Supporting Unstructured Activities in Crisis Management: A Collaboration Model and Prototype to Improve Situation Awareness

Cláudio Sapateiro
Systems and Informatics Department
Superior School of Technology,
Polytechnic Institute of Setúbal, Portugal
csapateiro@est.ips.pt

Pedro Antunes
Informatics Department
Faculty of Sciences of the University of Lisbon, Portugal
paa@di.fc.ul.pt

Gustavo Zurita, Rodrigo Vogt, Patricio Infante
Management Control and Information Systems Department, Business School
Universidad de Chile
gnzurita@fen.uchile.cl, rodrigovogt@gmail.com, patoinf@gmail.com

Nelson Baloian
Computer Science Department, Engineering School
Universidad de Chile
nbaloian@dcc.uchile.cl

ABSTRACT

Organizations orchestrate work along a continuum of structured and unstructured activities. Particularly in emergency situations and crisis management scenarios, the organization's procedures and information systems may not cope with the information and collaboration requirements imposed by the dynamic of unplanned situations, emerging such unstructured work practices. In this paper we present a collaboration model and a PDA prototype to assist these unstructured activities aiming to improve their consistency and effectiveness. Inspired on the Reasons Swiss Cheese model for accidents, the proposed approach relies in the development of a shared Situation Awareness, constructed from a set of collaboratively constructed Situation Matrixes which expose involved users contributions to the overall solution strategy. An application Scenario in the Emergency management area is presented.

Keywords

Crisis Management, Unstructured Work Activities, Collaboration, Situation Awareness, Ad hoc Networks, PDA.

INTRODUCTION

The most flexible and reliable organizations are accustomed to orchestrate work along a continuum of structured and unstructured activities (Sheth, Georgakopoulos et al. 1996; Bernstein 2000) fostering at the same time productivity and responsiveness. Structured activities are designed a priori based on work plans and models addressing coordination problems, efficiency and consistency. Information Systems (IS) are then usually developed with the purpose to instantiate work models and support the necessary information processing (actions, action sequences, roles, responsibilities, resources allocation, etc.) Unfortunately many unknown variables, both external (e.g., market dynamics and natural disasters) and internal (e.g., deficient requirements analysis, latent problems, emergent work processes or lack of flexibility in work structures), are among the factors that may lead to the lack of support of existing IS to unstructured activities occurring when facing unplanned, emergent or highly fluid scenarios.

An example of such an unstructured scenario is crisis management. A crisis is an unexpected, unfamiliar chain or combination of events, causing uncertainty of action and time-pressure (ESSAY 2000). In these situations even contingency plans are challenged by particular dynamics, which promote the emergence of mutually adjusted activities. Beyond the scope of formal procedures and contingency plans, people will engage in informal relationships and make use of their tacit knowledge in an opportunistic manner, which quite often reveals as a source of innovation, creativity and flexibility. (Markus, Majchrzak et al. 2002) highlights several characteristics of emergent processes contradicting the traditional IS approach: no best structure or sequence; typically distributed; dynamically evolving; actor roles unpredictable; and unpredictable contexts.

The concept of resilience, which may be characterized as a comprehensive endeavor towards increased resistance and flexibility dealing with crisis situations (Hollnagel and Woods 2006; Sheffi 2006; Cocchiara 2007), has recently become very important to organizations facing, e.g., global operations and data security threats. In that context, IS should be analyzed and designed to incorporate resilience properties and contribute to organizational resilience. (Hollnagel and Woods 2006) define the goal of resilience engineering as the capacity of maintaining control when facing complex and unpredicted situations. (Sheffi 2006) also emphasizes that every disruption in normal functioning should contribute to organizational learning; and it is more important to infer new work structures rather that recover usual ones. Resilience engineering should thus be regarded as an important and innovative approach to IS development, at least because the traditional approaches have revealed many limitations regarding unstructured scenarios.

From an analysis of the proceedings of the International Community on Information Systems for Crisis Response and Management conferences (ISCRAM) between 2004 and 2006, some recurrent concerns may be identified: shared awareness of crisis situations; information and knowledge representation and management; usability and interface design concerns. A study conducted by (Milis and Walle 2007) inquired 3.000 Belgian and German companies about the types of crises they faced and what mitigation strategies were adopted, and pointed out communication and information management as major issues. (Kanno and Futura 2006) also conducted an inquiry about the informational needs in emergency situations, which emphasized the construction of Situation Awareness (SA) as a major endeavor. Several definitions for SA may be found in the research literature, typically referring SA as an understanding of the situation elements (people, objects, etc.) and dynamics (interactions, events, etc.) The most popular definition is from (Endsley 1995), which states that “Situation awareness is the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.”

Our research aims to study the IS support to unstructured activities based on the collaborative construction of SA. As stated before, many effective collaborative structures occurring in crisis situations are not present in the organizations charts or planned a priori. They emerge from social networks pulling together common interests according to expertise, available time and other contingencies (Clark and Bernnan 1991). Considering that each involved actor may have his/her own perception of the situation, creating a shared understanding of what is going on may be quite difficult. Also, actions inevitably will take place beyond the IS, thus creating an additional challenge for IS development, which has to avoid work overhead, provide instant benefits, minimize the gap between the perceived and the real emergent situation, and seamlessly integrate with current work practices.

In our research we also adopted the concept of Context of Action (CA) as an evolving relational entity to structure awareness information (Dourish 2004). Our concern is capturing the contributions of all involved actors and delivering the relevant sub set to the right CA. Concerns about team coordination and decision-making strategies are outside the scope of this work.

