Command Centers and Emergency Management Support

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ABSTRACT

According to studies of emergency command centers, working methods differ and difficulties may appear which negatively affect the response to the emergency. This paper intends to present a method, in the form of a model, which, could obtain optimal efficiency in the command center. Four principles will be presented as the basis for an efficient emergency management operation. How these principles can be used in order to define an emergency management support system, and more particularly a telematics structure for decision support system will be presented. The authors discuss this model within an exemplary situation as a hypothesis, therefore idealized, in order to derive the features (human and technological) which may be adapted to a wide range of various disaster situations including both natural and man-made

INTRODUCTION

From the analysis of crisis command centers and discussions with many experts, there are a number of considerations in developing and evaluating models for crisis command centers. These include the development of a plan and procedures, testing those procedures, training personnel and in the event of a disaster, evaluating the performance and response of all personnel including the command center team.

It has been suggested that one of the key operational problems in emergency management is the lack of or inadequate communication.[DRA95]. For effective response, communication and defined roles for each individual plus a structure for their interaction is necessary. Information, the ability to process it, the relationships in a multi-person communication network and the authority to structure, control and regulate information across an emergency command affects the total effectiveness of the response system

Nilson [NIL95] has suggested that scholars and professionals have experienced only partial success worldwide in changing actual emergency management organizational approaches.

Possible explanations for this situation may well be rooted in some of the stereotypical notions about disasters and the human reaction to emergencies. On the one hand, there is the belief that in an emergency everyone is "out of control", irrational in their actions, and need detailed direction from the command center. In other words, a command center focused on social control. This belief leads to an authoritarian, tightly controlled response from emergency managers.

On the other hand, since the 1970's researchers [QUA77] have explored human response behavior during emergencies and found, not that social order breaks down, but that in many instances the opposite is true. People cooperate and coordinate survival and rescue efforts. - a focus on social mobilization. They communicate, share information, assume and share tasks. In this paper, the authors propose a model for a crisis command center emergency management support system that is based on a cooperative multi-person, multi-expert, shared decision model. This support system is based on four general principles.

1. FOUR PRINCIPLES FOR EMERGENCY MANAGEMENT

From the analysis of Command Centers functioning and from interviews with a number of Emergency managers, we propose a model based on a small set of basic principles. This model (see fig. 1) represents a first stage in an emergency management support system definition.

1.1. Ability's distribution and communication

Emergency management personnel may be represented as a group of responsible experts assembled in the command center. Each individual has a specialized function, abilities, and responsibility to manage. So that the center may function well, the experts must know their coworker's abilities and roles. The experts must be able to communicate equally, without any difficulty among themselves.

First principle: to ensure the distribution of abilities/skills and communication. Each expert has individual abilities and knowledge. Efficient communication and equal access to each other in the crisis center to facilitate mutual knowledge is necessary.

1.2. Adaptability

A crisis command center is a dynamic organization. Experts can constantly enter and be added to the group, or leave and quit the group. Faced with this necessity, the center must be "robust" or highly flexible. The model must accommodate new sources of expertise and abilities and put them to the best use. It must go on working in spite of one member's departure.

Second principle: to possess an adaptability as the group develops and changes, either adding or canceling skills as needed.

1.3. Classification of the actors

In order to identify the function of each actor, a categorization of the functions in the crisis command center must be developed. The authors propose that the actors in this setting can be classified into four categories. First, one group composed of all those who are in charge of data collection. In a way, these are eyes and ears of the command center. They collect crisis event and environmental data and process it to synthesize it into helpful information for the other actors. In addition, at the other actors' request, they are able to search for a necessary information. We name them **perception actors.**

The second category of actors are those responsible for analyzing a situation or its evolution through the external occurrences. Generally, they are also responsible for proposing action alternatives, or even for making decisions about emergency management. We name them **analysis actors.**

The third category is in charge of operational and tactical communication with the actors outside the command center. We name them **communication actors.**

The last category of actors are those responsible for informing the persons not directly involved with the management of the emergency, but who are concerned, either because they are directly threatened, or because they need specific information about the unfolding crisis. We name them **information actors.**

Third principle: the emergency management's actors can be classified according to four categories: perception, analysis, communication, and information.

