

The Need for Cross Discipline Awareness and Interoperability in the First Responder and Emergency Management Communities

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ABSTRACT

This article looks at the current state of medical disaster preparedness and the need to improve cross discipline awareness, communication, and interoperability between members of the first responder and first receiver community. Further it reviews the nature of crises to which the biomedical first responder community must react and inadequacies in response capabilities and actions already identified by experts. The use of coordination and collaboration to develop first responder and first receiver interoperability at the individual and cross agency levels to surmount these barriers is discussed. Finally, a training approach that incorporates educational neurobiology to achieve individual and cross agency interoperability is identified.

THE NEED FOR CROSS DISCIPLINE AWARENESS AND INTEROPERABILITY IN THE FIRST RESPONDER AND EMERGENCY MANAGEMENT COMMUNITIES

WHAT IS INTEROPERABILITY AND WHY IS CROSS DISCIPLINE AWARENESS IMPORTANT FOR FIRST RESPONDERS

With the advent of advanced computer and telecommunications systems, interoperability has come to refer almost exclusively to what the Institute of Electronics and Electrical Engineers (IEEE) defines as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" (IEEE Standard Computer Dictionary, 1990). While this is a sufficient definition for the specific types of interoperability systems (such as computers and telecommunications) it fails to properly recognize or address the implications of the broader sense of interoperability occurring within social, political, organizational, and cultural systems. Further, applying a limited view of interoperability to only computers and telecommunications systems, and not the broader societal view, may inadvertently lead to inadequate attention being given to the need for

developing shared understanding of needs, practices, and capabilities across the first responder and emergency management communities during crises.

Without shared understanding of the capabilities, methods, practices, and needs of the differing first responder and first receiver disciplines (e.g., police, firefighters, emergency medical practitioners, public health and safety, etc.) valuable time, evidence, information, and operational performance is jeopardized. This shared understanding across these emergency management communities is more than a common language and set of information sharing protocols. It is in fact the condition achieved by the broader definition of interoperability which recognizes that shared understanding results from common knowledge across individuals and groups. This paper will first address the emerging state of crisis and disaster management, issues and implications for biomedical crisis management, and discuss methods for training within the first responder and emergency management communities to develop cross discipline awareness and interoperability.

EMERGING CRISIS AND DISASTER MANAGEMENT ISSUES

Crises endanger large segments of a given population and often call for unique response actions. The numerous sources of crisis events, both natural and man made are unpredictable, creating the need for flexible, trained personnel that can respond to all hazards. Responders must rapidly assimilate emergent threats, such as those which may come from biologically hazardous materials, and act accordingly using appropriate interagency measures for containment and incident recovery.

The rate of growth in economic costs of incidents involving natural hazards, as well as technological or man-made hazards, continues to increase. Bouwer, *et al.*, (2007) note that over a 20 year period, the cost of these events has risen from 8.9 (1977-1986) to 45.1 billion dollars (1997-2006), a five-fold increase. This rate of growth well exceeds economic growth and may be predicated upon global climate changes and the “clash of civilizations” noted by Huntington (1993). Regardless of the causes, increasing demand and complexity of crisis management has resulted. In addition, globalization, and improvements in transportation systems have hastened the spreading of diseases, as evidenced by the rapid spread of SARS from Asia to Canada.

One aspect of disaster management is the field of biomedical crisis management. Biomedical crisis management encompasses a wide variety of individuals trained in a diverse set of scientific fields and services in addition to the traditional health and human services and emergency medical practitioners. Cross-training and interoperability for these individuals is particularly important.

INTEROPERABILITY IS MORE THAN JUST COMMUNICATION AND COMPUTERS

The need for interoperability is not fully understood by today’s crisis managers. While most grasp the necessity for technological interoperability, such as the use of common emergency frequencies, there is insufficient appreciation of interoperable personnel. It is good to have

equipment that is interoperable during crisis, how much better would it be if not only an agency's equipment can be used cooperatively, but if the operators of the equipment could also function in conjunction with other agencies? Lerner, *et al.*, (2005) define the scope of interoperability as:

All aspects of collaboration and interaction needed to effectively prepare for, and respond to, disasters and other public health emergencies. Individuals and agencies from each discipline must be willing and able to interact and exchange essential information with each other. While this concept appears relatively straightforward, it necessitates both infrastructure, as well as intra-agency cultural changes.