For the time being we are focusing the support of unstructured activities in crisis management scenarios and due the mobile collaboration requirement that such scenarios encompasses the presented prototype was developed to PDA devices.

In the next section we present some related work that influenced our approach. Section “Proposed Approach” presents our IS approach to support unstructured work activities and is followed by a section describing the developed prototype. Then we present a discussion of a possible application scenario: Emergency Management. Finally we draw some conclusions and point future work directions.

RELATED WORK

We may find in the research literature several projects addressing the gap from fully structured activities to ad-hoc unstructured activities, e.g., Freeflow (Dourish, Holmes et al. 1996; Bernstein 2000; Mourão and Antunes 2007). These works studied how to bring IS back to model guidance after deviations caused by unpredicted events. The problem addressed by this paper goes beyond this perspective towards the support of new emergent and collaborative work structures, where models do not serve as prescriptions but rather as artifacts that may help getting the work done (Suchman 1987; Gasson 1999).

Our approach to support unstructured activities is grounded in the collaborative construction of SA, relying upon the IS to maintain up to date and shared information about the situation. One of the most established models in SA research is presented in figure 1 (Endsley 1995).

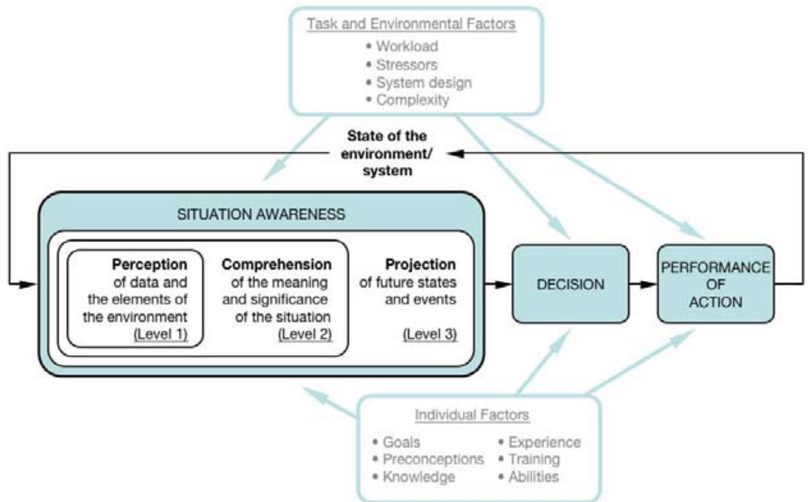

Figure 1. Situation Awareness Model (Endsley 1995)

This model regards perception, comprehension and projection as three essential dimensions in SA. (Endsley 1995) organize these dimensions in three levels:

1. Perception produces Level 1 SA: the most basic level of SA, providing awareness of the multiple situational elements (objects, events, people, systems, environmental factors) and their current states (locations, conditions, modes, actions).
2. Comprehension produces Level 2 SA: an understanding of the overall meaning of the perceived elements - how they fit together as a whole, what kind of situation they fit, what they mean in terms of mission goals.
3. Projection produces Level 3 SA: awareness of the likely evolution of the situation and possible/probable future states and events.

It is tempting to see this three-level model of SA as a sequential model but clearly it is not. Despite presenting a hierarchical model, Endsley defends that SA alternates between data-driven (bottom-up) and goal-driven (top-down) processes.

The support to SA has received considerable attention in Computer Supported Cooperative Work (CSCW) research (Bolstad and Endsley 2000; Gutwin and Greenberg 2002; Neale, Carroll et al. 2004; Storey, Cubranic et al. 2004). However, the vast majority of research has focused in specific context/domain proposals and a product perspective, while in our research we emphasize a process perspective, considering the resources and activities necessary to obtain, manage and use SA information in crisis scenarios.

According to the CSCW perspective, team members should be able to monitor, analyze and anticipate the SA needs of their colleagues while adjusting their own actions accordingly. Hence, (Shu and Futura 2005) define team SA as not just the sum of shared SA but also the mutual adjustment of one and another's minds as they interact as a team in a specific context of action.

Beyond the CSCW area, the role of context in problem solving and decision-making has also been studied in the artificial intelligence field (Borges, Brézillon et al. 2004). These studies on context address two main perspectives: positivist and phenomenological (Dourish 2004). The positivist perspective, traditionally adopted by the engineering field, regards contexts as stable information entities and separable from actions. In our work we adopt the phenomenological perspective, traditionally used in social sciences, which regards contexts as relational entities relating all involved actions and objects, and evolving dynamically as actions enfold (Borges, Brézillon et al. 2004). Such an approach affords going beyond the traditional Social Actors Networks (SAN) analysis of relationships (Anklam 2005; Pereira and Soares Outubro 2005), which lacks the analysis of dynamic, unplanned and evolving aspects mandatory in our case.

Teams also constitute communities of practice, which are more than groups of people interacting, encompassing for instance practices, norms and rituals (Garrety, Robertson et al. 2001). The challenge in designing IS for communities of practice reside in the support for continually redefined, negotiated and shared work processes. IS should support contexts in an effective manner, promoting the teams' interpretations of the situation. Based on several works regarding information visualization, which state that visual representations enhance cognition and information awareness (Donath 1995; Erickson, Huang et al. 2004; Storey, Cubranic et al. 2004; Thomas and Cook 2004), in our work we specifically address the visualization of contextual information.

