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14. ABSTRACT
Inter-agency and inter-sector communication and collaboration experimentation during emergency management response is the focus area of this paper. Since 2007 the New Jersey Institute of Technology (NJIT) has been working in collaboration with the Armament Research Development and Engineering Center (ARDEC) at Picatinny Arsenal and Northern Command (Northcom) experimenting with, a public sector/private sector engagement model called the Business Emergency Operations Center (BEOC). The BEOC is a multi-dimensional construct using qualitative research techniques to identify factors that enable enterprise agility and adaptability. It is a physical and virtual construct that can be actualized during a catastrophic event as well as tested during training exercises; these exercises are described in this paper. Most importantly the BEOC is a research program designed to investigate inter-sector and inter-agency collaborations during response scenarios to catastrophic and extreme events. It is this confluence of research (theory) and exercises (praxis) that is explicated. The paper concludes by positing a framework based upon the results of research to date using the BEOC model as an integral component of the framework. The relationship of the evolving framework to the process dimension of command and control is weaved into the overall explication.

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Abstract

Inter-agency and inter-sector communication and collaboration experimentation during emergency management response is the focus area of this paper. Since 2007 the New Jersey Institute of Technology (NJIT) has been working in collaboration with the Armament Research Development and Engineering Center (ARDEC) at Picatinny Arsenal and Northern Command (Northcom) experimenting with, a public sector/private sector engagement model called the Business Emergency Operations Center (BEOC). The BEOC is a multi-dimensional construct using qualitative research techniques to identify factors that enable enterprise agility and adaptability. It is a physical and virtual construct that can be actualized during a catastrophic event as well as tested during training exercises; these exercises are described in this paper. Most importantly the BEOC is a research program designed to investigate inter-sector and inter-agency collaborations during response scenarios to catastrophic and extreme events. It is this confluence of research (theory) and exercises (praxis) that is explicated. The paper concludes by positing a framework based upon the results of research to date using the BEOC model as an integral component of the framework. The relationship of the evolving framework to the process dimension of command and control is weaved into the overall explication.

INTRODUCTION

We begin with a discussion of how the inter-agency and inter-sector experimentation process that we, the New Jersey Institute of Technology (NJIT), the New Jersey Business Force (NJBF) and the Armament Research Development and Engineering Center at Picatinny Arsenal (ARDEC) eventually embarked upon took shape. We will show that the experimentation framework we call the Business Emergency Operations Center (BEOC) model has its roots in military command and control (C2) as well socio-technology theory. Our emerging experimentation process suggests a qualitative research approach grounded in activity theory and action research. The discussion also indicates the focus on BEOC capabilities is drawn from current C2 capabilities thinking (NECC 2006), the C2 process model (Chumer and Turoff, 2006), and the outcomes from a series of DARPA brainstorming sessions. It is the capabilities and therefore the systems and technologies enabling those capabilities that are being tested during the exercises that are addressed in this paper. Further this research posits those capabilities as factors with the potential to enhance inter-agency and inter-sector communications and collaborations important during the response to catastrophic and extreme events.

Our experiment approach will be both described and explained in the section on **Research Approach**. We will outline the exercises that we participated in, helped develop, and resulted in data necessary to systematically test and assess the BEOC model.

Lastly we will address the key findings from our research project and suggest research thrust areas that are necessary to move research forward.

First we will describe the historical background of the model.

HISTORICAL DEVELOPMENT

BEOC inter-agency, inter-sector model and experimentation process

With the creation of the Department of Homeland security (DHS), emergency management (EM) began to change from its use by Federal Emergency Management Agency (FEMA) to what we call Homeland Security (HLS) enabled EM. We preface EM with HLS because the basic four dimensions of EM, (preparedness, prevention/mitigation, response, and recovery) (Lindell 2006) have undergone and continue to undergo changes within the scope and content of each individual dimension as DHS matures. EM certainly predates the establishment of the DHS, for example FEMA was active in all 4 dimensions well before DHS was created. Though FEMA was included in the basic organization structure of DHS, the four EM dimensions have been carried forward organizationally but imbued with meaning unique to DHS. For example:

1. ***Preparedness***- Upon the establishment of the DHS preparedness focused upon manmade disasters such as terrorism but quickly grew to embrace natural disasters such as

hurricanes, tornadoes, earthquakes, flooding, and a host of similar threats under an "All Hazards" approach. An integral component of this dimension is the exercises that are created to develop the processes and procedures that would be used during an actual response.

