
Emergency Response by Wire (ERBW)

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Abstract

The current emphasis on emergency management and business continuity was punctuated by the recent natural disasters such as the earthquake in Pakistan, the tsunami in Indonesia, Hurricane Katrina, as well as man made disasters such as the attacks on the World Trade center and the Pentagon. These events, to include their response and recovery, suggest a rethinking about the mediating role of systems and technologies and the nature of technology interfaces. Human and human collective emergency response behavior occurs through the mediation of enabling interfaces and resulting representations of reality. These representations

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pose design opportunities that can be researched pragmatically. The effects of human centered interfaces also suggest a rethinking of emergency response as “Emergency Response by Wire” ERBW following the “Digital Fly by Wire” [5] and “Management by Wire” [6] constructs. This paper outlines a research program based upon an “Action Research” approach designed to identify factors and pragmatically test those factors within an ERBW framework.

Keywords

Emergency Response by Wire, User Interfaces, System Integration, Action Research

ACM Classification Keywords

H5.2. User Interfaces, H5.3 Group and Organization Interfaces

Introduction (uncertainty and ambiguity)

As environmental complexities that face organizations and collectives within organizations increase, technologies and technology architectures will be required to assist sense-making activities. The nature of environmental complexities is identified by Karl Weick [17, 18, 19] when he describes the difference between environmental uncertainties and ambiguities. Relevant to Weick’s discussion is a corresponding articulation about the technologies that can be used to reduce both. He suggests that uncertainties are grounded in

ignorance and the technologies that best reduce ignorance are those that can very quickly provide answers to well formed questions and queries. These technologies are represented by the current mix of search engines that provide immediate answers to simple and complex Boolean strings presented as queries.

Ambiguities are different and suggest that there are conditions of confusion in the environment that need to be understood. Technologies that reduce confusion tend to be rich in communication cues and appeal to more than one of the senses. Multi-media of various types seem to assist making sense of ambiguous situations. For example pictures and video assist in forming both individual and collective perceptions of the situations that surface from time to time from the environment. Couple the visual representations with audio and tactile cues and the perceptions of individual and collectives deepens. This deepening in turn suggests the development of effective responses. However the relationship between effective responses, the integration of emergency management technologies and systems, and the user interfaces to these systems needs research programs designed to investigate potential emergency response value chain issues and causal linkages.

In emergency response situations where command center operations are involved these visual and audio cues are integrated into web portals providing real-time visualization of an emerging situation contributing to "situational awareness" and "shared situational awareness. Emergency response technologies properly interfaced possess the potential to assist in the decision making resulting in effective action scenarios, see Turoff, et al [16]

The NJIT research program outlined in this extended abstract is being designed to pragmatically test the integration of

systems and technologies by addressing issues of technology, integration, user enabled interfaces, and the concept of usability as that concept relates to command center responses and the research area of command and control (C2).

Emergency Response by Wire (ERBW)

Before I outline the research program, I would like to build a foundation for understanding ERBW and its use as an integral component for research.

In 1972 an F8 crusader fighter aircraft was modified with digital technology and served as the test bed for a series of human -technology interface studies. The aircraft was called NASA 802 and resulted in approximately 210 experiments designed to test Digital Fly by Wire (DFBW) technology interfaces [5]. The reasoning behind the DFBW concept was that as aircraft became faster and more agile it was difficult if not impossible for humans to fly the aircraft directly using the hydraulic systems of that period of time. Digital processor technology allowed for a level of intermediation between the pilot as human and the flaps, rudders, ailerons, and other aircraft controls. In other words the pilot did not interface with the aircraft controls directly but with the digital computer technology which in turn controlled the aircraft. Over time this form of intermediation resulted in auto-pilot technology and the ability to control the flight of the aircraft with ground control technology. The DFBW allowed pilots to control high performance aircraft through an environment that required rapid response. This environment is not dissimilar to the turbulent and chaotic environment surrounding a natural or man made disaster. Response during an emergency or disaster requires technology and technology interfaces similar in concept to the DFBW explained above.