PROPOSED APPROACH

In our approach we aim to facilitate the exposure of user's tacit knowledge to the team, enhancing the individual contributions to the overall understanding of the situation. As referred in (Nonaka and Takeuchi 1995), the main processes for sharing tacit knowledge include socialization and internalization. We assume that the collaborative construction of a shared computational artifact will definitely influence the "perspective making" and "perspective taking" (Boland and Tenkasi 1995). By sharing individual assessments, we also facilitate collective sensemaking (Weick 1996) and situated framing (Gasson 1999; Gasson 2004).

We adopted the well-known Swiss-Cheese accidents model (Reason 1997) to organize SA (actors, resources, actions, events, goals, etc.) The Swiss-Cheese model posits that for an accident to occur, an alignment of holes in different dimensions must occur. We defend that in order to construct SA, the involved actors should be able to align and correlate different situational dimensions in a way very similar to the proposed by the Swiss-Cheese model. Regarding the visualizations issues, we adopted a perspective proposed by (Miles and Huberman 1994), which uses several types of matrixes to visualize qualitative data: concept cluster matrixes, empirical matrixes, and temporal or event driven matrixes. We therefore defend two complementary ways to organize and visualize SA: (1) using Situation Matrixes (SMs) to visualize two dimensions of the situation and corresponding correlations (such as goals/actions and actions/actors, see Figure 2; note that the circles marking the correlations are directly related with how strongly they are perceived); and (2) aligning a set of related SM as in the Swiss-Cheese model, thus affording structuring SA according to multiple dimensions.

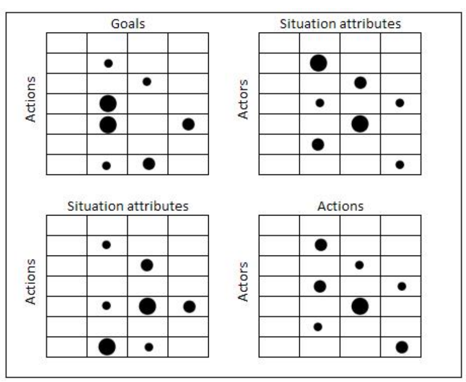

Figure 2. Situation Matrixes

This approach also provides a continuous situation feedback mechanism necessary to maintain complex SA. As situations evolve, information is renewed in the SMs (e.g., more actors involved, more actions proposed, more situation attributes considered as relevant) and different SMs may be aligned.

Another dimension of SA that has to be considered concerns the contexts of action. A context of action may be, for instance, a specific goal or a sub-team. A context of action is characterized by different information needs, focusing on designated goals, actions and actors. To implement this perspective, we define multiple views over the SMs. These views constitute a filtering mechanism capable to deliver the relevant subset of information to a specific user/group. We designate these views as Contexts of Action CAs (Figure 3).

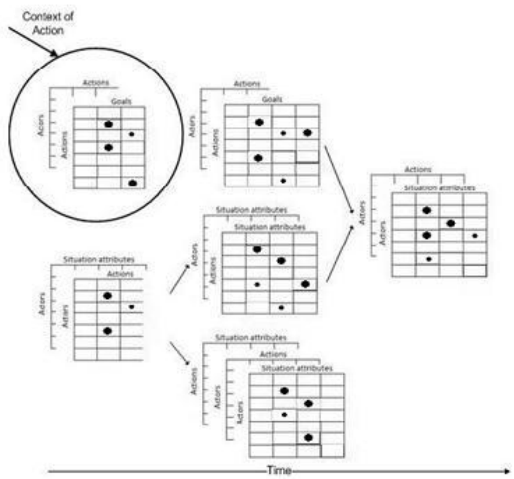

Figure 3. Contexts of Action

PROTOTYPE

The computer application supporting the creation and manipulation of Situation Matrixes during the management of a crisis should necessarily also support a mobile collaboration, since it should be possible to create, share, analyze and modify collaboratively those matrixes in emergency situations, when two or more people responsible for dealing with the situation and find solutions may meet. For the same reasons, the manipulation of these matrixes should be as fast and simple as possible, without limiting their potential to describe and share the different views of the situation people may have. The system does not support different roles in order to stay as flexible as possible (in emergency situations roles may change dynamically). We assume that the members of a crisis managing team will operate the system according to the attributes of the role they have inside the organization. The system is a full peer-to-peer application. This means, every user has exactly the same application and they communicate in order to share data using the ad-hoc network that emerges when two or more PDA are set together. Using multicast messages, the application finds automatically other partners and established a reliable TCP link with them for transmitting data.

Matrix Creation: A matrix is created by a one person and distributed to the rest. This is necessary in order to avoid chaos by having different representations of the same matrix. This can be done during the collaborative session or previously, as seen on figure 4. A new matrix is defined by drawing a “half rectangle” (figure 4a). This gesture will be recognized by the system and a rectangle representing an empty matrix will be created on the working area figure 4b). In order to specify the dimensions represented by rows and columns a menu is displayed after a double click gesture at the right hand vertical border of the screen. The different options for row and column dimensions can be dragged from the list to the rectangle identifying the newly created matrix in order to define the vertical and horizontal “dimensions” of the matrix (see figure 4c), like action vs. actors, actions vs. goals, etc.