2. ***Prevention/mitigation*** - This places value on the gathering and dissemination of "actionable" information, as intelligence, offering alerts and/or notifications about a threat in order to either prevent the threat from occurring or to mitigate its effects. The establishment of State fusion centers and their approach to the fusing of law enforcement sensitive information coupled with information that carries a certain level of classification forms the basis of activities within this EM dimension.
3. ***Response*** **-** This dimension suggests everything from a single individual response to an event to a joint response that requires coordination and collaboration across agencies and sectors (private sector and public sector). It is during the response dimension where C2 thinking directly applies. The process model of C2 described in (Chumer and Turoff, 2006) suggests that increasing the speed of the process loop during the response to an emergency directly affects the overall ability of an actor (individual, collective, organization) to take appropriate action to reduce the effects of an emergency, especially in the reduction of casualties. It is this assertion that forms a basis for the research explicated in this paper.
4. ***Recovery*** – This suggests that both individual and joint efforts begun during response would continue in order to return to a state of normalcy. Discussion and debate is continuing with respect to this dimension. Some of the elements of this debate focus upon the nature of "normal" suggesting that a "new normal" direction may result as part of recovery scenarios.

The four EM dimensions formed the basic structure for organizing our research efforts within and between the public sector and private sectors, which we refer to as inter-sector, as well as organizing and coordinating efforts between agencies which now include the DoD and other Federal entities, which we refer to as inter-agency. Though our overall research gave us the flexibility to navigate and investigate collaborations within each EM dimension, the focus of this paper is upon research into collaborative and communicative response behavior observed primarily during a series of well defined exercises. At the onset we identified an initial set of capabilities focusing upon the technologies and systems that can best enable those capabilities. We represented those capabilities as an integral component within an initial framework which we call the BEOC capabilities matrix. During our research we used and built upon this framework. (Table 1)

Conducting qualitative research from 2007 through 2010 in an inter-sector and inter-agency mission space was both enlightening and frustrating. Enlightening from the standpoint of identifying and developing processes and procedures to better understand how sector and agency collectives would jointly work together to prevent/mitigate, respond to and recover from, a

variety of hazards and threats. At the same time it was frustrating because within the private and public sector, as well as different agencies including the DoD, there emerged (and continues to emerge) both organizational and cultural silos that fly in the face of the collaboration and coordination so important to the four phases of EM. It became obvious that factors, which include individual, organizational, and political, emerged and continue to emerge during the research period suggest the existence of organizational silos that functioned as impediments to the overall nature of inter-sector and inter-agency collaboration and communication. Attempts to understand and address the nature of the silos to include existing impediments to, and enablers of, collaborative efforts resulted from our programmatic research approach. The framework which we call the BEOC capabilities matrix was established to investigate technological and system capabilities in order to understand whether and how these capabilities present themselves as essential factors during collaborations and communications in a response to a catastrophic and or extreme event.

Seeds of the Emerging Research Framework First DARPA Brainstorming session(s)

The BEOC concept was initially developed over the summer of 2007, refined during September and October 2007, and then researched using qualitative research approaches during a series of exercises conducted from that time to December 2010 (the period of time covered in this paper).

The initial thinking that went into the BEOC development framework had its roots in:

1. Two brainstorming sessions sponsored by Defense Advanced Projects Research Agency (DARPA) during June and July of 2007 (RFI 2007).
2. New Jersey Business Force (NJBF) private sector members suggesting that an effort be undertaken that encourages business sustainability during emergency and catastrophic events under a business to business (B2B) communication model.

The DARPA brainstorming sessions focused on the areas of Humanitarian Aid and Disaster Recovery (HADR) and Stability, Security, Transition, and Reconstruction (SSTR). Both areas are parts of the expanding mission space of the Department of Defense (DoD 3000.5, 2005). The common theme surrounding HADR and SSTR was what DARPA referred to in 2007 as Strategic Collaborations. It was not unusual during HADR and SSTR for different organizations and groups, many which have never worked together in the past, to be thrust into a common effort requiring all the entities to collaborate during the response to, and recovery from, a catastrophic event. Examples of these collaborations were the response and recovery efforts surrounding the Pakistani earthquake and the Indonesian tsunami. Both required the collaboration of military forces from the United States and other countries, NGOs including the Red Cross, Salvation Army, Catholic Charities, as well as a host of smaller NGOs and nonprofit organizations, plus the private sector writ large, the United Nations and the host countries. The collaboration between all entities was unprecedented and required massive coordination to ensure that a unified and joint response and recovery effort proceeded in a mutually agreed to direction.