While it is certainly true that interoperability requires communication, it also must involve interactive and resilient relationships between crisis responders. For these relationships to be effective, they need to be encouraged and developed before a disaster occurs. It is unreasonable to expect that responders can merely be told to cooperate and that they will be able to achieve cooperation. Barbera and Olson (2004) note that agencies must work together with operators getting to know each other to build these relationships long before the disaster happens. Contact between agencies during normal procedures has the potential to improve the relationships that will be relied upon in a crisis. Conferences, training sessions, and disaster simulations can also aid in developing these relationships.

INDIVIDUAL AND INTERAGENCY BARRIERS TO FULLY ACHIEVING FIRST RESPONDER INTEROPERABILITY

McConnell and Drennan (2006) recognize that one of the greatest difficulties facing the crisis management community arises from the vertical and horizontal fragmentation in today's governing organizations, which creates significant roadblocks to crisis planning. They also noted that difficulties to collaboration from horizontal fragmentation may be largely overcome through development of interpersonal relationships between actors in the first responder community. The challenges presented by vertical fragmentation, however, require more formal solutions that address the bureaucratic aspects presented by vertical silos which exist across agencies. McConnell and Drennan (2006) note the appropriate response, the one that enjoys the greatest chance of success, is a hybrid of formal and informal actions between agencies and individuals.

Another significant obstacle to interoperability is the reliance on government funding programs. *Many funding programs are competitive in nature and make it difficult to develop the relationships that are an essential part of interoperability.* Barbera and Olson (2004) find that this competitive culture of 'win-lose' outcomes that is created is one in which collaboration and cooperation are extremely difficult. The complexity of these obstacles note McConnell and Drennan (2006), "highlight the tension between the integrated logic of contingency planning, and the disaggregated nature of public, private, voluntary and community bodies."

Political maneuvering, poorly defined command systems, uncertainty in which roles and responsibilities are held by which organizations were also on Barbera and Olson's (2004) list of barriers to crisis response. They put emphasis on the need for a clear command structure,

noting that ambiguity in this essential area could cause significant disorder in a crisis, hindering effective response.

THE NEED TO CULTIVATE A FIRST RESPONDER COMMUNITY CULTURE

Formation of disaster planning and response teams before crisis is essential in developing more realistic and effective crisis management plans. These teams are not only crucial to response and planning, but as a means to identify potential response deficiencies. The formation of these groups provides a venue for high level members of the organizations to emphasize the need for interagency cooperation in disaster preparedness. While having preexisting relationships clearly enhances the ability to produce more realistic and effective crisis management plans, having preexisting plans in place is crucial to reducing response cycle time. Fink (2000) finds “that those organizations that did not have a plan reported that the crisis lasted two and one half times longer than those organizations that had a crisis plan in place.”

Helsloot and Ruitenberg (2004) outline a means of accomplishing coordination “through the normal planning and repetition activities, the establishment of personal contacts, development of liaison structures and shared operational facilities for emergency situations.” They go on to address the tendency of current crisis planning practices, which lean towards planning which incorporate go-between actor’s instead of direct interaction as occurs in actual field operations. They further note that instead of developing strict protocols for every possible situation, a process which requires greater rigidity and shortens the list of options available to responders, a more fluid response plan which incorporates the emergent properties of a crisis is preferable. It is important to note that they warn against creativity and flexibility taking the place of pre planning, stressing the continued need for clear and precise crisis response action plans. Their ideal is one in which plans are clear, definitive, and flexible.