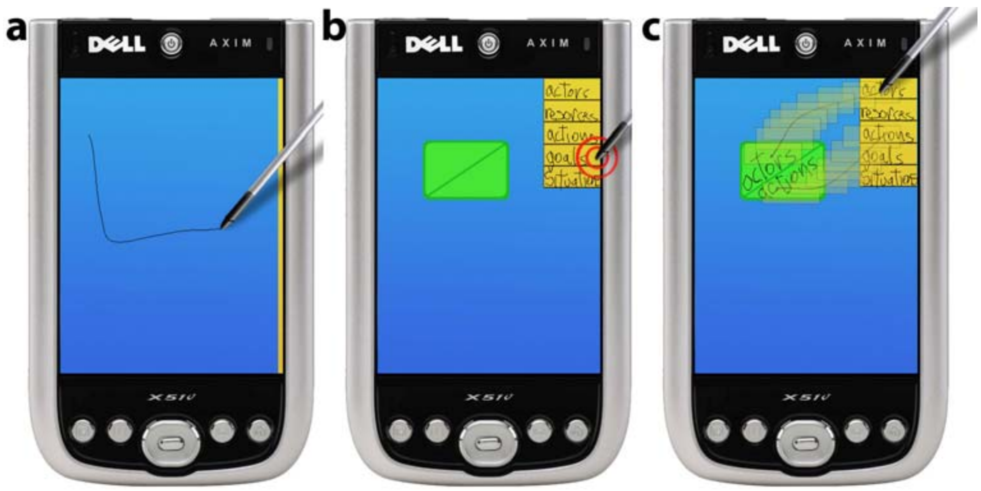

Figure 4. Screenshot of the MC-CM application (Mobile Collaborative Crisis Management) showing. a) matrix creation, b) a created matrix without defined dimensions, and c) defining the matrix dimensions

Specifying rows and columns content: In order to specify the content for the matrix it should be "expanded" by a double clicking on the rectangle. The empty matrix will be shown with the previously defined labels for the vertical and horizontal dimensions (Figure 5). In order to create a new column the user has to double click on the label of the columns (Figure 5a). After this, the user has to enter the header text for the column as shown in the figure 5b. After this, the new column with the given header text is created at the right hand side of the last created column. Figure 5c shows the user has created already 3 columns and is starting the creation of a new row. The width of the columns will be uniformly distributed, depending on the number of columns. If the number of columns exceeds the possibility to show them all on the screen, the columns to the left will be hidden and a scrolling mechanism will be activated. If the order of the columns should be altered, the user has to point to the header of that column until it changes the color and then drag it to the new position.

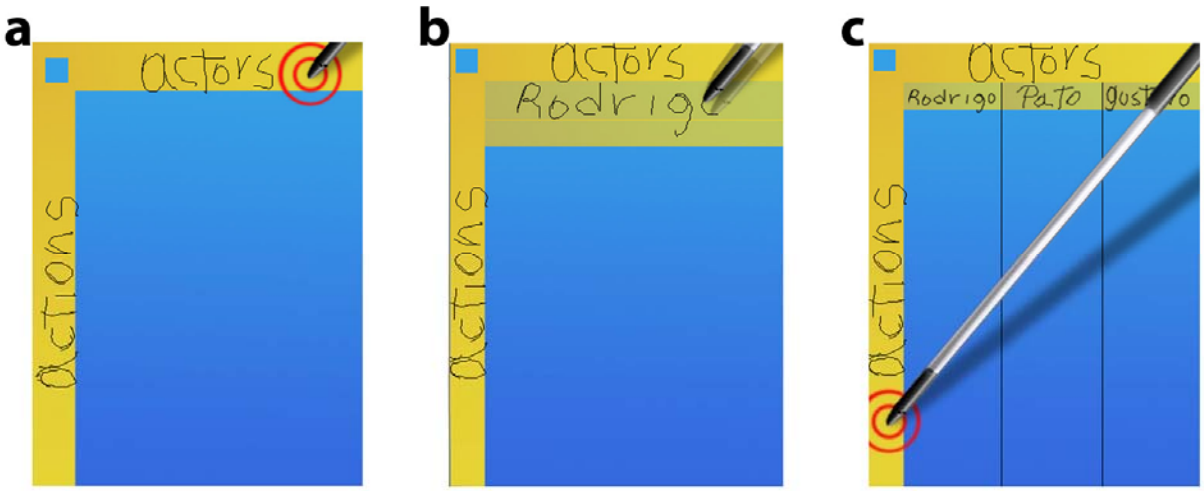

Figure 5. Creation of rows and columns of the matrix is shown in three steps.

The creation of the rows is done in a similar way. The text for the columns and rows which has been entered by free-hand writing will be scaled in order to fit the width or height the columns and row have at any time.

Traversing the matrix: The left-right and up-down scrolling functionality combined with a zoom-in and zoom-out functionality enables an easy and swift traversing of whole matrix. Figure 6 shows the use of this feature. First the user has to click on the icon located at the upper-left corner of the screen, as shown in figure 6a. After that an up-down or left-right scrolling is possible by moving the stick in the respective direction, as shown in figure 6b. A zoom-in or zoom-out of the whole matrix can be done by moving the stick diagonally (figure 6a). In this way the user can define the portion and the size of the matrix area she/he wants to work with.