The issues and recommendations that surfaced from both DARPA brainstorming sessions focused upon the following thematic areas specifically mentioned in the original DARPA Request for Information (RFI 2007). These thematic areas are listed as follows:

1. ***Semantic Glue*** – the meaning and sense-making processes that surface during a response to a catastrophic and/or extreme event.
2. ***Ad Hoc Dynamic Networking on Diverse, Unstable Networks*** - the capability to rapidly create networks that permit the flow of information between responders on the ground and different levels of command structures in the event that existing communication networks either fail or become disabled because of the nature of the event.
3. ***Mobile Computing Applications to Support Local Optimization*** – the potential use of social media to contribute to the overall development of a common operating picture.
4. ***Understanding (Human) Network Performance*** – develop a better sense of how human and social networks emerge during the response to a catastrophic or extreme event to include their utility function during the response.
5. ***System Level Issues*** – identify the various systems, technology based and /or not technology based, that emerge to include how these systems are formed and how they can enable different components of a joint response. Begin to develop a system of systems approach
6. ***Mensuration (instrumentation/measurement)*** – the ability during an actual response to measure how well the response is going by accessing different types and levels of instrumentation to include but not be limited to sensors that may be deployed within an affected area or can be deployed in parallel to a specific response.

The six thematic areas (an initial list) surfaced by the DARPA sessions, that underlie HADR and SSTR, are also vital to understand, and are applicable to, the collaborations that are required during a response and recovery to catastrophic and/or extreme events within a Homeland Security (HLS) all hazards environment. This assertion is important to understand because it begins to suggest that there exist linkages between initiatives that occur outside the DHS organizational structure (such as within DARPA and potentially the DoD itself) that can inform in a positive way response activities being framed within the DHS.

The BEOC capabilities matrix (table 1) was developed subsequent to the DARPA brainstorming sessions. It was developed upon the assumption that there is a linkage between the six DARPA thematic areas and a framework that could be used to build a deeper understanding of the relationships between individuals, collectives of individuals and the systems and technologies that can strengthen and provide focus to joint response and recovery efforts.

Creating the Capabilities

Being informed by the outcomes of the DARPA brainstorming sessions coupled with an understanding of the concepts underlying the Net Enabled Command Capability (NECC, 2006), NJIT in partnership with the NJBF, as well as representatives from several technology organizations, collaborated in September 2007 to create an initial set of capabilities that should be present during a response to a catastrophic or extreme event. Several brainstorming sessions were held which resulted in the capabilities matrix. It was envisioned that these capabilities in one form or another should be present during a response scenario. The initial set of capabilities that were developed is listed as follows:

1. ***Notifications/Alerts***
2. ***Intelligence gathering and analysis***
3. ***Collaboration***
4. ***Communication***
5. ***Reachback***
6. ***Incident Management***
7. ***Incident Management Support (added later during the research process)***
8. ***Visualization***
9. ***Modeling, Simulations. Training***
10. ***Integration (expanded to include a virtual capability)***

During research conducted from 2007 through 2010 the capability of "incident management support" was added and "integration" was expanded to include the ability to function during a response, virtually, instead of physically (from a command center perspective).

Each of the capabilities will be expanded upon next, after the capability the dimension of EM that is related to the capability will be mentioned. However, since this paper is focused upon inter-agency and inter-sector response research the relevance of the capability to response only will be described:

1. ***Notifications/Alerts (prevention/mitigation, response, recovery)*** **-** Focusing on response collaborations, (inter-sector and inter-agency), the creation, transmission and receipt of periodic alerting messages are important from two perspectives and both of these perspectives are grounded in the process model of C2 (Chumer and Turoff, 2006). First, the transmission of these messages enable ground truth to be communicated to a command center constructed as a joint or unified command center by first responders directly involved with an emergency situation. In the domain of Homeland Security a unified command can be staffed by personnel communicating with firefighters, police, emergency medical services teams (EMST), urban search and rescue, as well as other first responders. Second, armed with "ground truth" constructed as alerts the command center provides "situational awareness" to the first responders as a form of message notification to assist them in their response behavior. In addition notifications and alerts

are communicated between command centers using systems and technologies designed to address different facets of incident management.

