Preparing for Emergency Situations

Viveca Asproth and Christina Amcoff Nyström

Mid Sweden University, 831 25 Östersund, Sweden
E-mail: viveca.asproth@miun.se
E-mail: christina.amcoff@miun.se

Abstract. Disaster relief can be seen as a dynamic multi actor process with actors both joining and leaving the relief work during the help and rescue phase after the disaster has occurred. Actors may be governmental agencies, non profit voluntary organisations or spontaneous helpers comprised of individual citizens or temporal groups of citizens. Hence, they will vary widely in agility, competence, resources, and endurance. To prepare for for disasters a net based Agora with simulation of emergency situations for mutual preparation, training, and organisational learning is suggested. Such an Agora will ensure future security by: –Rising awareness and preparedness of potential disaster responders by help of the components and resources in the netAgora environment; –Improving cooperation and coordination between responders; –Improving competence and performance of organisations involved in security issues; –Bridging cultural differences between responders from different organizations and different backgrounds. The developed models are intended to reflect intelligent anticipatory systems for human operator anticipation of future consequences. As a way to catch what should be included in this netbased Agora and to join the split pictures that is present, Team Syntegrity could be a helpful tool. The purpose of Team Syntegrity is to stimulate collaboration and incite cross fertilization and creativity. The difference between syntegration and other group work is that the participants are evenly and uniquely distributed and will collectively have the means, the knowledge, the experience, the perspectives, and the expertise, to deal with the topic. In this paper the possibilities with using Team Syntegrity in preparation for the development of a netbased Agora is discussed. We have identified that Team Syntegrity could be useful in the steps User Integration, Designing the netAgora environment, developing Test Scenarios, and assessment of netAgora environment.

Keywords: Emergency, simulation, modelling, Team Syntegrity, anticipation
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1. INTRODUCTION

Natural and man-made emergency events can cause serious risk and threat on the well-being and safety of a population. Those involved in such processes need to be able to cope with stress situations and high work pressure. In addition to that, several authorities and organizations become involved and cooperation between these people is crucial and is not trivial. These multiple organizations have different characteristics and their goals may differ. Disaster relief can be seen as a dynamic multi actor process with actors both joining and leaving the relief work during the help and rescue phase after the disaster has occurred. Actors may be governmental agencies, non profit voluntary organisations or spontaneous helpers comprised of individual citizens or temporal groups of citizens. Hence, they will vary widely in agility, competence, resources, and endurance.

Crisis management demands rapid and timely coordination, not only between members within a team but also between members of different teams. Each team has different roles and responsibilities. In particular, during a crisis, the coordination between team members need to be tightly coupled and aligned with organizational goals for effective crisis response. (Reddy et al, 2009)

Computer systems for information and communication during the rescue work, or when preparation for emergency situations, will be a great help. However, before we can effectively design such systems, we must first understand the challenges that these teams face when trying to coordinate with each other during a crisis. Some of the major challenges associated with team coordination during crisis management include information mismanagement (Comfort,et al, 2004; Kyng et al, 2006), resource allocation issues (Seifert, 2002), and ineffective communication (Hale et al, 2005; Mattox, 2001). These challenges collectively can lead to coordination and communication breakdowns in and between teams. To bridge the challenges that team members face when

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communicating and coordinating their activities with each other during a crisis it is essential that different emergency team members can describe their roles and their working environment. It is also of great importance that the team members can practice in beforehand.

To prepare for for disasters a net based Agora with simulation of emergency situations for mutual preparation, training, and organisational learning is suggested.

As a way to catch what should be included in this netbased Agora and to join the split pictures that is present, Team Syntegrity could be a helpful tool. In this paper the possibilities with using Team Syntegrity in preparation for the development of a netbased Agora is discussed.

2. STATE OF THE ART

2.1. Emergency Management

The netAgora environment, including the disaster simulator, scenario editor, and assessment kit, will be designed and adapted to state of the art risk management research. A central point in developing such a computer and net based integrated environment for preparation and training for disasters and complex emergency situations is a thorough understanding of emergency management and organizational learning.