The DFBW concept was extended by Stephen Haeckel [6] during the late 90s and early 2000's into Management by Wire or MBW. Haeckel argues that lessons learned by the DFBW program can be applied to management. The environment facing business organizations is characterized by Haeckel as a chaotic one that is changing constantly. Management needs to keep up with and adapt to changing conditions in the external environment that it faces and technologies and systems interfaced within IT adaptable architectures possess the potential to accomplish that. Haeckel argues further that management as part of environmental adaptation needs to interface with representations of the environment that it confronts. This is not dissimilar to the representations that pilots face when flying high performance aircraft. The construct of MBW includes the mediating effects of technology and systems in helping shape human understanding of the often times volatile environment that faces organizations and their management.

The NJIT research program is being designing around the developing construct of Emergency Response by Wire (ERBW) that builds upon DFBW and MBW in the following ways.

1. assumes a chaotic external environment
2. emphasizes the mediating role of technology and systems
3. focuses upon technology integration and human interfaces required to interact with the technologies and systems
4. couches 1-3 in an action research framework (technologists refer to this as iterative

prototyping , systems analysts and designers refer to this as a spiral development model)

NJIT in focusing upon ERBW is assuming that during command center operations when either incident management control is passed onto the command center or the command center is monitoring peripheral activity of first responders or other command centers a chaotic environment exists that needs to be understood. In the time that immediately follows a disaster event, environmental uncertainties and ambiguities are the norm often times resulting in response confusion. Well integrated technologies, systems, and adaptive user interfaces are required. These user interfaces need to be pragmatically researched in a plug and play lab environment that mirrors the chaotic environments that will be confronted. Technologies that permit collaborations with other command centers and centers of expertise need to be included as part of the research program. Further, portal like interfaces and other technology interfaces need to be tested during a series of well designed exercises similar to the exercises conducted by NASA 802.

In the following sections you will see that these exercises, consistent to those conducted during the preparedness dimension of emergency management, have been designed as researchable "activities" during 2007. This will continue through 2008 and into 2009 with preparedness exercises having the dual role of actually exercising the public and private sectors in integrated "all hazards" response and recovery scenarios. The exercises will also have an academic research dimension under the theoretical umbrella of activity theory/ action research/ articulation. This is explained in the sections that follow.

Research Framework

NJIT and the NJ Business Force [8] have collaborated in developing a Business Emergency Operations Center (BEOC) construct as follows.

Business Emergency Operations Center (BEOC)

The BEOC is constructed as a Private Sector organized, managed, and staffed emergency coordination/operations center focused on all-hazards disaster prevention, preparation, response, and recovery. Its goal is to make the Private Sector self-reliant and self-sufficient during emergencies and disasters through information sharing and shared situational awareness. The BEOC is being jointly developed through a collaborative effort between academia, led by the NJ Institute of Technology (NJIT), and business, as represented by the New Jersey Business Force (NJBF.) BEOC development is consistent with the basic guidance provided by President Bush's October 2007 **National Strategy for Information Sharing** as well as the January 2008 **National Response Framework**. NJIT has been informed by the U.S. Department of Homeland Security (DHS) that the BEOC private sector engagement model is one of only two prototypes being considered by the DHS for national implementation. This BEOC effort places the NY/NJ region in the forefront of visibility at the both the Federal level and among several Department of Defense (DOD) agencies.

BEOC Roles and Functions

1. Business-to-Business collaboration and communications. The organization and design of the BEOC will facilitate 360 degree communications between private sector participating organizations. It will establish both a physical and technologically enabled virtual hub to connect individual company emergency operations centers (EOC's) on a real-

time basis. This will provide for effective cross-industry support during a crisis.

2. Interface with Public Sector Emergency Operations Centers (EOC's.) The BEOC will be independently activated in parallel with Public Sector agencies at multiple levels of government (city, county, state, regional, national) such as the Hudson County EOC. Our objective is to provide a timely communication conduit with different levels of Public Sector agencies starting with those in New Jersey as the epicenter. This role is intended to be an additional level of support to the Public Sector and not to intrude upon the incident management responsibilities at play during response scenarios at the municipal, county, state, federal, and DOD levels.

