary Survey of the Operational State of the Art. *International Journal of Emergency Management*. Vol. 1, No. 1, pp70-81.

[14] Irwin, R (1989). Disaster Response Principles of Preparations and Coordination: Chapter 7 - The Incident Command System. Atlanta. Accessed online February 7, 2010. Available at http://orgmail2.coe-dmha.org/dr/static.htm.

[15] Johnson, T (2010). Conversations with the authors. January 28, 2010.

[16] Johnson, T (2009). Conversations with the authors. April 1, 2009.

[17] Madey, G., Becerra-Fernandez, I., Nikolai, C., and M Prietula (2009). Ensayo: A Virtual Emergency Operations Center for Training and Research. *Informs 2009*, San Diego, California.

[18] Miami-Dade EOC (2009). Hurricane Suiter, Full-Scale Exercise, June 1, 2009.

[19] Nikolai, C., Becerra-Fernandez, I., Prietula, M., and G. Madey (2009) Project Ensayo: Designing a Virtual Emergency Operations Center. *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics*, San Antonio, Texas.

[20] Nikolai, C., Johnson, T., Becerra-Fernandez, I., and G. Madey (2010). Leveraging WebEOC in Support of the Haiti Relief Effort: Insights and Recommendations. *The 7th International Community on Information Systems for Crisis Response and Management (ISCRAM) Conference*, Seattle, WA.

[21] Sniezek J., D. Wilkins, P. Wadlington, and M. Baumann (2002). Training for Crisis Decision-Making: Psychological Issues and Computer-Based Solutions.

*Journal of Management Information Systems*. Vol 18, No 4, pp 147-168.

[22] Statement of N. Rabkin. Hurricane Katrina: Providing Oversight of the Nation's Preparedness, Response, and Recovery Activities. *GAO Testimony Before the Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives*. September 2005.

[23] Weyns, K., and M Höst (2009). Dependability of IT Systems in Municipal Emergency Management. *Proceedings of the 6th International ISCRAM Conference*, Sweden, May.