Community emergency planning has its roots in military analogies which viewed emergencies and disasters as conditions of social chaos only rectifiable by command and control. Social scientific research has, however, repeatedly showed that emergencies are characterized by complexity, dynamic but rational behaviour, and that models based on continuity, coordination, cooperation, process and improvisation are more adequate than traditional rigid views on involved organizations and the emergency process (e.g. Alvinius et al. 2007, Boin et al. 2005, Boin & Lagadec 2000, Dynes 1994, 2000, Harrald 2006, Kendra & Wachtendorf 2006, Rodrígues et al 2006, McConnell & Drennan 2006, Olofsson et al 2006, Quarantelli 2000, 2004, 2006, Tierney 1994, Wachtendorf & Kendra 2006). Still, emergency management, and related fields e.g. crisis communication, emergency organizational learning, training and simulation, are generally handled and studied as an intra, rather than an inter, organizational phenomenon (Fearn-Banks 2002, Gordon 2008, Olofsson 2007). Needless to say, intra-organizational management is crucial at emergencies (Levine & White 1961). Hence, the netAgora project is particularly focused on creating an environment for training inter-organizational and international emergency situations.

Further, the netAgora project will have a process oriented point of departure for the development of scenarios and the simulation model. Employing a process, rather than a plan, oriented view of emergencies has several advantages (Rodrígues et al 2006); A process is open for change and improvisation; it can involve other actors and allow network management, rather than command and control; it embraces the range of understandings of the situation; and acknowledge the diversity of needs (Alvinius et al. 2007). Needless to say, organizational cooperation is mandatory in all kind of emergencies and current trends indicate that the future brings challenges to involve a wider range of actors from different regions and countries, i.e. demanding more complex collaborations (e.g. Caruson & MacManus 2008, Conca 2008, Quarantelli 2006, Robinson, Barrett & Stone 2006).

As mentioned, the process oriented emergency management approach addresses the crucial issue of different understandings of the emergency situation. Today emergency training and simulation tools assume that involved organizations and individuals have the same image, or view, of the emergency site/situation, although empirical evidence indicate differently (Alvinius et al. 2007, Danielsson et al. 2007): Different organizations, as well as individuals within organizations, understand the situation differently depending on their task, position, information, knowledge, organizational culture and preparedness for action. Theoretically, the concept of sense making has proved to be successful here (Weick 1998, 1995, 2005). 'Sense making' can be understood as a process of placing stimuli or phenomena into context or a framework (e.g. organisational culture). Sense making makes it possible to focus on individual actor's (e.g. a leader of a rescue operation) understanding of emergencies as not only an individual or organizational construct but also influenced by social relations and general beliefs of the actor and her organization (Kendra & Wachtendorf 2003, 2006, Wall & Olofsson 2008). There are few studies of how this works at an international emergency site with actors not only representing different kinds of rescue agencies, public and private organizations and volunteers, but also different countries. However, the need to train and educate emergency agencies in handling such situations is vital. The netAgora project will develop this field of research further and improve upon the European emergency management in practice.

In earlier work by the research group we have approached the following related general problem domains:

- Decision support for spatial planning (Asproth, Holmberg, Håkansson, 1999; Asproth, Holmberg, Håkansson, 2002; Asproth, Håkansson, 2002)

- Spatial modeling and simulation (Asproth, Holmberg, Håkansson, 2004)
- Water regulation (Asproth, Holmberg, Håkansson, 2001)
- Visualization of spatial decision situations (Asproth, Holmberg, Håkansson, 2002)
- Simulation and anticipation in critical situations (Asproth, Håkansson, 2005a)
- Information system tools for emergency situations (Asproth, Håkansson, Révay, 2005; Asproth, Håkansson, Révay, 2006; Asproth, Håkansson 2005a; Asproth, Håkansson 2005b; Asproth, Håkansson, Révay, 2008)

A conclusion that can be drawn from this work is that it is not the technical aspects of a system for simulation of and training for emergency situations that is the challenge. In stead it is the organizational and human aspects that need to be dealt with.