2. ***Intelligence Gathering and Analysis (prevention/mitigation, response, recovery)-*** Specifically, important during prevention/mitigation when both law enforcement sensitive information and classified information is assessed and trends / threat briefs are developed. This capability is also important during a response in order to provide a level of analysis required in understanding potential mid to longer term implications of the event.
3. ***Collaborations (all EM dimensions)-*** During response, collaborations between individuals and organizations that may be working together for the first time become important to understand and enable through processes, procedures, systems and technologies with the best potential to encourage and enable the collaborations. The DARPA brainstorming sessions in 2007 were developed under the overall construct of "Strategic Collaborations". An understanding of tactical and operational collaborations suggested by the process model of C2 as evidenced by loop synchronization of Observe, Orient, Decide, Act (OODA) and Sense, Interpret, Decide, Act (SIDA) loops is important to understand and research as part of this capability (Chumer and Turoff, 2006).
4. ***Communications (all EM dimensions) –*** This capability was selected because of the importance of researching different modes of communication in the event that one type of communication failed and another was required for backup purposes. The tacit assumption is that the Internet will always be available and many systems and technologies are designed for it. However, radio communication to include line of site and satellite based approaches become important to be able to access during a response. During the DARPA sessions the ability to very quickly enable some form of a hastily formed and/or adhoc network becomes important to understand, develop and or plan for.
5. ***Reachback (all EM dimensions) –*** The ability to reach back to pockets of expertise and subject matter experts becomes an important capability to provide for during response scenarios. Often times as "ground truth" is communicated by responders and first responders to initial command centers functioning as control nodes, it becomes important to provide accurate and timely "situational awareness". In many instances the attendant knowledge required might not reside in a physical command center. This suggests that from time to time during various response scenarios the capability to reach back to knowledge centers and/or to specific individuals must be provided.
6. ***Incident Management (response, recovery) –*** An incident management capability is certainly important for the public sector and is embedded within the overall incident command structure that governs response behavior in an all hazards environment. This formalized incident command approach is not evident within private sector response scenarios to the same level and extent that it is during public sector incident command grounded behavior. In addition the military utilizes technologies and approaches embedded within systems such as the Command Post of the Future (CPOF) (Greene,

Stotts, Paterson, and Greenberg 2010) which differ in concept and scope from DHS and FEMA based incident command, This capability requires research into systems and message inter-operability especially between disparate incident management systems which often do not work very well cross system wise. This assertion is addressed during the conclusion section of this paper.

7. ***Incident Management Support (response, recovery)–*** This capability was not identified during the initial development of the capabilities matrix but surfaced during testing of the BEOC construct during the researchable exercises. Since we are unpacking the components of an inter-agency and inter-sector model, the role of the private sector to include the DoD is not directly within the sequential and hierarchical chain suggested by the incident command structure, The incident command structure enabled in part by incident management systems is mainly public sector oriented (municipality county, State, FEMA Region, Federal). As an event rises in severity, control passes up the public sector chain. Incident management support suggests that as an incident rises in severity the private sector writ large and the DoD engages in "anticipatory process" enabled by incident support communications, technologies and systems that allow these organizations to anticipate what would be required. The private sector assesses and anticipates supply and value chain implications as well as how and can they contribute to an incident when asked to during the incident response. The DoD, through Northcom, anticipates how, when, and where to pre-position assets when asked to support appropriate civil authorities. This capability becomes important to research and develop in any BEOC model.
8. ***Visualization (all EM dimensions) –***Collaborating around different forms of visualization to include maps embedded as part of Geographical Information Systems (GIS) surfaced as an important capability during response. Different forms of visualization to include video streams from cameras (as sensors), video feeds from helicopters and unmanned aerial vehicles, satellite feeds, and other forms of video become important capabilities in the emerging BEOC model.
9. ***Modeling, Simulation, Training (all EM dimensions)*** – This capability seems to be primarily grounded within the preparedness dimension of EM. However it is certainly relevant within response as well. Modeling and Simulation suggests different things to different people which makes it desirable when conducting research. Identifying its specific capabilities, especially in enhancing and contributing to decision making processes that occur during response, requires testing and evaluation. There are many technologies and systems that perform different types of simulations and allow for different forms of modeling. Developing an understanding of this capability becomes an important ingredient within the evolving BEOC framework.
10. ***Integration –*** This capability was initially developed to assess and research the overall integration of technology into a physical and/or virtual BEOC. An integral component of this capability was and is technologies that can integrate in some manner the capabilities

addressed in 1 – 9 above. Examples of this are web portals, dashboards and similar technologies that bring together in a virtual and physical manner other capabilities. It is in this capability where technology can assist in the development of a "common operating picture and "shared situational awareness".