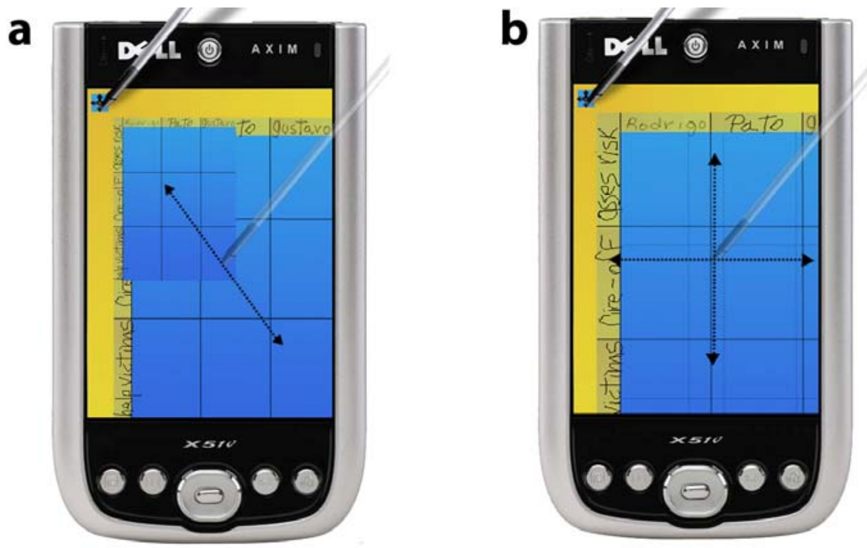

Figura 6. a) Zooming b) Scrolling.

Inputting information into the cells: As explained in section 3, the matrix helps the users to describe and share their situation and context awareness by stating with the help of a situation matrix, how important is the relationship between a certain element of the column with a certain element of the row with a dot of a certain dimension, with bigger dots meaning tighter relationship (more important). For example, a user can record that actor *x* has a big importance in dealing with the action *y* by inputting a big circle in the cell corresponding to the intersection of the column and the row identifying them, while another can put a smaller or no circle at all. In order to facilitate the input of a dot and (even more important) the comparison between dots assigned by different users, the system will allow four previously defined “importance values”: a) no importance is specified with an empty cell; b) small importance with a small dot; c) relative importance with a mean circle; d) big importance with the biggest circle as shown in Figure 7a. The initial state of a cell is of course empty, a new value can be input by clicking on the cell. This will cause a pop-up menu to be displayed with the four “importance values” options. The user can select one, after which the pop-up menu disappears. It is also possible for the user to attach an annotation to the cell, which may be used for instance to justify the selected relation strength. The sliding bar in the bottom part of the screen represents the “timeline” of the matrix. Each change on the cell values will be recorded by system as a new event in the life of the matrix. By moving this sliding bar the different stages of the cell values will be shown, in addition to the time and date the change was made.

Different users may be interested in viewing different parts of the matrix according to their context of action. Therefore, the system allows hiding rows or columns by clicking on the label of the row or column the user wants to hide (see Figure 7b, 7c). The hidden row or column will be represented by a thicker line. In order to show again a hidden column or row the user has to double click on the thick line.

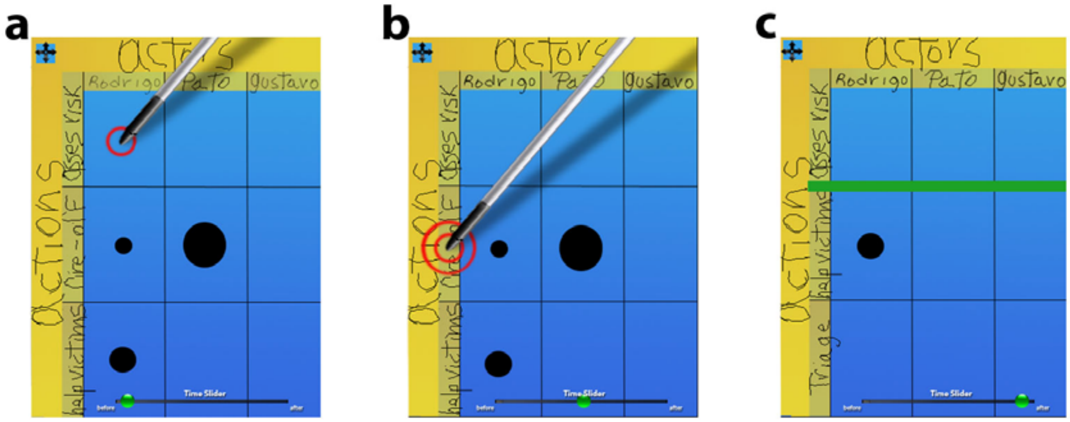

Figure 7. a) changing the cell content b) hiding a row, c) a hidden row can be made visible again by clicking over the green thick line

Information sharing and collaboration: Sharing the information is of course one of the important features of this application. In the first place, the author of a certain matrix has to share it with the other users. After that, they should be able to work synchronously over the matrix in order to exchange their views about the situation and converge to a unified assessment of the situation represented by the Situation Matrix. The exchange of information between two users' is made using the ad-hoc wireless network the PDAs create. However, in order to detect there is another team member physically close with whom the user wants to share information the IRDA device of the PDAs is used. When two users approach their PDAs they activate an "exchange zone" which appear in the upper part of the screen (see figure 8). A matrix can be shared by dragging its corresponding icon to the exchange zone. The other user will receive it and has to drag it to his/her working area. A shared matrix is automatically synchronized additively. This means, when user A shares a matrix with user B, if B did not had a corresponding matrix before, it will be created with the same content. If B had already a corresponding matrix, all corresponding cells of the matrix of B without information (no circle) will be filled with the information of the matrix of A and vice-versa. Also all new rows and columns will be added on both sides. In the case there are incompatibilities of the information in corresponding cells of the shared matrix, these are highlighted and the users have to agree on a unified representation.

Figure 8. Two PDAs activate an "exchange zone" when they approach each other

APPLICATION SCENARIO: EMERGENCY MANAGEMENT

We adapt the crisis management model proposed in (ESSAY 2000) which explains how actions unfold in dealing with crisis situations (see Figure 9).