3. Business to Non-Government Organization (NGO) collaboration. The BEOC will provide an important interface and collaboration function with NGO's like the American Red Cross and Salvation Army that are involved in community preparedness and response initiatives. This may include the mobilization of needed supplies and volunteers during an emergency.

4. Asset and Volunteer mobilization. One of the primary operational functions of the BEOC will be to solicit, both on a pre-arranged and spontaneous basis, supplies and volunteers as needed by the Public Sector EOC partners and member NGO's. The NJBF developed Business Response Network (BRN) is available now and is populated with thousands of items available on a pro bono basis. See [1] for further information.

Relevance of BEOC to Research Framework

NJIT has developed an activity theory/action research framework as an extension to the BEOC construct. The research framework that has been developed uses the subject pool within BEOC constructed exercises to determine the effectiveness of technology interfaces and technology infrastructure. This framework draws upon **activity theory**, Nardi [9]; Dourish [4]; Spinuzzi [11]; D'Andrade [3]; Hutchins, [7], **action research** Clark [2]. Reason and Bradbury [10]; **articulation** Strauss [13, 14], Star and Greisemer [12]

Activity theory suggests that knowledge can be developed by identifying or establishing a researchable activity and observing and recording the "subject" interactions occurring during the activity. Of particular interest is the establishing and maintenance of joint activities and the role that technology plays in information and communication exchange. In addition the technology infrastructure support role within which information and communication exchanges occur will be included as part of the overall research framework. The framework that has been developed for BEOC pragmatics and NJIT research is represented by Table 1. It represents a capabilities approach and matches those capabilities to a set of technologies and systems that can provide the capabilities required of an emergency operations center to a set of existing technologies and then to a set of future enhancements. The existing technologies are presently available through the initial BEOC technology infrastructure. Future enhancements will be developed, designed, and implemented as a result of exercises constructed as both exercises with a pragmatic orientation and activities with an academic theory orientation.

Table1

Capabilities	Existing technologies	Future enhancements
Notifications/ Alerts (CAPs)	NC4, NJN (datacasting)	(1) NC4+, (2) NJN (datacasting on steroids, appliance development, testing potential miniaturization) (3) RACES, MARS, use of Ham radio technologies
Intelligence (Anal./ Verif.)	??	Non classified repository – similar to competitive intelligence, text & data mining, content analysis for trends)
Collaboration (SSA)	Marratech (virtual)	(4) Marratech with enhanced capabilities, IP based VTC, VTC room integration Physical ((5)ARDEC EOC, NJIT) Mobile & ((6)Monmouth Rapid Response)
Communication (SSA)	Internet	Internet & linternet2
Reach-back (SSA)	??	VTC + push to PDAs + other BEOCs + global reach-back to pockets of

		expertise
Incident management (Anal./ Verif.)	??	Link to ROIC, PA NY/NJ, NC4, other BEOCs, DHS, N/NC
Incident management support/ resource tracking (Anal. Verif.)	I-info BRN	(7) Resource inventory control, Resource sharing (ROIC, N/NC, DHS)
Visualization (SSA)	??	GIS, GPS (in and out)
Modeling, simulations, training	Phase I UAV modeling research w/ARDEC	(8) Test EOC research project w/ARDEC (9) Phase II UAV Model
Integration (total emergency Management Planning)	??	Secure integrative portal ((10) moving from the class project), ROIC, PA NY/NJ (access to JSAS, access to NC4 ESP) others

The activity or series of activities are where individuals or collectives are working together to solve a problem and/or develop a solution. Action research extends the activity theory focus by suggesting the use of researchable treatments applied during an activity and assessing the effects of the treatments upon the researchable focus of the activity. Further, articulation permits the investigation of interactions and the effect on interactions that may be due to

the mediation of technology and technology infrastructure. This (activity theory/ action research /articulation) will be the overarching academic framework that will inform academic inquiry. During the activity, technology and technology “mash ups” act as human and collective mediators to the activity. It is the mediating effects of technology on the work that humans and collectives engage in that are being investigated within the research program framework. Specifically, as private sector entities engage with the public sector during exercises (activities) interactions become enabled or constrained during the emerging collaboration processes. The technologies to include technology interfaces and infrastructure are being investigated as factors during the exercise activities that affect collaboration. Factor components will then be identified and taxonomized.

