Business Process Analysis, Modeling and Simulation for Geo-Political Risks and Crisis Management

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ABSTRACT

The paper aims to present a real experience of designing a Control, Command, Communication, and Intelligence system to support crisis management through a three step business process. A better understanding of what is a crisis and a model of knowledge gathering appeared within the system development. We will explain this particular business process management through the successful example of the CHEOPS Project.

PAPER TEXT

When a company wants to offer a new tender for its clients in the geopolitical crisis management domain, it has to solve a dilemma. Firstly it has to build rapidly, a functional product in order to take a place on this well discussed market but on the long term this strategy isn't sufficient. An incremental design process is required in order to organize an architecture, to bring out functional and ergonomic specifications, and to structure an ontological application such as a multi-agent cooperation model.Furthermore a reflection on what a crisis is, on the values level which helps to make the model more accurate can be added.

We will explain this three step business process through the successful example of the CHEOPS Project. Firstly, we will describe its risk management system, then we will put the emphasis on its multi-agent cooperation model, and lastly, we will present a situation analysis as a constructive modelling process and we will finish with an analysis on the CHEOPS project business management and its possibilities of evolution.

1. TECHNICAL PROCESS

The CHEOPS Project is based on a fictive crisis simulation called CHEOPS-TCHAD, where Chad is involved in a civil war opposing the government and rebels supported by Libyans. The French Army has to protect the official government against Libyan's threat.

Before the CHEOPS-TCHAD Project, success in crisis management depended mostly on the Military's Attaché (AM) experience. The system was composed of two major parts: the Chadian operation field and the Military Intelligence Direction (DRM) located in Paris. Protocol constraints regarding communication between them were too important to define a cooperation model. In the project, each actor has a CHEOPS system and they are linked together. The AM provides its CHEOPS' database with geopolitical information. The DRM's CHEOPS system has a huge image, plan, map and document database. In addition the system is connected with a lot of information sources.

The constraint in such a multi-user system is that each user has a specific need in terms of information objects. The thematic layer concept allows each user to build his own vision of the geopolitical operation field selecting objects relevant to him.

In order to model crisis, it is essential to define the event, situation and scenario concepts. An event is a pool of facts; their identification and handling is the base of crisis situation analysis. A situation is a geographical operation field in a given moment and is composed of relevant objects essential for its analysis. A model situation is a situation which has been analysed and described. A scenario is a collection of model situations. When a scenario is encapsulated in a period, it becomes a crisis.

We can define the crisis concept showing differences between permanent and crisis states. In the crisis state, the situation analysis is made harder because human discernment is wasted by stress, importance of stakes and indeed cost. The crisis generates a temporal paradox because its analysis and linked tasks, like communication or justification of choices, need time incompatible with crisis resolution. One man can not manage a whole crisis by himself like in the Marc Aurèle time [Marc Aurèle 92]. Only virtual or real human groups working together can face a dynamic and complex situation, and so it is a typical multi-participant activity.

To meet this group working requirement is one of the main stakes of this domain. Crisis management gets it sense only if it is coordinated which adds a complexity level. This complexity is due to the fact that coordination should dispatch participant productivity without limiting their efficiency. Crisis analysis should be split in time, space, speciality, actions and functional roles of participants [Brugnot 01]. The crisis management Information and communication system (ICS) anticipation is important but is not always enough to avoid crisis and so it is essential to implement a three part operational crisis management:

- Anticipated operational management: to plan emergency action, to allocate needed resources and to optimize key parameters.
- Real time operational management: to update situation and decision parameters, and to make plans matching with reality.
- Back to normal operational management: to disengage efficiently allocated resources.

Therefore rules and constraint propagation techniques based planning modules have to be realised. In crisis management ICS, information of the situation is critical but documentary information is critical too. Commented past crisis files create a database which brings a comparison point, decisional argument and a base for innovation [Boyce & Barnes 06] In addition, on request data extraction can justify decisions and brings complementary information. An electronic document management system, based on indexed full text has to be realised.

In this ICS, the emphasis is put on heterogeneous systems interoperability, but in order to build a real multi-participant system, it is essential to develop a strong collaboration between experts who can have a different point of view and to be able to organize and deploy a crisis cell very rapidly. AI can be very interesting to help the decision process, particularly with new automatic learning techniques [Kodratoff & al. 87] like the Case Based Reasoning, which uses analogy mechanisms, and other learning techniques ([Michalski 86], [Michalski 93], [Mitchell & al. 83], [Kodratoff 86], [Rousseaux & Tecuci 87], [Dejong & Mooney 86], [Barès & al. 94]) which takes benefits of experts produced explanations in order to generalize problem resolution modes.

Some other problems which represent knowledge modelling constraints have to be taken into account:

- Databases for objects modelling in space and time, and uncertainty management and management of fuzzy.