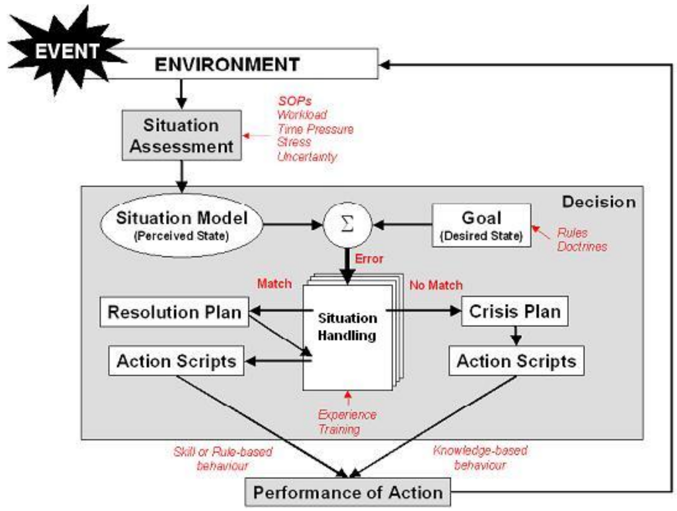

Figure 9. Crisis Management model (ESSAY 2000)

When facing an emergency situation two main behaviors will coexist: rule-based behavior and knowledge-based behavior. Rule based behavior relies on existing contingency plans originated from simulations and training. On the other hand, knowledge-based behavior relies on contextual information, tacit knowledge and expertise to address the situation.

(Berrouard, Cziner et al. 2006) showed that several emergency scenarios (e.g., fires, floods) share common crisis management characteristics, such as: teams organization, information paths, cross teams/organizations communication and information needs. For instance a common firefighter's organization is presented in Figure 10, where the overall organizer and decision-maker is the Incident Commander (IC). Depending on the size of the situation, operations are conducted by a number of companies, each constituted by a Captain and a small group of firefighters. The role of the IC is to organize and understand the overall situation; and plan how to deal with it, making decisions about which actions to take to solve the emergency, and how to manage the available resources in that specific situation context.

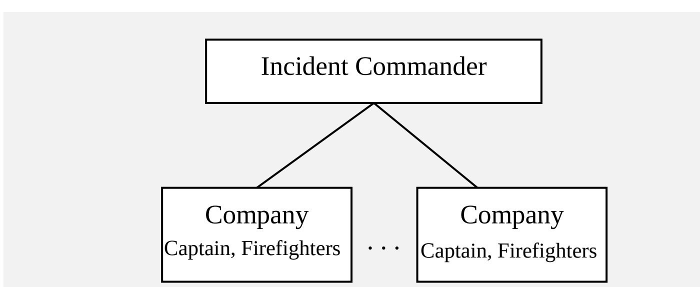

Figure 10. Firefighters emergency scenario organization

Firefighters actually maintain situation awareness by communicating with a radio and/or by conducting meetings at regular intervals. However, this type of information lacks persistency. The prototype proposed in this paper supports persistency, maintaining SA between the IC and the Captains. It also delivery a common artifact for support cross organizations collaborations, e.g. Police, Civil Protection and Firefighters, which often make use of different radio communications (many times, IC have to listen three radios plus cellular phones). This artifact will assist planning, decision-making and collaboration support. The major requirements to collaboration between the IC and the Captains were identified by (Jiang, Hong et al. 2004):

- Accountability: Accountability of resources and personnel
- Assessment: Assessment of the situation through multiple sources
- Awareness: Promoting a shared awareness of the situation
- Communication: Communication support should add reliability and/or redundancy to existing channels

These requirements are aligned with the main concerns of our model and prototype. Initial SM may be available (e.g., as part of initial plans, usually originated in training and simulation). As the emergency situation unfolds, the situational dimensions (involved actors, needed resources, proposed actions, etc.) may evolve. The correlation between these dimensions will be continuously updated, recurring to the aligned SMs. A qualified person will make the changes to SMs. To support resilience, the prototype does not control who is allowed to modify the SMs. Such protocols are relegated to training and discipline. Actually firefighter's procedures already present roles flexibility.

The adoption of our prototype assumes that agents involved in crisis scenarios are professionals with expertise in emergency management and have specific training to address unplanned situations. In this way the information shared through the prototype will have a clear semantic meaning and the available information may be clearly related with the situation.

Next, we present a description of the proposed model and prototype usage by firefighters in an emergency situation. Since IC usually stays at a safe distance of the incident (but close enough to be aware) he/she could be equipped with a tablet PC which due the dimension and interface may promote a better overall situation state awareness and application usability, and deliver to company captains PDAs which will assist them in the management of relevant awareness information to their CA and also in their contributions to the solution strategy.

Prototype usage description

After an alarm is received, depending on the perceived scale of the accident, a predetermined number of emergency response resources are dispatched. On the way to the incident location teams receive by radio additional information regarding the type of incident they will face (e.g. a urban fire), such as weather conditions, existence of victims, existence of dangerous materials in the neighborhood, …

Once identified the type of incident a set of initial (pre-determined) SM can be selected containing typical dimensions necessary to address the kind of situation (in this example they could be for instance Situational Attributes versus Actions, Situational Attributes versus Actors and Actors versus Actions). The situational attributes presented above (weather conditions, existence of victims, existence of dangerous materials) could be registered in a Situation Attributes dimension and related with other dimensions such as Actions to take (e.g. to deal with the presence of dangerous materials), and/or involved Actors (e.g. with specific expertise for dealing with dangerous materials). All the situation dimensions, could initially contain typical items, for instance, the Actions dimension could enumerate typical actions under the type of faced scenario: crowd control, traffic control, obtain fire hydrants locations, etc. Also recommended correlations (e.g. expert actor to specific action) could already exist in the matrixes cells.