At present 2 major activities have taken place:

1. **TOPOFF4/Looking Glass** - In October 2007 the first activity was conducted at NJIT on Oct. 17 and 18. It was part of TOPOFF4 [15], the fourth in a series of congressionally mandated exercises and the business interface portion was called “Looking Glass” The following organizations participated: Prudential, NJ Resources, NJN (New Jersey Network), NJIT (Host), NJAHS, World Cares Center, Bayonne Visiting Nursing Association (Home Health Care Association), Christ Hospital Home Health Services, Visiting Homemaker Service of Hudson County, Hackensack University Medical Center Home Health and Hospice Agency, Atlantic Health, NC4, The Salvation Army, Goldman Sachs, Lehman Brothers, Port Authority of NY/NJ, NJ State Exercise Support Team, DHS Science & Technology Directorate, AIG in New York City did a local scenario focusing on the Wall Street area but exchanged operation information during exercise play. The exercise included using and assessing the following existing user interfaces to:

- a. notification and alerting technologies,
- b. incident command systems,
- c. synchronous collaboration technology,
- d. business resource logistics systems.

Subsequent to the Oct. exercise, the above interfaces to existing technologies and systems were integrated within an application sharing web portal. This integration and portal interfaces were then tested again in December during a virtual hurricane response exercise (the second activity). The homepage of the “prototype” web portal is shown as Figure 1. In addition Figure 2 represents the portion of the Web Portal that used interfaces to “notification and alerting technologies” during the second exercise (activity) conducted in December. This specific Web Portal web page was used to deliver exercise event notifications used during the actual exercise that was conducted during December.

Figure 1 Web Portal Homepage

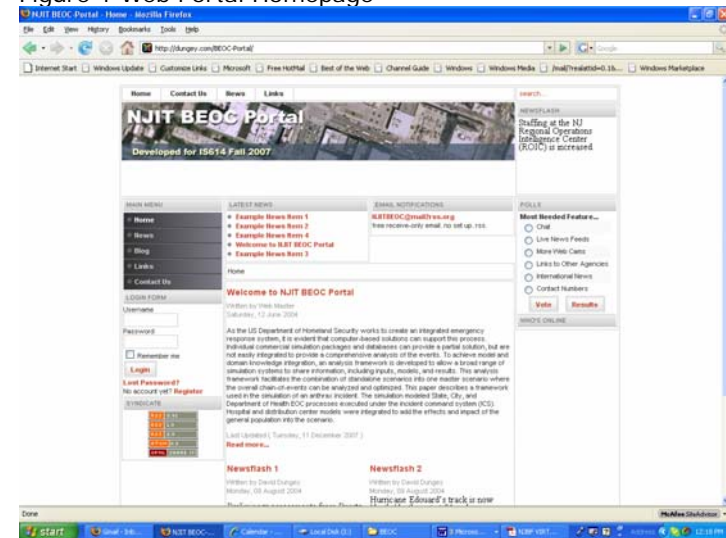
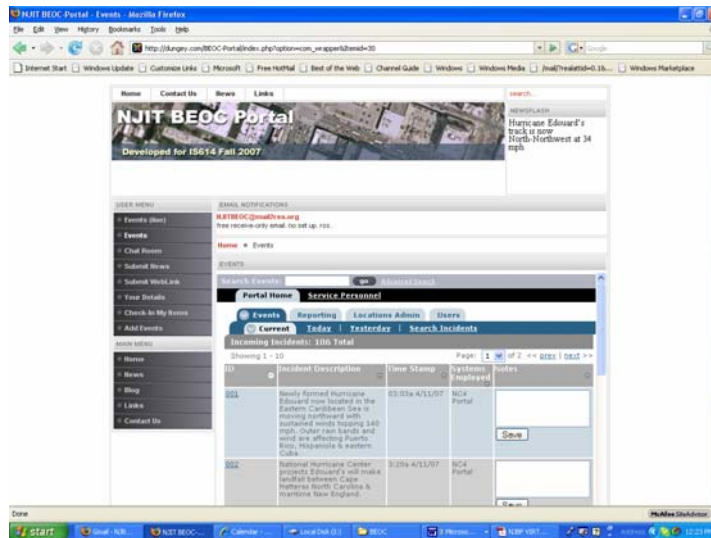