- Attention management for relevant granularity scale in space and time: phenomena can be predictable only with a certain amount of prior spatial-temporal data.
- Decision help to take pictures of interesting situations, to compare and comment on them. But also to be able to model something which no longer exists.
- Ergonomics to detect the user's intentions from basic actions, to anticipate and solve ambiguity in concordance with user's supposed goals (GEOCOOP [Zacklad & Rousseaux 95]).

2. METHODICAL PROCESS

The CHEOPS-TCHAD simulation has demonstrated that in order to solve efficiently complex collective problems, a multi-agent cooperation model has to be designed [Van Peach 02]. It is what has initiated the MadeInCoop model. This one can be divided into four main principles:

- The knowledge level cooperative human-machine activity design, which describes users and system activities considering that artificial and human agents have goals and knowledge.
- The cooperation situations positioning in global organisational context, which describe organisation, tasks and characteristics of its agents, and especially which enables identification of agent sub-groups which are usually interacting.
- Cooperation dynamic description, which is based on agent interactions.
- Actor cooperative activities description, which models one actor activities in problem resolution, coordination and communication actions.

The Collective General Activity model in MadeInCoop can be divided into three sub models. The first one is the task model, which has to provide a general schematic which models main activity aims and the means used to reach these goals. It includes a chronological dependency description between aims. In this simulation, we can find two main tasks groups according to the situation: in normal phases, it consists of imagining all possible scenarios and following answers, and in crisis phases, it consists of following situations and its evolution feeding databases, to analyse events, to define goals and plan the means to reach them. The second one is the agent model. For each agent, the know-how, the responsibilities and the availabilities are defined. Finally the organisational model defines the negotiation rules between agents and tasks in order to respect characteristics coming both from agents and tasks. The result is the definition of some interaction situation between agents and general coordination principles between inter or intra agent groups.

There are six main agents. The Military Attaché (AM) collects information and sends argued reports on the situation (it is a human agent), the event database manager (GETEV) classify each event, the map database manager (GESTCART) manages different maps, provides zoom and can put in relief thematic layers , the messenger (MESSAG) transmits messages (it is a human agent), the news report analyst (ANALYS) translates text news reports into the database format, the tactical simulator (SIMUL) makes calculations and simulations in order to estimate current strength or necessary time to move units, and the arguer(ARGU) lets the user from tactical hypothesis to search corresponding events in the database and on the opposite, to analyse a pool of events in order to find strategic hypothesis.

In MadeInCoop, the general model draws the background, where the different cooperation situations will happen which will let agents solve the problems collectively. The shift, between the general model and the cooperation, changes the way to handle the situation in two ways. It is a shift from a static view to a dynamic view focused on the interaction between agents, and it is a shift for a more detailed view where problem resolution activities and coordination are handled more precisely.

Based on most of the activities on cooperation between human agents, we will use the Maieutic approach (Maieutic is Socratic Method that induces a respondent to formulate latent concepts through a dialectic or logical sequence of questions) where the cooperation can be modelled with high level dialogues between agents. Agents try to cooperate; they share a working memory where a history of their dialogues is recorded. This record can be used on 3 different processes: The first is the problem resolution process, which is the progressive exploration of the group "problem space". The second is the coordination process; it's a record of the agent's progressive engagement. This process controls the first. The third is a communication process which enables us to follow the steps of a collective speech.

In order to illustrate this model, we will use an artificial problem resolution dialogue between local crisis management computer agents. In this scenario, the Chad is in a civil war context opposing the official government and the rebels