2.2. Organizational Learning, Simulation and Scenarios

The netAgora environment is a training process aimed not least to support organizational learning. To achieve high preparedness and embedded crisis management, organizational learning plays an important role, or rather, learning is a condition for the organization to adapt to new circumstances and handle emergencies (Boin et al. 2005, Casey 2005, Czeglédy 1996, Sundelius et al. 2001). However, the capability of organizations to adjust to new advice, policies and regulation is limited, and some even claim that collective learning is not possible in complex organizations (cp. Perrow 1999). Instead it is during and after a crisis that the learning occurs (Gouldson et al. 2004; Kim 1998; Olofsson 2007, Tanifuji 2000). This indicates that crisis management is context dependent: The organization's preparedness depends on earlier decisions and experiences related to crises (Sundelius et al. 2001). A classic in organizational learning studies, Argyris and Schön's (1978) model of single and double loop learning also teaches us that organizations need to rethink organizational norms and policies to adapt to new situations (Argyris & Schön 1978: 2-3): "*Double-loop* learning occurs when error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies and objectives.". Although it is important not to overstate the difference between the two modes of learning, the latter kind is desirable in dynamic and changing environments (Argyris 1998, cf. Espedal 2008, Hoon Song & Chermack 2008, Smits & Champagne 2008). Hence, organizational emergency management in heterogeneous societies must move forward from the national cultural determinism that has been predominant so far, and begin to include the (international) environment in which organizations exists and collaborate.

Simulations and scenarios can be used to achieve organizational learning and stimulating double-loop learning without actually being subject to an emergency or disaster (McLean & Egan 2008). In the netAgora project scenarios will therefore be developed in accordance with the state of the art in the field (Burt & Chermack 2008, Keough & Shanahan 2008, Lene et al. 2004). Multi disciplinary based knowledge is, however, critical to accomplish simulation models and scenarios as realistic tools for emergency planning and intervention. Santos and Aguirre (2004: 44) writes: "…research and theory in the social sciences can have an important effect in grounding the models in realistic assumptions regarding social behaviour in crisis situations, and such modelling in turn could enrich our understanding of collective behaviour in crisis situations". The netAgora project is genuinely multi disciplinary, and in all parts of the project scientists from different disciplines will work together to achieve the optimal learning environment.

Theories of sensemaking and trust in and between organizations, and earlier research of crisis management and organizational learning, will be an important reference for the project in general and the development and building scenarios in particular. Some research in this are has been performed by (Asproth, 2007; Asproth and Håkansson, 2007; Asproth and Nyström, 2008).

2.3. Virtual Organizations

Organizations might exist in different shapes – co-located or geographically dispersed. Dispersed organizations, sometimes called distributed organizations or distributed teams (Jansson, 2005), could be more or less distributed - both in the meaning of space; distributed in one building or distributed over several cities - but also in time; the members are working in different time zones. Many of this dispersed or distributed organizations, wholly or partially, uses different kind of technologies when they communicate and collaborate. They act as a virtual organization - VO (Camarinha-Matos and Afsarmanesh, 2007). VO could also exist under special circumstances related to the goals of the participating members or organizations. Such VO often exists under a limited period. This

period can be limited in time but also depended on if the organization has solved their common tasks or reached settled goals.

