New protocol supporting collaborative simulation

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ABSTRACT

Major researches in the domain of complex systems are interdisciplinary, collaborative and geographically distributed. The purpose of our work is to explore a new methodology that facilitates scientist's interactions during the simulation process. Through the analysis of the collaboration and pluridisciplinary in a simulation project, we have identified the needs of a common representation about models and simulators. Then, we provide an extension of ODD protocol including new features dedicated to collaboration design. This new protocol associated with identified tools tackle an interesting way for defining exchanges in simulation.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous; D.2.8 [**Software Engineering**]: Metrics—*complexity measures, performance measures*

General Terms

Theory

Keywords

Complex system, Collaborative simulation, CSCW, ODD protocol, Pluridisciplinary project

1. INTRODUCTION

Modelling and simulation of complex systems are interdisciplinary and collaborative activities. Data collection, model conceptualization and their implementation using computational tools require welded teamwork composed of participants coming from various domain. However, members of a project often live in different cities, countries or continents. An answer to this problem is to use Internet technologies and modern communication media to support and help exchange among scientists.

Last decade was the web technology years, in which many and many research works achieved by the creation of the framework that reduces the distance among project members. These platforms such as Openmeeting, are based on generic tools (video-conferencing, chatting, social network, and so on) and address a large public. Nevertheless, they do not take into account specificities of research in complex system sciences.

The key of success of a complex system oriented project is the exchange among participants. In this domain, scientists have to manipulate models they use or produce. Therefore, generic tools are not significant for complex system studying [9].

The aim of our research is to provide a method and a framework facilitating collaboration among scientists. The originality of our approach is to place models and simulators at the center of decision making. We take advantage of existing approaches and tools in the collaboration domain to adapt them to complex system sciences. From this idea, we have to determine what the collaboration in modelling and simulation projects is.

Collaboration depends on the case study, the constituted teamwork, member experiences and the scientific questions. So the collaboration manner is linked with research projects, goals and partners. Nevertheless, we can imagine a protocol to determine how scientists have to collaborate. It is the aim of this paper. This protocol could be a guideline to determine exchanges. Identifying these exchanges permits to fix and deploy suitable tools for an efficient collaboration.

Identifying the collaboration around a model or a simulator is an interdisciplinary process. Such as modeling and simulation tasks, the results of collaboration identification are comprised of several models, which determine with accuracy how project members interact. In this paper, we focus on the first stage of process for designing collaboration. The aim of this stage is to establish a domain model (according to the Drogoul *et al.* [12]), in an interdisciplinary way, to enumerate users, exchanges (and so on) according to simulation objectives. Thus, we have investigated the ODD protocol [18] and extended it to introduce collaboration primitives.

First, we present the collaboration problem in the simulation process. Secondly, we introduce the CoODD method supporting specification of the collaborative simulation project. Finally, a case study is proposed to illustrate our approach.

2. COLLABORATION IN COMPLEX SYSTEMS SIMULATION

A complex system is a system composed of interacting components that are difficult to describe, to understand and to predict evolving due to the huge of exchanges [23]. These systems are usually qualified as an auto-organization: they produce emergent dynamics we could not predict. Nowadays, modelling and simulation are considered as an efficient method for studying of complex systems.

2.1 The aim of collaboration in the simulation

Contrary to other sectors in computer science, the modelling and simulation belong to multidisciplinary projects (usually with social sciences, physics or life sciences).

Because of this multidisciplinary characteristic, the simulation of the complex systems is the activity where the collaboration is highly required and constitutes the usual working way rather than an exception.

Figure 1: multidisciplinary problem

A simulation project usually passes through several iterative stages [28]. There are some works that tried to define them, for example: the process of Fishwick [13, 14], Gilbert and Troitzsch [17, 16], and Drogoul [12]. In general, three principal steps have been identified: Design, Simulator Construction and Simulation.

The actors of these steps are *thematician*, *modeler* and *computer scientist* [12]. Usually, the modelers are experts of a specific modelling method, but do not know the domain. The thematician has detailed knowledge about a particular domain or a specific theme. The computer scientist makes the simulation can be executed on computer. Hence the modeler and the computer scientist design and build simulation that will be used by thematicians.

According to Drogoul [11], simulation is an activity in which the actors use a simulator to change the inputs of a dynamic model, execute it, and collect the outputs. *This activity is not the effort of an individual thematician, but relies on team work* [6].

Collaboration among different thematicians is necessary. Because, it seems difficult to use only one discipline to understand and anticipate the behavior of a multidisciplinary system. This problem is not specific for any field. It presents in almost all the different fields of the complex systems.

Take an example of MIOR project in soil science. The aim of the MIOR project [24] is to model and simulate the process of mineralization in the soil and the decomposition by micro organisms of substrates organic matter.