Figure 1. Inference structure

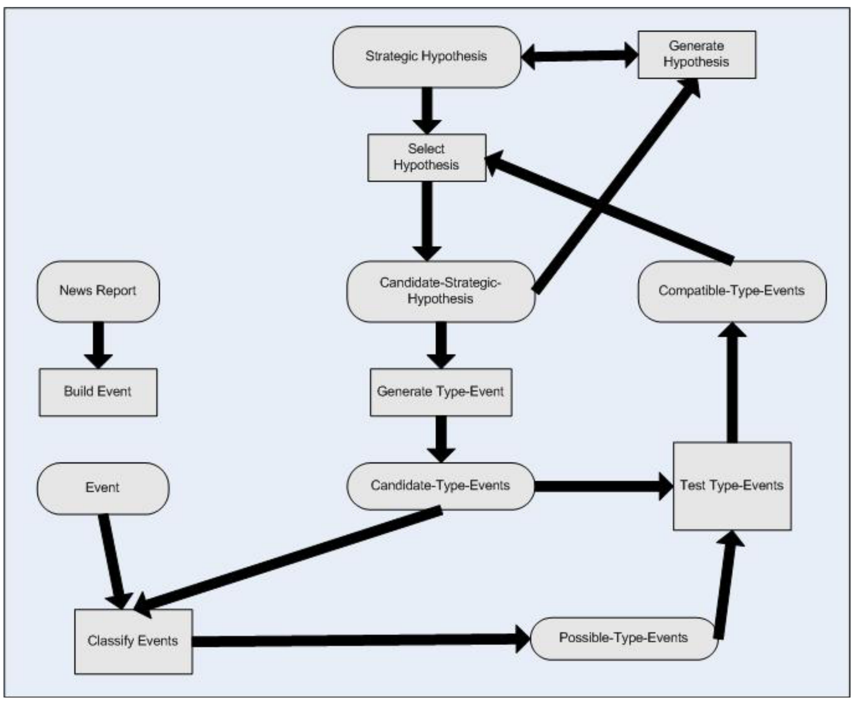
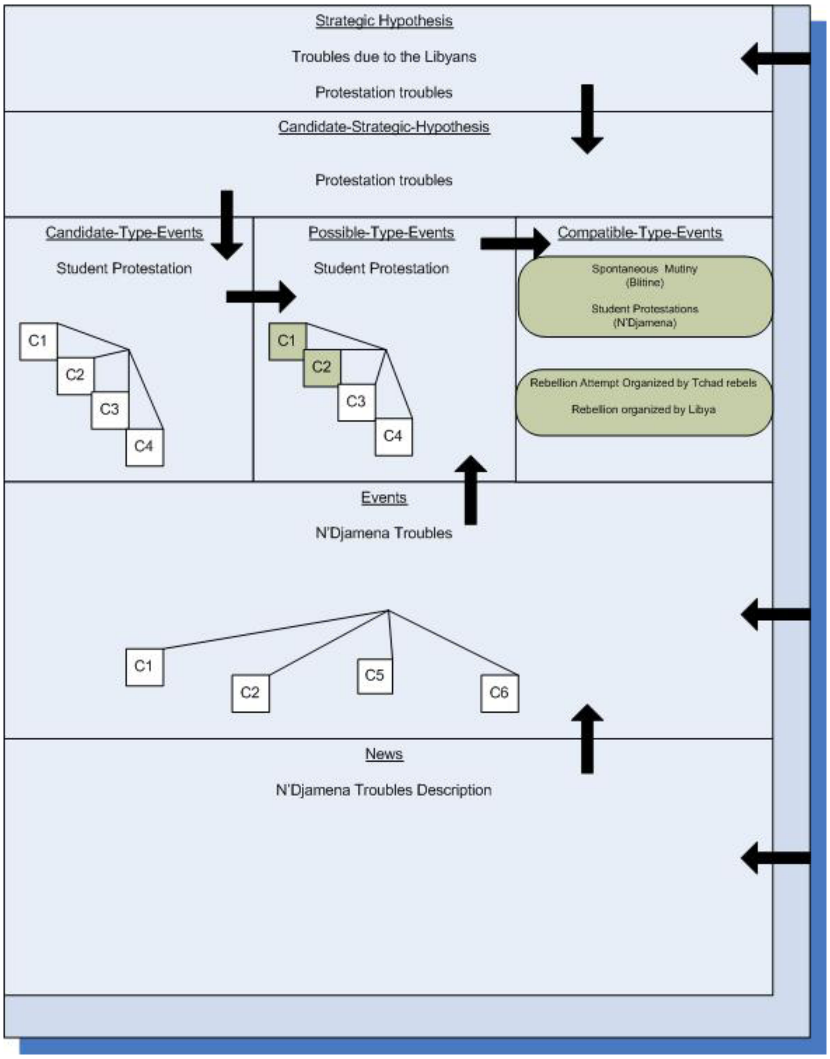


Figure 2. Virtual memory workspace of the local crisis management PC



helped by Libyans. The goal of the system is to help French military direction to take decisions, identifying if movements are spontaneous civil war movements, which do not need French intervention, or if these movements are due to the Libyans trying to invade the Chad area, which would need a French intervention because it would be an international law-breaking. The last events chronologically logged are the following:

- Troubles have appeared in the Biltine's barracks, which is near the north frontier without having the possibility to know the causes of these troubles.
- Street Fights have been signalled in Chad's capital N'Djamena near the national assembly, the consequence is that governmental troops have been sent from the north area to the capital.
- The airport of the Chadian capital has been bombed but the enemy fighter planes have certainly not been identified. Experts are analysing bomb impact pictures. Rebels have old Soviet planes which would not have permitted them to commit this bombing.

In MadeInCoop, the collective problem resolution method is based on a "structure induction" method [Simon & Lea74], [Hoc 87].

An event is built from a news report before being paired with candidate type events. The quality of these pairings selects possible type-events , of which compatibility with context is selected with confrontation with possible type events precedently identified.