VOs have their strength when the markets are turbulent and/or the common task to solve is critical in time. VOs can be formed rapidly – maybe triggered by business opportunities or serious incidents which have to be taken care of. Camarinha-Matos and Afsarmanesh (2007), describes VOs as one of the most discussed examples of collaborative networks which have raised considerable expectations in several applications domains. Incident management and disaster rescuing processes is one application area where there is a need to rapidly engage and coordinate activities of a large number of entities (e.g. fire brigades, hospitals, police). VOs – or virtual teams which is another used concept for the phenomenon – should therefore be a suitable and supporting form of organization in situations as described above – and in analogy with the NetAgora when a training or education environment is established to illustrate the complexity and problems to solve in a critical situation when several stakeholders are involved. Hence, cooperation through virtual teams has, shown up as successful with respect to the feeling of equality and balancing of power (Asproth, Nyström, 2008; Nyström, 2006; Gilliam and Oppenheim, 2006). Furthermore, the work in virtual teams, often bridges differences between the members according to background, positions and so on. However, several authors claims that cooperation in virtual teams needs trust (Handy, 1995; Maznevski and Choduba, 2000; Crossman and Lee-Kelly, 2004) with the meaning of "trust needs touch" – virtual meetings should be preceded by physical meetings. Some other obstacles are high initial costs to start the collaboration process, lack of common collaboration infrastructure and lack of preparedness of organizations to join the collaborative process (Camarinha-Matos and Afsarmanesh, 2007). Furthermore, virtual communication often lacks contextual information, which can cause perceptions of time pressure because alternatives to face-to-face communication are more time-consuming and effortful. Misunderstandings among team members can lead to inadequate critical thinking, human error in information processing, uncertainty, perceived isolation, as well as reduced satisfaction, task- and organizational-commitment, trust, and team cohesion (Walvoord et al., 2008; Caballer et al., 2005; Driskell et al., 2003; Jarvenpaa and Tanriverdi, 2002; Timmerman and Scott, 2006; Workman et al., 2003). This lack of contextual information must be considered in the NetAgora case but would probably not be a problem because the common goal is in focus. Anyhow, when a VO or a virtual team is established, there must be much effort put on choice of technology/communication channels, and all the members must be well aware of rules for communicating and in what context they communicate.

The advantages and driving forces for establishing virtual teams or VOs, are much higher than eventually disadvantages and the obstacles should therefore be taken care of and related problems solved. Main driving forces are information sharing, knowledge exchange, balancing of power (equality among the members) and possibilities to collaborate despite the distances – not only geographically, but also in time.

In the work with establishing the NetAgora, physical meetings should be a starting point – for example a workshop where Team Syntegrity is demonstrated and tested. Another issue to test and discuss is suitable netbased tools for collaboration. It is important that the members of the NetAgora/Virtual team, feels that the used technology is transparent and work as a support and not a hindrance.

3. THE NetAgora PROPOSAL

The netAgora project will develop a computer and net based integrated environment for mutual preparation and training for disasters and complex emergency situations. The netAgora environment will be all comprehensive with a disaster simulator, a scenario editor, and an assessment kit included in its core. It will support cooperation, coordination, training, preparation, and learning on individual, group, and organisational levels. The netAgora will further include support for an exchange of experiences, tools, and models of response to emergence situations within and between nations with a special emphasis on handling the cultural differences that may impede the emergence response.

The suggested net based Agora aims to prepare for disasters with simulation of emergency situations for mutual preparation, training, and organisational learning. The Agora will ensure future security by:

- Rising awareness and preparedness of potential disaster responders by help of the components and resources in the netAgora environment.
- Improving cooperation and coordination between responders.
- Improving competence and performance of organisations involved in security issues.
- Bridging cultural differences between responders from different organizations and different backgrounds.

The developed models are intended to reflect intelligent anticipatory systems for human operator anticipation of future consequences.

A deep and thorough understanding of the problem domain, i.e. the disaster situation and its context, is of primary importance. That domain knowledge, however, has to be creatively combined and integrated by first-rate ICT skills from the solution arsenal. Consequently, the key issue of this project will the integration of problem domain knowledge with solution arsenal skills in order to meet the requirements of disaster preparation, training, and learning.

Further, to prepare for relevant and predictable disaster situations will also increase the capability for meaningful improvisation in unexpected situations. There is also important with long time management of disaster situations (recovery), not just immediate rescue during the acute phase. Current disaster research has also demonstrated that the final outcome of a disaster situation is highly dependant on the preparations made before the disaster occurred.

At last, in order to be useful for all disaster responders, even the ordinary citizens and spontaneous groups of such, the training tool has to be utterly robust, simple, intuitive, and easily accessible.

The objective of the netAgora project is to design, construct and make operational the netAgora Environment (nAE).

Disaster relief can be seen as a dynamic multi actor process with actors both joining and leaving the relief work during the help and rescue phase after the disaster has occurred. Actors may be governmental agencies, non profit voluntary organisations or spontaneous helpers comprised of individual citizens or temporal groups of citizens. Hence, they will vary widely in agility, competence, resources, and endurance. There will also be no sharp limit between helpers and victims but in almost every situation individual helpers / responders will be the first on place.