Figure 2 Web Portal Notifications/Alerts



2. Category 3 Virtual Hurricane Exercise - In December 2007 the second exercise (activity) was conducted at NJIT. The participants in this exercise included: New Jersey Institute of Technology, New Jersey Network, Monmouth University, Wayne State University (Observers), National Weather Service, NC4, NJ Resources, CIT, AIG – New York City, Atlantic County Medical Coordination Center, Cooper University Hospital – Regional Medical Coordination Center, Somerset County Medical Coordination Center, Burlington County Office of Emergency Management, Hudson County Office of Emergency Management, Ocean County Office of Emergency Management, Monmouth County Public Health, Monmouth County Radio Amateur Civil Emergency Service (RACES), Fort Monmouth, USNORTHCOM – Interagency Coordination Directorate – Private Sector Integration. The research results of this second exercise will determine the enhancements

suggested to the web portal user interfaces and a reconstitution of the activity matrix (table 1) prior to the third exercise (activity). The third exercise (activity) will be performed in May 2008 as part of the NORAD/Northcom (N/NC) Ardent Sentry 2008 National Level Exercise (NLE).

Some Future Thinking

Three additional exercises (activities) are planned in 2008, beginning with Ardent Sentry 2008 in May, during which the portal user interfaces and additional technology interfaces will be tested and refined further. In total there will be a series of 3 activity theory/action research exercises (activities) in 2008 where the treatment under investigation during each will be the evolving user interfaces to the web portal prototype. Action research suggests the application of certain treatments during each ensuing exercise (activity) so that the effects of these treatments can be assessed. In general, the treatments that will be applied to future exercises (activities) result from the actual use of the systems and technologies accessed and used by the exercise subject pool during a previous exercise.

Initial treatment analyses suggests that for the web portal, information “push” to portal users through well designed RSS feeds are desired as well a “push” of critical notifications and alerts to PDAs to include cell phone interfaces. In addition there is an emerging user requirement for backup notifications using secure data casting technologies. To that end, based upon user feedback, we are investigating the use of “self booting” data appliances that can access notification broadcasts over the air waves and display these notifications over low cost monitors and other display devices. The look and feel of the data cast displays will be similar to looking at a web page. This technology “mash up” has potential to be used by small businesses as well as communities that may be

affected during the initial time right after a catastrophic event when cell technologies and Internet ISPs may become unavailable.

Final comments on the Research Framework , ERBW, and Reality Perceptions

This paper began with a discussion about the ERBW construct and how it was derived from the military DFBW approach to technology interfaces. It then moved on to describe MBW as a concept underlying management obtaining a view of reality not gained by interfacing directly with reality but interfacing with the representations of reality. The interfaces may contain symbols and in many cases simulacra requiring interpretations of the evolving reality by interpreting the symbols suggestive of a reality space. As we move into the world of emergency management, especially the response dimension, representations of reality presented to users interfacing with various technologies permit the construction of reality by the users as collaborators in the emergency response effort. The development of HCI approaches indicate a research framework that captures users and their interactions as they are being mediated by technology and the technology interfaces.

The verisimilitude of interfaces is important because they contribute to the interpretations and perceptions required for timely and accurate situational awareness that results in timely, accurate and appropriate responses.

The NJIT/ NJ Business Force BEOC has embedded within it a research framework, briefly described in this paper that is grounded in activity theory /action research and articulation. This research framework permits the systematic investigation

of technologies, technology interfaces, and technology infrastructures that are the ERBW mediators.

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