In the following example, two strategic hypotheses have been generated and the AM tries to select the "protestation troubles" hypothesis. The process begins with extracting some properties of the news report (C1, C2, C5, and C6). From the candidate hypothesis, the AM generates a candidate type event with the C1, C2, C3, C4 properties. Comparing it with the capital's troubles, he is concluding that "student protestation" is a possible type event to model these troubles. The following step is to test the possible type event, to verify that it defines a compatible type events pool with other candidate type events. The conclusion of the test is not favourable because another interpretation of the events exists: "spontaneous mutinies" which are associated with "student protestation" is compatible with "protestation troubles".

Table 1 presents an extract from the virtual dialog between agents:

The actions of the coordination model are the same as those for the collective problem resolution (CPR) but different memory areas have to be reserved. A common group position area has to be reserved, where are recorded all the arguments and decision validated by the group and reflecting the "official" point of view of the group. An individual area has to be reserved to put the individual group members' decisions when they differ from the group decision. The imple-

Table 1

	Interpretation based on the problem resolution process	
1	AM: Did you receive the description of the N'Djamena events? It seems to be protestations organized by students near the opposition. This confirms that Biltine events are probably just the consequence of a problem linked with the soldiers' salaries and so it is interior troubles…	Build-Event Classify-Event Test-Type-Event Select-Hypothesis
2	ARGU: I disagree, the cause of Biltine events is unknown because the M'Boutoul ethnic group implicated is with the rebels.	Classify-Event
3	AM: Can you show that is it possible that rebels can be implied in recent events?	Test-Type-Event
4	ARGU: Yes I can demonstrate it. (Demonstration following)	Classify-Event Test-Type-Event
5	AM: What are the consequences?	Generate-Strategic-Hypothesis

mentation of coordination acts is mainly determined by group members' actions on virtual memory workspace. Its structure has four type: ACTION(OBJECT, PLACE,RIGHT,SEQUENCE).

3. EPISTEMOLOGICAL PROCESS

When we talk about crisis management intention interpretation, mission preparation or battlefield intelligence with militaries or civil servants, they have clear advice on the concept of an event. For them a fire or a bombing is clearly an event. For these operational actors the world is made of objects which exist in a reduced space and time and which have behaviours [Cauvet & Rolland 92] and of events which happen and which have to handle in order to control the situation. For them a decision helper system should be a representation of the operations field with plans, maps and pictures, a representation of real objects, with their associated properties, and a model, which enables the user to translate the real situation into a simulation where he can simulate the actions to take and their consequences.

The CHEOPS system has been designed and specified with operational officers. This representation could bring to an efficient digital representation only avoiding some aporias [Chaudron 94] [Poirel & Chaudron 94]. In a first time the event concept to be clearly defined: to be considered as an event in a crisis management context, an event has to gather some properties: it has to be linked with facts and so with environment objects to be localized in space and time, to be linked with a considered environment where the event is interpreted [Sperber 92] and to be linked with an intentional context [Sieroff 92]. We can wonder if in designing crisis management systems we try to rationalize and make a situation collectively understandable. This model is based on a deterministic concept: the same fact produces the same effects and if you understand the causes of a crisis you can avoid this crisis the next time that the cause will merge.

This project, which has succeeded in a military context with strong constraints, can be easily applied in a civil context. A lot of complex systems are multi-agent because it implies different actors working separately, but the solution of one subsystem has consequences on others and so a cooperative system like MadeInCoop should be useful. In addition most of these systems are based on people knowledge which could be integrated to the system making the other agent benefit from it.

4. APPLICATIONS

These risk management systems can be applied in a lot of domains: in ecology, in order to avoid ecological disasters, to preserve natural resources or to protect the endangered. In industry, these systems could be useful to avoid risks and crisis without affecting the production. For example, in a car production chain, a production stop costs a lot of money, these failures could be predicted and avoided with a risk management system. In transportation domain, these systems can increase the quality of services because one failure happened, it affects all the transportation network and the related activities, and so the crisis risk prediction is essential. In the health domain, such systems could avoid large epidemics, predict possible diseases and propose prevention actions to take. Finally, such risks and crisis management systems which work like a closed system could be linked together to make a meta-agent network where each risk management system would be considered as an agent taking part in a more global management system.

5. CONCLUSION

As a conclusion, we can say that this project, through the design of the CHEOPS collective crisis management system has contributed to a knowledge gathering method for ICS.

The goal was to adopt a global description on the knowledge level, without neglecting industrial organisational constraints.

We can see that this business process is cyclic and each iteration helps the system to become more accurate and more competitive. The business process management was a complete success and it enabled us to increase incrementally the experimentation field to other concrete cases adding a scientific goal to the technological objectives.

A lot still has to be done but the matter is scientifically rich enough to let a great deal of researchers in multidisciplinary domains to bring their contribution. This subject is a challenge for our societies because beyond technological and scientific aspects ICS invites us to collective intelligence.

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