The first column in Table 1 lists the capabilities described in 1-10 above. The "Existing" column contains the technologies and systems that were available to and accessible by NJIT, NJBF and ARDEC researchers. These technologies and systems are listed because of their potential to leverage and/or enable the capabilities enumerated in column 1. In the "Future" column are the technological and research thrust areas (numbered 1 -19) that surfaced through research as areas requiring further investigation.

Table 1 BEOC Capabilities

Capabilities	**Existing**	**Future**
Notifications/ Alerts	NC4's E-Team and ESA, New Jersey Network (NJN) (datacasting)	(1) NC4 secure portal technology (2) NJN (datacasting, appliance development and miniaturization). (3) RACES, MARS, use of Ham radio technologies
Intelligence Analysis	NC4 ESA historical data	(4)Non classified repository data and text mining project – similar to competitive intelligence, text & data mining, content analysis for trends)
Collaboration	Marratech (desktop VTC) NC4 Cybercop	(5) Marratech with enhanced capabilities (6) /Elluminate VTC/ other. (7) Teleconferencing, Mutualink technology (8)ARDEC test bed EOC, NJIT (physical collaborations) (9)Monmouth University Rapid Response (mobil collaborations)
Communication	Internet	(10) Internet 2 and National Lambda Rail, radio communication

Reach-back	??	(11) VTC + push to PDAs + other BEOCs + global reach-back to pockets of expertise
Incident management	E-team, WEBEOC	(12) Link to NJ Fusion, NC4, other BEOCs, DHS, Northcom
Incident management support/ resource tracking	I-info BRN	(13) Resource inventory control, Resource sharing (14) Develop Logistics tool
Visualization	L3 Insight viewer	(15) GIS sensor integration into common operating picture, (16)Interface with San Diego State University Vis. Center-Dr. Eric Frost…distributing satellite vis. info.
Modeling, simulations, training	Phase I&II UAV modeling research w/ARDEC L3 modeling and simulation	(17) Critical Infrastructure inter-dependency modeling (18) Military modeling and simulation applied to Homeland Security
Integration	??	(19) Information sharing using dashboards, secure portal compartments, and message interoperability

In general the overall research activity identified technology and system gaps within each capability. The gaps were then posited as research thrusts to be explored further during exercises which were in turn constructed as researchable events.

The research approach that was used will be explained further in the sections that follow.

RESEARCH APPROACH

The theoretical grounding of the Research Approach

Our overall experimentation and research approach was and continues to be grounded in action research and activity theory while drawing upon some elements of articulation (Strauss 1985, Strauss 1988). We include within this research approach basic cognitive anthropological approaches, the social worlds approach to the sociology of organizations, occupations and work,

and ethno-methodological and activity-theory-based approaches to social informatics and computer-supported cooperative work.

This approach is squarely grounded in qualitative research and critical theory techniques (Brooke 2009, Kirk and Miller 1986, Van Maanen 1988). The instruments are the researchers and subject matter experts themselves as observers embedded within the phenomena being investigated. Our approach is different than the NATO C2 Model (Alberts and Hayes 2006, SAS050 2006) which suggests and taxonomizes a wide variety of variables and posits relationships between those variables identified. The major reason we embarked upon qualitative research was we were seeking factors that could naturally emerge from the process rather than using factors that were pre-defined such as those contained in the NATO model.

Ethno-methodological and activity theory

These approaches to social informatics and computer-supported cooperative work (Nardi 1996, Dourish 2001, Spinuzzi 2003) focus on the establishment and maintenance of joint activities with a particular focus on communication, information exchange and the role of information infrastructures in supporting these activities. This approach has permitted, and continues to permit, the investigation of the communicative behavior between private and public sectors by examining each exercise as an experiment as it moves through its mission space. This also includes investigating the enabling effects of systems and technologies.