Usually the highest rank of the first team that arrives to incident location will assume the IC role. This team will make a quick in place size-up of the situation considering an initial assessment of: hazards, safety procedures, incident scope, etc. and develop an attack plan. Again, regarding the situation assessment a set of SM can be selected (or created) to accommodate information gathered. If the situation demands, more resources are requested and the IC role may be passed to a higher rank that arrives later on, providing a quick status report. Since information is persisted in a set of SM, they may help this role transition in a very important issue: perceive overall situation status.

As situation evolves, a problematic concern for IC is to track resources allocation, *"who or what is where and doing what?"* (accountability and awareness above presented requirements (Jiang, Hong et al. 2004)). IC has a number of threads going on and information comes from multiple sources. To overcome this problem the set of SM: Resources versus Actors, Actors versus Locations, Resources versus Actions and Resources versus Locations could be used.

In such scenario the locations dimension is important to maintain awareness due the fact if an incident is large enough companies are organized into divisions which operate within a specific geographic region (e.g. north, third floor). Divisions may also be organized in groups which perform specific functions (e.g. rescue, medical care). The support to the specific information needs in different contexts of action is done by the proposed concept of CA which will constitute an appropriate view over a subset of the overall SMs.

Since, with this approach, a lot of incident's related information is registered, the proposed prototype has an additional utility: it will allow *a posteriori* analysis of the course of action to promote further improvement in procedures, as well as new situation dimensions (and respective dimension items) and/or SMs to be initially available.

DISCUSSION AND FUTURE WORK

In this paper we propose a collaboration model and prototype aiming to support unstructured organizational activities. Although, as discussed, there are a number of scenarios with similar requirements for IS support to unstructured activities, there are also some specific characteristics that may influence the type of support required, e.g., the existence (or not) of: a support organization, adequate training, clearly defined hierarchical structures and chains of command, group support and decision support tools, cross-organization cultures regarding coordination and collaboration, geographic dispersion, and time criticality. The approach proposed in this paper assumes an existing organization with trained professionals responsible for and focused on crisis management.

Based on the Swiss Cheese model for accidents (Reason 1997), we propose the construction of situation awareness, capturing what involved actors perceive, know and expect about a situation into a series of aligned Situation Matrixes (SM), each one allowing to visualize and correlate qualitative data about the situation according to situation's dimensions. Furthermore, as situation awareness is tightly coupled with action, we also propose filtering situation awareness according to the specific actors' needs, using a visualization mechanism implementing the concept Context of Action (CA). The combination of the Situation Matrixes and Contexts of Action provides a rich and flexible, yet manageable, mechanism to visualize situation awareness. We have presented an application scenario: Firefighters Emergency Management, in which the proposed approach beside the main goal of overall SA achievement through the all involved actors contributions, will also deliver a redundant and information's persistency support artifact, which are two important properties to improve work efficiency in crisis management.

We should note that similar collaborative approaches exist and are already used in some domains. For instance, flight operators and firefighters adopted a Crew Resource Management (CRM) training, which concerns not so much the technical knowledge and required skills but rather the interpersonal skills used for gaining and maintaining situation awareness, solving problems and making decisions. The CRM approach fosters a climate and a culture where the freedom to respectfully question authority is encouraged, aiming to increase resilience while reducing the discrepancy between what is happening and what should be happening.

Keeping the IS up to date in these unstructured situations, without adding unacceptable overhead, presents major challenges (Erickson, Huang et al. 2004). For instance, status reports and situation assessments are hard to track due to their dependencies on the explicit user interactions with the IS. To address this problem, we aim to: (1) focus on immediate gains, which may overcome the losses associated to the required interaction with the IS, for instance offering persistency; and (2) further develop the quality control of information available in the IS, mostly addressing information filtering according to context. We will also address prototype usability concerns, e.g. minimize interactions and explicit user's information declaration by for instance, using a pulling strategy: as information becomes old, respective users may be prompted to report their validity, in combination with a visualization schema to express the degradation of the quality of the available information. Another feature that we intend to further develop is to auto fills some dimensions relations inferred by the other existing related dimensions relations. For instance, based on fulfilled correlations in some SMs (e.g. Goals versus Actions and Actions versus Actors) some dependent relations (e.g. Goals versus Actors) can be inferred by the systems. With this mechanism we can also detect correlations conflicts. We think further improvements are also needed to manage CAs, as awareness profiles, since it should be evaluated the balance between contextual information needs and loss of overall SA (Wang, Grather et al. 2007).

Currently, we have a prototype allowing us to study the feasibility of the proposed collaborative model. Once we refine the prototype, a real life evaluation will be made. As referred in (Markus, Majchrzak et al. 2002), once a new system is introduced to support a work process, the actual way of conducting that process changes. (Vyhmeister, Mondelo et al. 2006) identify some organizational elements in which impact should be evaluated:

1. The nature of work (quality, task specialization and temporal aspects)
2. The individuals (role identification, stress, perceived status, job satisfaction)
3. The organizational communication (efficiency, communication type between organizational levels, volume, job monitoring methods, and job perception)
4. The interpersonal relationships (social interaction quality and quantity, social reinforcement, number of sociometric relations and communication hierarchy)
5. The interdepartmental relationships (conflicts, cooperation, independence, and departmental limits)
6. The organizational structure and processes (physical limits and organizational adaptability).