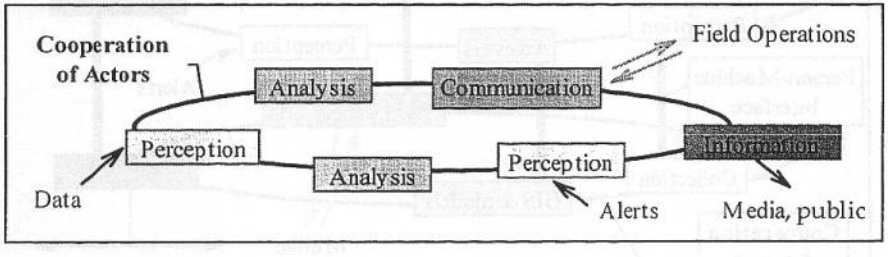

Figure 1: Actors of the Command Center

1.4. Distribution of tasks

A crisis command center must begin the job of resolving the crisis by prioritizing problems and setting tasks. These priorities and tasks can be set by one of the actors, but generally, they are going to be best if in collaboration, combining more elementary tasks and involving

everyone in the process.

In order that the center functions efficiently, each task needs to be assigned to an actor and each actor must take responsibility for his/her task. This is true whether the actor makes the decision him/herself, volunteers for the task, or is assigned by an authority.

Once an actor takes on the responsibility of a task, he must analyze the necessary steps to complete the task and then divide the steps among the various actors in the command center. These assignments should be done primarily according to the actor's abilities, then according to other factors, such as availability and efficiency. Once having made these decisions, the actor will assign the tasks and supervise their correct performance.

Fourth principle: tasks to be carried out by the crisis command center are distributed as one major or several elementary tasks. Each activity is one actor's responsibility. The actor who is responsible may delegate some of the elementary tasks to other actors.

2. SUPPORT TO EMERGENCY MANAGEMENT

Our goal is to define an emergency management support approach that can be generalized, based on the hypothesis that decision support tools must be very close to the actors actual roles, needs, and function. The support system must meet the needs of both persons and institutions. The help is offered to support both the actor's function and provide a capacity to communicate and cooperate with his/her counterparts.

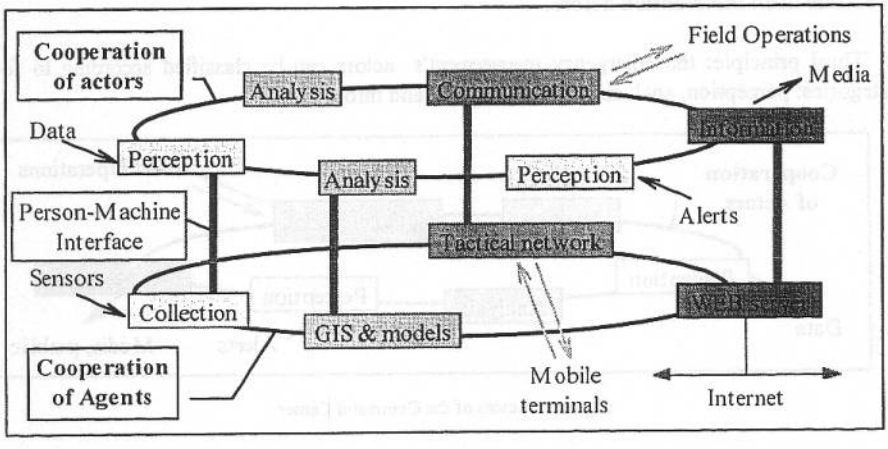

Figure 2: Two cooperation networks: Actors and Agents

With this aim, the method we propound is to superimpose on our crisis command center, a similar structure as the one just discussed using a set of computer applications (we name them

agents). These **agents** are endowed with individual and collective understanding and are able to work in cooperation on complicated tasks to resolution (see fig. 2).

Going over our "prototype" crisis center function (in the sense that it can be generalized), that amounts to supplying some command center actors with computer "agents" having identical type skills and being capable of communicating and working together to solve complicated decision support tasks.

In that way we acquire **perception agents** by using a sensors network connected and capable of processing functions, like spatial interpolation or warning threshold detection.

We equally acquire **analysis agents,** in charge of data management, by means of GIS (geografical information systems) or data bases, simulation functions or advice functions, with the help of Artificial Intelligence technologies.

The **communication agents** will be taking charge of tactical bonding with operational people in charge of crisis management, for transmitting instructions, following the actors positions in the field and following the situation as it unfolds.

Finally, after many years, information spokespersons have come to have an essential role in crisis management. The media has been getting more and more involved in the coverage of the world's crises every year. It has become essential for a crisis command center to be capable of providing relevant, up to date information, while respecting the requirement for confidentiality. Keeping the public informed is one of the crisis management support tasks which must be well organized, and facilitated in such a manner so as not to disrupt crisis command center operational functioning. The **information agents** achieve this task.

Setting up a decentralized and cooperative decision support system, using this structure as its' foundation, allows the authors to propose a crisis management model with potential for improvement in four areas: sharing of information, decision support, system sturdiness and back experience.