Cognitive Anthropology

Cognitive anthropology (D'Andrade 1995; Hutchins 1995) provides a wealth of research and theory on the relationship between cognition and culture where culture is understood as a collection of interrelated cognitive schemas for interaction and an associated set of practices, routines, or techniques. Within the BEOC, whether functioning in a physical or virtual mode, there are interactions occurring at the individual, group, and organization levels. C2 process loops, OODA, developed by John Boyd, (Coram 2002, Lind 1985) and/or SIDA, (Haeckel 2001) are functioning at multiple levels and the concept of loop synchronization between levels becomes salient especially during response and recovery. Cultural factors are at play on each level and need to be ferreted out and understood. For example first responders could be firefighters, police, EMTs, corporate employees, spontaneous volunteers, NGO volunteers, the military, each embedded within their own culture which mediates the decisions that are made during response and recovery. The use of technology and systems is passed through cultural filters that affect the behavior of all responders to include collectives within command centers, such as the BEOC, performing C2 activities during HLS and Homeland Defense (HLD) emergency response and recovery. One of the keys is to realize that culture is a larger, encompassing term.

Social Worlds The social world's framework of the sociology of organizations, occupations, and work (Becker 1982; Strauss 1993; Star 1995) focuses on observing and explaining the interaction

of interdependent but distinct occupational and organizational worlds (characterized by observable cultures and practices in the pursuit of common lines of action e.g. engaging in disaster response or recovery operations.)

Data collection: An Action Research Approach to evaluation methodology

We conducted extensive formative evaluation as well as summative evaluation of the systems utilized and technologies accessed during each exercise (experiment), using a form of action research (previously mentioned) that is appropriate to developing an understanding about the enabling effects of these systems and technologies on collective collaborations. The major contributions of this research fall within the realm of design science, which seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts. In the design-science paradigm, knowledge and understanding of a problem domain and its solution are achieved in the building and application of the designed artifact (Hevner et. al. 2004). Such a process is very iterative; as feedback is obtained from users, the design specifications, prototype and eventually the operational systems and technologies are changed. Because the components of the artifact are a moving target, most traditional quantitative research techniques are not appropriate. Instead a form of action research, like the soft systems methodology described by (Checkland 1981), obtains iterative rounds of mostly qualitative input into the evolving design. Qualitative methods are most suited to obtaining an understanding of the interaction of people, organizations, and technology with applications such as those to be developed and tested in our research, that aim to change the very nature of communication and social interaction within an organization (Klein and Myers 1999: Turoff et.al. 2004).

To be clear, Action Research is a methodology of investigation that centers on research to improve the quality and performance of an entity or organization (Lewin 1946). Although usually applied to traditional organizations, it is also appropriate when the intended user groups may be communities of practice, or partially distributed teams of members of different organizations at different places, interacting during the preparation for, or response to, a disaster. Action research has been described as a post-positivist research method that is empirical, yet interpretive, experimental, yet multivariate, and observational, yet interventionist (Baskerville and Wood-Harper 1996, DeLuca et al. 2008).

Five Phase Framework

Typically, five iteratively repeating phases have been identified for introducing scientific rigor into action research (Susman and Evered 1978; Baskerville and Wood-Harper, 1996; Lindgren, Henfridsson and Schultze 2004):

1. ***diagnosing***
2. ***action planning***
3. ***action taking***
4. ***evaluating***
5. ***specifying learning.***

In the diagnosing phase, the situation is analyzed and problems that may be aided by information technology are identified. In the action planning phase, we plan how a combination of software tools and a set of training modules for effective use could improve matters. Action taking then will implement the designs arrived at to create a series of prototypes and eventually final versions of the software, technology, and/or technology mash-ups. The evaluation phase aims to determine if the desired effects are achieved. It is judged in the sense of whether the artifact(s) created are likely to be adapted and used by the members of the target user groups in such a way as to obtain the desired objectives, and also, most importantly, to obtain suggestions for how to improve the artifacts in the next iteration. The specifying learning phase is where lessons learned from the iteration are documented. This phase occurs during each iteration as research results are used to inform the next phase of design.

RESEARCH OUTCOMES AND RESULTS

During 2007 through 2010 the BEOC model (capabilities framework) was tested and analyzed using the five phase framework previously described against the backdrop of a series of exercises and an actual event. Data was collected using participant observation as well as observing participant processes (Chumer 2009), logs were kept, observations recorded, and minutes of meetings and teleconferences occurring during each exercise as well as the event were kept and later analyzed using the qualitative approach previously described. Techniques to include content and thematic mapping were also used. This was done to obtain observer and cross observer textual data. The five-phase process was the framework that was followed by each observer (as data collector and generator) during each exercise. The results of the analysis were used to both inform the research underlying each exercise (as an experimental activity) and in the writing of the exercise after action reporting and hot-wash process. In addition, the themes that surfaced from the meeting minutes, teleconferences, and individual observer data collections about the use of different technologies and systems by private sector and public sector exercise participants were identified. Lastly, theme commonality and differences between the data were analyzed.