So far the need for collaboration between members within and among agencies has been stressed. It is also important to incorporate members of academia who can aid in improving existing or developing new methods of responding to crisis. Livet, *et al.*, (2005) notes that experts in crisis management, public health, emergency medical services, societal dynamics, biological systems, civil engineering and an entire gambit of other related fields must be linked by cooperative alliances with first responders and be active participants in the first responder community. Barbera and Olson (2004) provide that a community, such as the one described above, would be able to address the growing concern over issues of standardization, integration of emergency response, and first responder training.

Granot (1999) warns, “achievement of genuine co-operation among emergency responders must not be taken for granted by planners and cannot be overemphasized.” Comfort (1990) points out that, “conflict among organizations seeking to respond to the sudden, extraordinary demands generated by disaster is a recurring and well- recognized problem.” Even with cooperation, response is a struggle. Issues of communication failures, differences in observed conditions, and inconsistent operational objectives can still exist. Granot (1999) notes that a community of thought and practice, which actively strives to

achieve higher levels of interoperability, may be the only way to address these issues and achieve the most effective response.

TRAINING OUR FIRST RESPONDER COMMUNITY

Livet, *et al.*, (2005) offers that training the first responder community presents numerous difficulties. The great diversity the community represents, be it across disciplines or on multiple levels of a single agency, is one of the causes of these difficulties. Additionally, according to Emergency Preparedness News, (2006), training must also help to build interagency relationships and trust, where team building must go hand in hand with imparting the technical and cognitive skills to achieve effective crisis response.

Along with the need to train first responders, Tierney (2007) notes, there is need also to train the emergency management professionals from other public support agencies such as finance and administration for response and recovery efforts are to be successful. *All parties involved in a crisis must not only be trained to a high level of proficiency in their given field, but must also possess awareness of the other operators who will be engaged in response.* Further, training needs to be an ongoing process which addresses all aspects of crisis planning, response, recovery, and mitigation. Tierney (2007), calls for greater training of those in managerial positions during a crisis saying, “professionalization and training efforts for mid- and upper-level managers must be strengthened even more to ensure that those who have to make hard decisions in future disasters will be intellectually equipped to do so.”

Some of the largest problems facing the disaster response community relate to the difficulties presented by resource limitations and health care delivery problems. Through the use of training, first responder competency and capacity can be greatly increased. Streichert, *et al.*, (2005) note that these greater competencies improve both the quality and quantity of health care that each responder can provide. Another benefit of training exercises is the increased awareness that can be brought to the community at large, with special focus on vulnerable populations. Through the training of service providers to vulnerable communities realistic ideas of what to expect and when to expect it in terms of crisis response can be achieved. Excellent examples of service providers to vulnerable populations that can benefit from this training are those working at rehabilitation clinics and retirement facilities. These service providers who support vulnerable populations will be better able to provide consistent healthcare if they are aware of the timetable of response and just what external assistance can be expected. Stahmer, *et al.* (2007) note that these facilities have response capacities that responders might utilize, such as medical facilities for non-critical injuries.

By uniting these communities, healthcare and emergency response, there is a greater opportunity for mutual benefits to be derived. Lerner, *et al.*, (2005) note that interdisciplinary training may assist healthcare providers in non crisis situations such as immunizations, where responders can act as reserve healthcare providers in limited capacity. Vernon (2007) notes, through type specific interdisciplinary training, such as violent situations, we can provide responders with the cross agency awareness that has been identified as essential to effective crisis response.

Finally, it must be recognized that not every type of crisis can be anticipated. Specific details of many disasters will only be truly understood when they are encountered in a given

crisis. However, responders can be made ready to address these diverse and emergent elements of a crisis through effective training. Key to this training is the issues of cross discipline and interagency integrated response. Without training greater vertical and horizontal awareness, obstacles which could have been removed or ameliorated will hinder response.

A PROPOSED TRAINING APPROACH TOWARDS FIRST RESPONDER INDIVIDUAL INTEROPERABILITY

A sound foundation and approach to developing a culture of interoperability must include training and educational programs. This training process should include evaluation of the nature of systems thinking, mental modeling, and symmetry learning as integral components for any proposed interoperability training process.