2.1. / Sharing a set of information

Many emergencies prove to be worse than could be planned for. A communication failing such as the misreading of existing information, shortcomings in keeping information up to date or sometimes transmission problems are often blamed. In our schema, each agent has a complete knowledge of the available information of the other agents and of its validity. Thus, the human actors using an agent have access to all this knowledge and can utilize what they need for their assigned task.

2.2./ Decision support cooperative tasks

This kind of structure allows for the sharing of decision support tasks, implementing one

or several agents, and utilizing their joint information and abilities. We can divide these cooperative decision support tasks into two groups: the one initiated on the actors command and the others which are automatic. The "manual" tasks fit with the functional needs of one actor, who will use his associated agent to define an activity by the arrangement of elementary tasks he will distribute to the other system agents. The "automatic" tasks fit either with repetitive functions, that must be realized at regular intervals, or with tasks which must be executed in a reactive way, notified of an external event or in answer to one of the actor's request.

2.3./ Improving the system sturdiness

The third important area for potential improvement is the system's ability to tolerate its own evolution, by adding or subtracting agents. Generally speaking, this ability is crucial for a crisis management support system, which should not create obstacles to crisis management if one of its elements is failing.

To achieve this important flexibility, it is suggested that the introduction of a new agent be completed through a systematic information sharing process with the active agents. In order to inform them of the new agent's available skills and to inform the new agent of the available skills of the others. The management of one of the agents dropping out or breaking down is achieved through periodic activity tests of all the agents and by the monitoring of activities the stopped agent is involved in, that must be either interrupted or reorganized by replacing or substituting an active agent.

2.4./ Back experience (back try)

The final important aspect is the ability of this structure to be a deciding factor in back experience, since it's possible to define a specialized agent (from information agents class) and an activities set managed by different agents of the system, fated to feed this agent with relevant information, which will subsequently allow an accurate analysis of the crisis and its detailed unfolding. This function is expected to play an leading role in the actors training, supplying them with real backgrounds, and in objective estimation of the crisis management.

3. THE CONTRIBUTION OF MULTI AGENT SYSTEMS

From the analysis of the structure and the functions of our management crisis support system, it's possible to search among the methods suggested in the scientific community for the one method that may represent the best medium for our model.

The Multi Agent Systems (MAS) propound a distribute formalization of artificial intelligence and offer attractive prospects to our application.

There are two principal agents categories: the "reactive" agents and the "cognitive" agents. The reactive agents are independent applications, whose intelligence is limited to the feedback

to external stimuli and to their environment. The MAS from this type are generally made of a great number of agents. This pattern is principally used to design the functioning of communities, for instance insect populations [DR095].

The second category of MAS sets "cognitive" agents to work, distinguished by greatest individual capacities, allowing the analysis of their own situation, their environment, but the collaboration with other agents for compound problems solution too, like industrial processes management [JEN95].

Generally speaking, each cognitive agent consists of three principal parts: communication, its own and other patterns, and its abilities/skills. The communication's part is in charge of exchanges with the other agents, principally in the form of messages. The second part contains the description of abilities it place at everyone's disposal and abilities placed at its disposal by other agents. The third part integrates its own capacities such as the information it manages, functions it can execute and its reasoning unit.

4. AN APPLICATION DEDICATED TO THE MANAGEMENT OF FOREST FIRES

Based upon the structure and analysis presented here, a first application of this crisis management support system is a reality, based on a multi cognitive agents system. It is principally dedicated to the management of forest fires [WYB96].

This application is achieved as part of a project financed jointly by the European Commission (DG XIII, Telematics for environment): the DEDICS project ("Distributed Environmental Disaster Information and Control System").

The analysis of users needs, completed in six countries of Europe, allowed the collection of data to define management, decision support functions and activities. We have equally identified necessary agents, dealing with the four classes presented above:

- Perception agents in charge of early detection of forest fires (by infrared sensors) and of climatic parameters measuring.

- Analysis agents are Decision Support Systems consisting of a GIS, a data base and a set of models for simulation and analysis of danger.

- The Communication agent is a system composed of portable units and stationary units, tied together (radio, satellite, etc.) Allowing their users to exchange information bearing a geo reference: symbols, icons, messages, through a cartographic machine man interface.

- The Information agent is a Web Server, offering its external users an access to a part of the information about the unfolding crisis, through the Internet, without disturbing the working of the operational system.

CONCLUSION

Analysis of crisis management, of crisis command center functioning and of several countries operational users needs, has allowed the authors to derive four basic principles for improving efficiency of crisis management.

From these principles, the authors propose a crisis management support system model that can be generalized. This cooperative model is based on a cognitive multi agent systems pattern. The conception of this system is adapted to the constraints and to the requirements of actual operations. A first application is dedicated to the management of forest fires.

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