A brief description of each exercise follows:

1. ***EXERCISE 1 – Topoff 4*** was a tier 1 exercise based upon a terrorist attack on various parts of the United States using a Radiological Dispersion Device (RDD). A tier 1 exercise is normally mandated to be held each year by the White House.
2. ***EXERCISE 2 - Virtual Hurricane Reseponse Exercise*** was a tier 3 exercise (locally developed) based upon a natural disaster (a category 3 hurricane affecting New Jersey and New York City.
3. ***EXERCISE 3 – National Level Exercise 2-08*** was a tier 1 exercise based upon a natural disaster, a hurricane affected the US capitol Region.
4. ***EXERCISE 4 – National Level Exercise 09*** was a tier 1 exercise based upon a terrorist threat in the Gulf of Mexico and the State of Texas.

5. ***EXERCISE 5 – National Level Exercise 2010*** was a tier 1 exercise based upon a Weapons of Mass Destruction (WMD) scenario.
6. ***EVENT 1- Democratic National Convention*** was an event where the BEOC supported our business partners in Denver during the Democratic National Convention, The BEOC functioned as a business fusion center.

GENERAL OUTCOMES

The outcomes and results of the data analysis from each exercise and from the actual event posited the following capabilities that generalized across each exercise

1. Notifications/alerts
2. Collaboration
3. Communication
4. Incident Management Support

In addition the following capabilities emerged during exercise 4 and 5 as being important to consider:

1. Visualization
2. Integration

These six emerging capabilities became the focus of future research activities currently being constructed.

These six defining capabilities are system and technology based which may be considered a potential shortcoming of the research effort. That shortcoming being the focus on the enabling effect of technology and systems to the detriment of considering additional factors such as organizational, individual, and/or political to name a few.

However it must be understood that our major focus area was tools technologies and systems as enablers of research framework capabilities.

RELATING OUTCOMES TO THE C2 PROCESS MODEL

It became clear during our research that C2 concepts so common in the military were being tacitly applied to HLS. For example in HLS there is talk about the development of a common operating picture (COP), situational awareness (SA), shared situational awareness (SSA) especially during the response and recovery dimensions of HLS EM. Yet these terms are common underpinnings in the domain of military C2. Two papers were written (Chumer and Turoff 2006; Chumer 2008) about deconstructing the basic C2 military model and suggested how the deconstructed components can fit into a HLS environment. The mediating effects of technology on collaborations were also addressed (Chumer, 2008). The principle components of the BEOC framework articulated in this paper are grounded in both the deconstructed process

model of C2 and the effects of technology mash ups as mediators of inter-agency and inter-sector collaborations.

The process model of C2 is grounded in OODA and SIDA loops addressed earlier in this paper. During exercises, the salient activity of moving through the process loops, by the agencies and sectors participating in the exercises, was the time it took to go through the process steps of one loop before starting the next loop iteration. The data collected showed that the alerts/notifications to include the various ways of communicating them and the types of collaborations that these communications spawned went a long way during the exercises to reduce the time it took to make decisions and to make collective sense of and get in front of a catastrophic or extreme event as that event grew in severity. For example, the need to communicate “ground truth” from first responders to the first joint/unified command center suggested developing tools that create a standard format for alerts and notifications as well as redundant communication media acting as a conduit for the messages so constructed.

Incident management support surfaced as an important activity for the private sector writ large and for the inter-agency support group of Northcom. It became important to differentiate the incident command system (ICS) role, where decisions are made by a coordinating agency (Municipality, County, State, FEMA Region, DHS, Other), to how incident management relates to incident management support. Incident management support was practiced largely by the private sector and Northcom during the exercises. Both entities are not directly in the response decision making process of ICS. However both entities need to be aware of decisions being made within the ICS during a response in order to anticipate response behavior. From the private sector perspective anticipation results in behavior applied directly to business continuity initiatives and continuity of operations plans (COOPS). Also from the perspective of the private sector, once continuity of business issues are addressed, then through anticipatory processes they can determine resource needs of the public sector to include how to function as an emergency support function in providing resources as required if asked. This is similar to the role of Northcom inter-agency support. Northcom in anticipation of some level of support to civil authorities needs to determine resources and the pre-positioning of resources ahead of time to ensure their availability when requested. The capability of incident management support surfaced time and again as being a vital framework activity.