A TRAINING PATH FORWARD

In a military environment the interoperability necessary to effectively respond to a crisis is achieved by cross training for every position. It is often impractical or nearly impossible in the civilian environment to train each of these responders in every field of concern that they may encounter as they respond. How then is it best to prepare these key actors for crisis response? Typical first responders to biomedical crises, such as policing, firefighting, emergency medical services, media, transportation, and public works, are likely initial target audiences for this training effort.

New to the crisis management field is the idea of All Disciplines response. All Hazards approach, while necessary, must be augmented by the emergent ideas of All Discipline. All Disciplines requires that those in the response community work in integrated teams that understand the complexities of each group's requirements and how those particular complex interdependencies, both inside and between groups, work and affect their ability to perform their mission. This approach has highly desired results. In the case of health care it is improving the quality of outcomes of health; in the case of policing it is the ability to be more able to determine the root cause of a particular malfeasance.

The paradigm that will guide this proposed interdisciplinary training approach will be a neuropsychologically structured view of learning that provides a framework for coupling systems of disciplinary knowledge to the design of useful pedagogical strategies to teach ontogenically developing human beings. The "cycle of pedagogy" (COP) is the term given to explicitly recognizing that a systems-modeling approach unifies human learning in that:

- The brain is biologically organized to process information through the construction of internal models;
- Disciplinary knowledge is itself structured and can be described in terms of a model that represents the reality under study;

- The process of learning from the level of the neophyte to expert represents an internalization of a disciplinary model of knowledge. Pedagogy is the process of coupling a disciplinary knowledge structure to the neuropsychological structure in such fashion that the neophyte mind becomes increasingly expert.

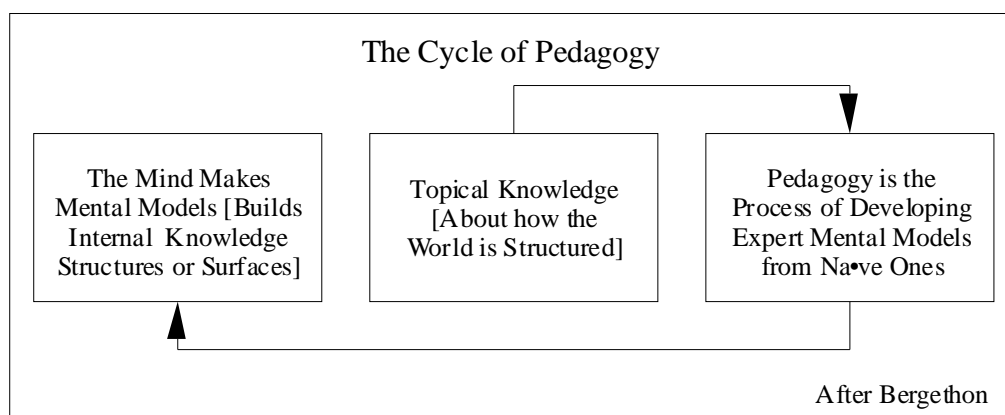


Figure 1: The Cycle of Pedagogy.

The brain organizes pattern feature analysis of any progressive and predictable development; information is treated concretely first and then progressively abstracted. This concrete abstract knowledge construction pattern is influenced by biological development and level of education. Human learning follows this pattern of biology and psychology. The brain is a remarkable pattern recognition engine and superb system for categorizing. Biological evolution has formed this powerful system for pattern exploration and classification, but at the expense of a tendency toward bias and prejudice. The brain is inclined to lock onto the most “obvious” image or cause and effect explanation for an observation. Once a particular viewpoint is learned, the tendency to jump to conclusions leads toward bias and prejudice that makes revisions of knowledge difficult and tedious.