The proposed approach should be evaluated with awareness measures techniques to evaluate if SA is really achieved and accomplish a situation handling efficiency improvement. To do so we will recur to explicit techniques, suitable for training/simulation environments, in which at certain intervals the simulation is temporarily frozen and subjects are presented to a set of predetermined multiple-choice questions about the situation (e.g. SAGAT method from Mica Endsley). Implicit techniques will also be used in which the state of someone's awareness is inferred from indirect evidence (e.g. task performance analysis).

REFERENCES

1. Anklam, P. (2005). "Expanding the field of Vision." The Learning Organization 12(6): 539-551.
2. Bernstein, A. (2000). How can cooperative work tools support dynamic group processes? Bridging the specifity frontier. CSCW.
3. Berrouard, D., K. Cziner, et al. (2006). "Emergency Scenario User Perspective in Public Safety Communication Systems." ISCRAM.
4. Boland, J. R. and R. V. Tenkasi (1995). "Perspective Making and Perspective Takin n Communities of Knowing." Organization Science 6(4).
5. Bolstad, C. A. and M. R. Endsley (2000). Shared displays and team performance. Human Performance, Situation Awareness and Automation.
6. Borges, M. R. S., P. Brézillon, et al. (2004). "Groupware system design the context concept." CSCWD.
7. Clark, H. and S. Bernnan (1991). Grounding in Communication. Prespectives on socially-shared cognition, Washington.
8. Cocchiara, R. (2007). "Beyond disaster recovery: becoming a resiliente business." IBM whitepaper.
9. Donath, J. S. (1995). Visual Who: Animating activities of an electronic community. ACM Multimedia, California.
10. Dourish, P. (2004). What we talk about when we talk about context. Personal and Ubiquitous Computing.
11. Dourish, P., J. Holmes, et al. (1996). Freeflow: Mediating between representation and action in workflow systems. CSCW, USA.
12. Endsley, M. (1995). "Toward a theory of situation awareness in dynamic systems." Human Factors 37(1): 32-64.
13. Erickson, T., W. Huang, et al. (2004). A Social Proxy for Distributed Tasks: Design and Evaluation of a Working Prototype. CHI, Vienna, Austria.
14. ESSAY (2000). Enhanced Safety through Situation Awareness Integration in training. European Community ESSAY project, Contract No GRD1-1999-10450.
15. Garrety, K., P. L. Robertson, et al. (2001). Communities of Pratice, actor networks and learning in development projects. The Future of Innovation Studies, ECIS, Netherlands.

16. Gasson, S. (1999). "A social action model of situated information systems design." The Data Base for Advances in Information Systems 30(2).
17. Gasson, S. (2004). A Framework For Behavioral Studies of Social Cognition In Information Systems. ISOneWorld.
18. Gutwin, C. and S. Greenberg (2002). "A descriptive framework of workspace awareness for real time groupware." CSCW(11).
19. Hollnagel, E. and D. D. Woods (2006). Resilience Engineering Precepts.
20. Jiang, X., J. I. Hong, et al. (2004). "Ubiquitous computing for firefighters: Field studies and prototypes of large displays for incident comand." CHI.
21. Kanno, T. and K. Futura (2006). "Resilience of emergency response systems."
22. Markus, M. L., A. Majchrzak, et al. (2002). A design theory for systems that support emergent knowledge processes. MIS Quaterly.
23. Miles, M. B. and A. M. Huberman (1994). Qualitative data analysis, Sage Publications.
24. Milis, K. and B. V. d. Walle (2007). IT for Corporate Crisis Management: Findings from a Survey in 6 different Industries on Management Attention, Intention and Actual Use. ISCRAM.
25. Mourão, H. and P. Antunes (2007). Supporting effective unexpected exceptions handling in workflow management systems. SAC, Seoul, korea.
26. Neale, D. C., J. M. Carroll, et al. (2004). Evaluating Computer-Supported cooperative work: Models and frameworks. CSCW.
27. Nonaka, I. and H. Takeuchi (1995). "The knowledge-creating company." Oxford University Press.
28. Pereira, C. S. and A. L. Soares (Outubro 2005). Tecnologias de colaboração em organizações de I&D: Uma abordagem por redes sociais. CAPSI.
29. Reason, J. T. (1997). Managing the risks of organizational accidents, Aldershot: Ashgate.
30. Sheffi, Y. (2006). Building a resilient organization. MIT.
31. Sheth, A., D. Georgakopoulos, et al. (1996). Workflow and process automation in Information Systems, NSF Workshop.
32. Shu, Y. and K. Futura (2005). "An inference method of team situation awareness based on mutual awareness." Cognition, Technology & Work 7: 272–287.
33. Storey, M.-A. D., D. Cubranic, et al. (2004). On the Use of Visualization to Support Awareness of Human Activities in Software Development: A Survey and a Framework.
34. Suchman, L. (1987). "Plans and Situated Actions: The problem of human-machine communication." Cambridge University Press.
35. Thomas, J. J. and K. A. Cook (2004). Illuminating the Path.
36. Vyhmeister, R., P. R. Mondelo, et al. (2006). "Towards a Model for Assessing Workers' Risks Resulting from the Implementation of Information and Communication Systems and Technologies." Wiley InterScience (www.interscience.wiley.com).
37. Wang, Y., W. Grather, et al. (2007). Suitable Notification Intensity: the Dynamic Awareness System. Group07.
38. Weick, K. E. (1996). Sense Making in Organizations, Sage Publications.