As a multidisciplinary project, MIOR needs the collaboration between biologists and computer scientists. The biologists who have the knowledge about soil science help computer scientist who is expert in programming simulator.

Let us take another example in social science, the modelling and simulation of the marriage age [5]. The timing of marriage has been studied from two different perspectives that require the collaboration among demographer, sociologist, psychologist and economist.

Another example in catastrophe management is the work of T.Q. Chu *et al* [8, 7] that addresses the vital problem of resource allocation for disaster response activities. It has been developed to support a spatial decision support system (SDSS) that has a triple objectives : (i) training people in preparedness phase; (ii) supporting people in response phase; and (iii) acquiring knowledge of people to improving system. A model has been built up. It takes into account geospatial, temporal and rescue organizational information. The collaboration is a key point of this model. This model needs the exchanges among practitioners, decision-makers, domain experts and common users. At this step, these thematicians are seen as the user of the simulator.

To build up simulator, the experience of thematicians is required for a well understanding of the studied complex systems and the thematic. Here, the role of thematician becomes the designer who helps the modeler design the model.

2.2 The common representation

A simulation can be considered as the negotiations among the thematicians. According to [25], the most important thing in a negotiation is the legitimation of content. This legitimation is required at the beginning of negotiation, by constructing a common representation of system [15].

Many unsuccessful negotiations have been identified by the utilization of model in the negotiation that is not being shared for all negotiators [27]. A method to reinforce this legitimation is the participation of all involved members. They unify a common representation of work or system that will be used in the negotiation.

Thus, to well simulate thematicians and modellers must collaborate in order to compose a common representation of future collaborative simulation. However, the questions here are: how can they collaborate? And which common representation will be used?

The first question can be resolved by applying a collaborative process with the help of generic collaborative tools, such as collaborative editor, communication tools, etc.

For the second question, the future representation must be satisfied the following conditions:

1. It must be widely used in modelling and simulation of the complex systems.
2. It must be an interdisciplinary document: due to the interdisciplinary characteristic of complex systems simulation, the common representation is used by the different actors and in different disciplines. Therefore, it must contain information of all related disciplines.
3. It must present the information of the model and its simulator also.
4. The document must be pointing out categories of participants and application aspects of the simulator: since several researchers who have different competencies will use the simulator, thus the information helps each researcher to know his/her partner before the experimentation.
5. Finally, the collaboration problem must be analyzed. The future common representation will explain why the participants collaborate, which collaboration problem they encounter, what their responsibilities and permissions are, and what a typical collaboration template is.

In our approach, this common representation is also the domain model about the collaborative simulation that will be handled. Many methods to form a domain model have been presented in literature, like Business Process Model and Notation [10], Use case models [4] .... However, there is only a textual model that can be easily understood by both thematcians and modellers.

Therefore, we will extend a textual solution to develop our desired representation. The solution is the one that satisfies most of the previous conditions.

3. RELATED WORK

Actually, with the advance in new information technologies and communications tools, it is possible to realize a collaborative simulation. We can combine simulator with collaborative tools which allow distant and sharing application running, such as NetMeeting NetMeeting [30], VNC [22] and so on.

This advent has enabled the development of many collaborative platforms named BSCW (Basic Support Cooperative Work) for simulation. Each approach has its own pros and cons.

They are successful in responding to some collaborative problems. However, they were not based on a concrete theory. Consequently, these approaches are just supporting tools or platforms. They are far from a standard methodology for collaborative simulation. Nevertheless, these works give us some experiences in supporting collaborative simulation.

We are interesting in platforms that dedicate to research works, for example, to the study of complex systems. In this domain, we can cite Web-Sim-MIOR [19], BSCW (Basic Support Cooperative Work) [21] and PAMS [19, 20] . The Web-Sim-MIOR portal is based on the generic NetLogo platform and allows users to run simulators on their own computer via their web browser without installing anything. However, this tool is just an interactive web portal rather than a groupware. It allows running only NetLogo simulators. Users can only interact with the browser, and they cannot communicate and run simulations in a group way.

Korichi Ahmed *et al* [21] present a BSCW usable in various research domains. It associates a BSCW system with external software that allows realizing synchronous collaborative functions. For this purpose, this groupware proposes a shared workspace with asynchronous collaborative features (e.g. forums, version management, and event service) and synchronous tools using external software similar to MS NetMeeting. The later introduces services such as videoconferencing, instant messaging, desktop sharing, and software sharing, and so on.

The approach proposed by Korichi Ahmed *et al*[21] is very simple, useful and generic. However, among its drawback, we can note that no privacy rules can be defined. Every participant of a session can control the simulation. In addition, there is no generic feature (e.g. a database) that allows storing simulation results: results are shared by the group during the simulation and cannot be reused afterwards.