Lastly visualization and integration activities began to surface as critical activities within our emerging framework. Visualization relates to the C2 construct of developing a common operating picture (COP). It became obvious when assessing research data that mapping technologies and geographical information systems (GIS) became important capabilities in speeding up decision making within OODA and SIDA loops as well as making sense of ground truth data. Visual data and their interpretations when coupled with the text data of alerts/notifications became strong capabilities within the research framework.

Integration of networked tools and technologies through dashboards and secure portal technology emerged as the fastest growing capability component. Through its integrating effect network access to other capabilities can be brought into one display.

Before concluding it must be remembered that a major focus area during the period of time from 2007 to 2010 was on the enabling effect to technology, systems and technological tools.

CONCLUSIONS AND WAYS AHEAD

It became evident during the research period that in addition to technology, technology factors, and technology enabled capabilities, there is the confluence of additional factors that are certain to play a significant role in understanding inter-sector and inter-agency communications and collaborations. These additional factors surfaced during the post hoc analysis of data from each of the exercises and the event mentioned in the "Research Outcomes and Results" section of the paper. They include but are not limited to the following:

1. ***Individual Factors***
2. ***Organizational Factors***
3. ***Societal Factors***
4. ***Political Factors***

Some of these are identified within the NATO model. However moving forward and expanding upon the framework articulated in this paper it will be important to surface these specific factors in future research projects and then link them as appropriate to the technological capabilities we have been researching and addressing herein.

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BEOC an Interagency Model

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Presentation Outline

- History
- Research Approach
- Specific Research Activities
- General Outcomes
- Specific Outcome
- C2 Linkage
- Ways Ahead

History

- DHS EM (4 major dimensions)
- 2007 DARPA Brain-storming session (2010 follow-on)
- Initial capabilities (Pvt. Sector meeting)
  - ***Notifications/Alerts***
  - ***Intelligence gathering and analysis***
  - ***Collaboration***
  - ***Communication***
  - ***Reachback***
  - ***Incident Management***
  - ***Incident Management Support (added later during the research process)***
  - ***Visualization***
  - ***Modeling, Simulations. Training***
  - ***Integration (expanded to include a virtual capability)***

Research Approach

- Theoretical Grounding
- Activity Theory/ Action research
- Cognitive Anthropology
- Data Collection (five phase framework)
  - ***diagnosing***
  - ***action planning***
  - ***action taking***
  - ***evaluating***
  - ***specifying learning.***

Specific Research Activities

- ***EXERCISE 1 – Topoff 4*** was a tier 1 exercise based upon a terrorist attack on various parts of the United States using a Radiological Dispersion Device (RDD). A tier 1 exercise is normally mandated to be held each year by the White House.
- ***EXERCISE 2 - Virtual Hurricane Reseponse Exercise*** was a tier 3 exercise (locally developed) based upon a natural disaster (a category 3 hurricane affecting New Jersey and New York City.
- ***EXERCISE 3 – National Level Exercise 2-08*** was a tier 1 exercise based upon a natural disaster, a hurricane affected the US capitol Region.
- ***EXERCISE 4 – National Level Exercise 09*** was a tier 1 exercise based upon a terrorist threat in the Gulf of Mexico and the State of Texas.
- ***EXERCISE 5 – National Level Exercise 2010*** was a tier 1 exercise based upon a Weapons of Mass Destruction (WMD) scenario.
- ***EVENT 1- Democratic National Convention*** was an event where the BEOC supported our business partners in Denver during the Democratic National Convention, The BEOC functioned as a business fusion center.

General Outcomes

- Notifications/alerts
- Collaboration
- Communication
- Incident Management Support
- Visualization
- Integration

Specific Outcome

- NLE 2011
- The NJIT C4IF lab Event page
- FEMA National BEOC model
- Public Facing
- Secure Portal Compartmentalization (the virtual scif)

C2 Linkage

- Process Model of C2… OODA to SIDA
- Linkage to the Incident Command Structure
- Incident Management and Anticipatory Processes

Ways Ahead

- ***Individual Factors***
- ***Organizational Factors***
- ***Societal Factors***
- ***Political Factors***