However, despite differences in competence and resources every responder both have some unique knowledge and information to supply to the others and some specific information needs that other responders can help in providing.

Hence, the obvious conclusion will be that there will be as much need for coordination and communication support as for control and command support systems. The winning strategy, according to current research, will also be to move the focus from reactive disaster relief and rescue toward anticipatory mitigation, preparedness, training, and education.

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Developed mathematical model of cross-border complex crisis mitigation system will consider the compromise between large scale modelling and detailed modelling of the certain emergency area. By the development of novel hybrid approach connecting micro and macro model, both levels will be effectively implemented in the object-oriented (Kindler, 2000) simulation engine connected to the platform for advanced 3D interaction and visual analytics. Aggregated model of complex emergency resources based on differential equations will be developed to represent capacity of emergency supplies (people, equipment, transport etc.) connected with user demand (the scale of the disaster impact) in order to define qualitative property of selected critical point (useful for the trainees to understand crisis situation). Macroscopic model will consider the flow of resources as a continuum in the sense of fluid with specific characteristics. The resources flow variables used to describe the dynamics of considered fluid, which represents the crisis mitigation resources, are the mean speed $v(x, t)$, the density or concentration of resources $\rho(x, t)$, and the emergency resourcers flow volume $q(x, t)$ at point x and time t. Here several concepts of modelling flows of material and human resources based on the mass preservation law being first or second order (Leclercq and Moutari, 2007; Festa et al, 2001) will be adjusted for the purpose of the project.

Majority of the models are focused on the understanding of the complex emergency problem. The aim of proposed research is to qualitatively understand complex emergency mitigation dynamics on a large scale in the cross-border setup for the purpose of the simulation for training and strategic control in the cases of crisis events.

NetAgora will develop mathematical models of complex emergencies situations of the cross-border infrastructure in order to provide the tool for understanding of system structure and dynamics. Developed mathematical model will focus on important control problems in the resources flow network such as

emergency area→information generation→ application ofrescue resources→ rerouting→emergency area

and corresponding cross-border communication protocols and delays which are critical for proper system control. Models will be constructed by using the object-oriented paradigm combined with agent paradigm. The developed

models are intended to reflect intelligent anticipatory systems for human operator anticipation of future consequences

The workpackages that is to be carried through in netAgora are:

- User integration and tools selection
- Design of netAgora environment with crisis simulator
- Development of test scenarios and test data collection
- Construction of crisis simulator and other tools of netAgora environment
- Testing, improvement and verification
- Assessment of netAgora environment and test results

4. TEAM SYNTEGRITY

Team Syntegrity is a new process methodology developed by the management cybernetics Stafford Beer to stimulate collaboration and incite cross fertilization and creativity. The full description is available in Stafford Beer's book *Beyond Dispute: the Invention of Team Syntegrihy* (1995). It has roots in cybernetics, and several other branches as logic, mathematics, information theory and sociology. Some of the roots can be found in McCulloch (1989), Ashby (1960), Shannon and Warren Weaver (1962), Sommerhoff (1950), and not least Fuller (1979) and his ideas about geodesics and the interplay of tension and compression. Fortunately, it is not necessary to master all these sources to participate in a syntegration, or to plan and deliver one. Beer observed that conversations concerning attention to the organizations future adaption and developt, as they took place in organizations, often were sporadic and fragmented. Good ideas might die because the innovators who proposed them did not have enough political muscle to prevail; important opportunities for synergy among parallel initiatives might be lost because of missing or ineffective transduction between significant players and a lack of cohesion or organizational closure might lead to a lack of direction and poor mobilization of resources. Leonard (1996)

The driving force behind the development of syntegration was to provide a structure for holding purposeful conversations which would be non-hierarchical and democratic but would be contained and not dissipate their energy or insights. Beer chose icosahedron with its thirty edges, twelve vertices and twenty sides as an ideal shape on which to map the meetings and manage their variety.

A scientific principle is necessary for enabling productive and effective work in large groups of people. Simply allowing everyone to enter the debate typically results in chaos. Syntegration opens up a route somewhere between unilateral dictatorship and chaos democracy, based on a reliable mathematical principle.