Learning, at least on the cognitive levels above simple adaptive behavior, may be usefully regarded as the process leading to alteration (revision, reconstruction or embellishment) of these internal models. Learning is a function of both the biological substrate and the environment. If educational practice can be related to the construction and revision of these internal models in a coherent theoretical formulation, the underlying biological and psychological processes can be connected to the learning behaviors that are manifested by the organism. The process of relating these internal models to educational practices can be accomplished through the use of dynamic-systems models that relate how behaviors, such as learning, can result from using patterns in data to integrate a multiplicity of factors in a self-organizing fashion to achieve a stable equilibrium: a state of knowledge or belief (Bergethon 1998, 2004, and 2007; Woodcock 1998). The neural models of Bergethon and Woodcock explain how a feature-extraction system can also succumb to misconception, have resistance to error-correction, and why the nature of scientific discovery is largely counterintuitive.

Models of cause and effect are built on a mode of explanation: *The gathering of information (observation) and understanding of what it means (mode of explanation) is the task of the brain.* To allow for true interdisciplinary interoperability it is necessary to recognize and adapt an individual’s bias in perception. Model making can provide the common link between disciplinary domains in the realm of crisis response. Modern science

and the critical-thinking practices that it supports depend on three linked stages of model making. These are the formation of descriptive models that represent observations, generation of explanatory models that embed hypothetical linkages of causality, creation of experimental models that allow empirical testing of the hypothetical structure of the explanatory and the epistemological structure of the descriptive models.

INTEROPERABILITY TRAINING APPLICATION

To achieve this greater capacity, it is necessary that the mental models held by crisis responders and healthcare professionals be interoperable.

To better illustrate how these training may increase interdisciplinary awareness and will affect day to day operation in the field, let us consider the example of forensic evidence gathering at a scene of a death cause by an unknown pathogen. Firefighters and Emergency Medical Services operators' greater awareness of the police domain will cause them to actively engage in evidence preservation by consciously limiting potentially contaminating a crime scene by only affecting areas of the scene that must used to preserve life. Likewise, police will prepare for the arrival of EMS by checking those areas that EMS must disturb to perform its tasks first. This cognizance of forensics will allow crime scene analyst to more readily determine the specific pathogen and its source. This will allow police and the Emergency Medical System to take appropriate containment steps sooner. All of this works to provide better healthcare for the public by maintaining the quality of EMS response, and promoting the containment of the pathogen. This is a discipline specific approach, below is the All Disciplines Approach, which allows for consideration of wider variety of factors. By taking into account the background space as well as other players a better response can be achieved.

Interoperability must also be in the language used by each group. Each of these groups has a diverse language set, with different definitions of terms and meanings conveyed. *Through the use of systems and symmetry thinking, a common mental map of the operating environment designed specifically for incident command and crisis response can be created.* This shared understanding of the operational playing field in the terms of interoperability and interagency cooperation is achieved through common perceptions and constructs of systems thinking for these different operators. The goal specifically for these types of training activities is to create an enhanced level of capacity in first responders, complete with a higher level of interoperability and interagency functional capacity.

Police, firefighters, emergency room personnel, and transportation authorities will be able to provide the public with a greater level of healthcare during response to biomedical or other crisis event if they enjoy a high level of cross agency cooperation. With the continued proliferation of research and industry biohazard infrastructure, interdisciplinary coordination is of greater and greater importance. This coordination is facilitated through use of these training conferences in developing similar mental models and methods of thinking and by creating an interoperable language.

Possessing a cross agency interoperable language increases the capacity for rapid response to crisis in two fundamental ways. First it allows for data transmission to be both more accurate and more rapid. The accuracy is gained because of shared definitions that will

allow members of one agency to communicate the exact nature of situation to operators in another agency. Likewise, the speed of knowledge acquisition is enhanced because there is no need to translate messages sent from one agency to another. A common language allows individuals to create similar mental models. *Language is a fundamental part of the context in which a situation is viewed, the more similar the language used to identify elements of a system the more alike the definition of that system will be between responders.* Similar models, those that have similar definitions, allow for increased capacity for responders to provide healthcare and to implement safety measures for at risk populations in a crisis by increasing unit cohesion. Increased interagency crisis response team unit cohesion is of paramount concern for both this conference and for continued research in the crisis management field.

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