In a syntegration a participant will be engaged directly in two teams as a member and two teams as a critic which will occupy him or her during four of the six scheduled time periods. In their two 'off periods' participants may observe (but not speak) in another team meeting or may use them as private time. (Leonard, 1996)

The difference between syntegration and other group work is that the participants are evenly and uniquely distributed and will collectively have the means, the knowledge, the experience, the perspectives, and the expertise, to deal with the topic.

5. TEAM SYNTEGRITY IN NetAgora

“Many instances occur where there is no 'management' to carry the can for better or worse. There are only disparate players, of comparable authority and status who may or may not find the means to work effectively together to promote a common objective. For these situations, the traditional organization chart was not only obsolete - it had never had any validity. They could only succeed if they could find the right balance between autonomy and coordination. It had to be rigorous to get anything accomplished and it had to be democratic to maintain their cooperation.” (Leonard, 1996)

In different steps, when developing and testing the netAgora, Team Syntegrity could be a useful tool. We have identifyed where and how Team Syntegrity could be used in the following steps:

5.1. User Integration

The objectives of the user integration are to outline the elements of successful user cooperation and collaboration.

Use of Team syntegrity: Here Team Syntegrity can play an important role both when designing the system for cooperation and collaboration and as a part of the test situation.

5.2. Design of NetAgora Environment with Crisis Simulator

The objective of the design of Crisis simulator is to set the basic principles for the creation of a training tool that uses information technology and improves the abilities of decision – makers, organisations, crisis managers and teams dealing with crisis events. As a training tool, Crisis simulator has to be flexible, capable to be used and adapt on any crisis type, facilitating problem solving. External simplicity, internal complexity, theoretical underpinning, element of surprise, social structure and verisimilitude should be considered before designing. Crisis simulator must be, realistic in appearance and in its internal process, capable of generating realistic outcomes. Simulations have to produce similar reactions and feelings in participants as experienced in real life crisis events, such as tension, uncertainty, time pressure, sense of inadequate information and frustration. End user (trainee) will be able to choose various possible locations for operational centers, shelters, food and first aid centers, meeting directly the results of his choice to disaster response.

Use of Team syntegrity: In traditional systems development processes there are methods for catching the information that is needed for the system and to here out the end-users wishes. Syntegration could be used as an alternative or as a complementary method for this purpose.

5.3. Development of Test Scenarios and Test Data Collection

Objectives of this work package are:

- To create a realistic and dynamic scenario of an international disaster involving a large set of actors representing public, private and non-governmental organisations. The scenario will be based on previous disasters and possible future emergencies.
- To design the scenario so that involved actors are trained in mitigating the disaster through intra- and inter-organizational cooperation including communication failure, conflict and confusion. This will facilitate a learning situation based on network management rather than control and command.
- To retrieve data from previous national and international disasters in Europe, as well as to map the different structures of emergency management in target European countries, to constitute the base for building the scenario.
- To interact in the development of the complex emergency model implementing the scenario in the model.

Use of Team syntegrity: To be able to get realistic scenarios it is essential that all all aspects of the possible scenarios are caught. Team syntegrity seams to be a useful tool as all team members can contribute in a democratic way.

5.4. Assessment of NetAgora Environment and Test Results

The objective of this WP is to use state of the art qualitative and quantitative research methodology (interviews, observations, web based surveys and document analysis) to analyse the process and effects of the SecSim project.

Use of Team syntegrity: As a complementary method a syntegration could be used.

6. CONCLUDING REMARKS

An emergency situation can be seen as a dynamic multi actor process, with rapid and timely coordination, not only between members within a team but also between members of different teams, where each team has different roles and responsibilities. The special conditions that are present during such a situation demand special attention. Team Syntegrity seems to be a helpful tool in preparation for such situation. It could be of help in different ways when designing a computer based system for training, when designing test scenarios, during the test phase and for evaluation of the tests. The difference between syntegration and other group work is that the participants are evenly and uniquely distributed and will collectively have the means, the knowledge, the experience, the perspectives, and the expertise, to deal with the topic. In the NetAgaora case this means that all aspects will be likely to be discovered and included.

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