In [19], [20], Nguyen *et al* have been developed a platform that supports collaborative simulation, called PAMS. This platform provides a unique interface for several simulators in GAMA [3], NetLogo [31] and Repast [26]. The users can manipulate simulators and realize experimentations collaboratively. One difficulty that they had encountered is the integration of new simulators in their collaborative platform because each simulator has its own specification. In order to reduce this inconvenience, a standard specification is needed for simulator.

These works support realizing the collaborative simulation, but they do not support the conception of collaborative simulation. For different simulation projects, the requirement of collaboration is different; we cannot apply a unique collaborative solution for all. We need an approach that allows designing the collaborative simulation based on the requirement of thematician.

For the common representation (discussed in section 2.2), we have concentrated only to thematician oriented approaches. We can cite here two approaches : ODD [18] and TRACE [29].

In 2006, Grimm *et al* [18] have established ODD protocol (Overview, Designs, and Details). This approach is an interesting way to establish the description model that is understandable by scientists coming from various scientific communities. It also allows exchanges around the same complex object.

An extend of the ODD protocol, the TRACE approach [29] introduces modeling process design. Formalizing the modeling process is necessary to keep much knowledge about the model. However, it is not sufficient to describe exchanges among simulator users.

Thus extending ODD protocol should be an interesting way to give an answer to our problematic. It is the way we choose. In next section, we will present more detail of this ODD [18] as a method for common representation.

4. COLLABORATIVE ODD PROTOCOL

As far as we know, there is no standard methodology for identification of collaboration in the simulation of complex systems. The purpose of our work is to solve this problem. We propose a collaborative approach that enables the participation of thematicians, designers and modeler in order to define the exchanges around a simulator. This new approach is based on different conceptual and software tools. In this section, we will present a short description about our approach, and then a conceptual tool that responds to the common representation (2.2) will be detailed.

4.1 Approach overview

In the context of the collaborative simulation and participatory simulation, it is imperative to have an infrastructure of software that can convey the exchanges among various stakeholders. However, major simulators are stand-alone applications that do not support collaboration:

- They allow only a local manipulation. The users cannot change the parameters, run the simulation and analyze the results from distance.
- They have a unique interface for all participants.
- They support only one interaction at a moment. If someone wants to change a parameter while the simulation is manipulated by someone else, it must wait until the action is finished.

Based on results of the literature, we propose an approach to introduce the collaboration in such stand-alone simulator. The approach is based on existing works about modelling and simulation, as in Alexis Drogoul [12].

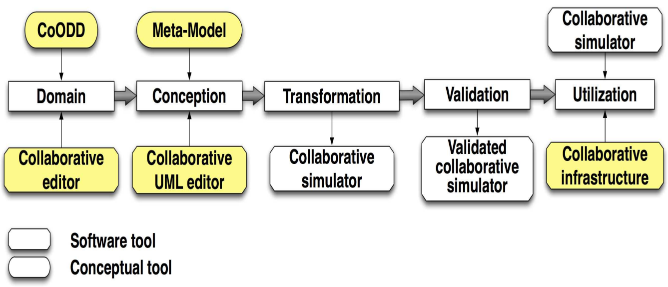

Figure 2: The methodology

The methodology has five steps:

- Creation of the domain model: Based on ODD protocol [18], we have proposed a domain model (Collaborative ODD - CoODD) that is a textual description of simulator, model and the collaborative process among the thematicians in a collaborative simulation. This domain model is also responded to the lack of a common representation in section 2.2. This model is the result of a collaboration between modelers and thematicians, facilitated by a collaborative editor.
- Creation of the conceptual model: It is a UML representation of the collaborative simulator that will be deployed. This model must respect the proposed meta-model. A collaborative UML editor is also developed for this step.

Table 1: ODD protocol

Overview	Purpose
	State variables and scales
	Process overview and scheduling
Design Concepts	Design Concepts
Detail	Initialization
	Input
	Submodels

- Transformation: At this step, stand-alone simulator is transformed to the collaborative simulator.
- Validation: During this step, the new simulator is validated by thematicians and modelers. Together, they ensure that all prerogatives of collaboration are considered.
- Utilization of the collaborative simulator: The simulator is now open to the community and can be used by thematicians. Thus, the simulator is accessible by all authorized members via a collaborative web platform.

The participation of modellers and thematicians at all steps is the advantage of our approach. Therefore, each step of process bases on meta-models and languages understood by both thematicians and modellers, and on collaborative software tools, which assure the exchange between them.

The aim of this paper is to present our result in the first step. In the next section, we will present a short description of ODD protocol and then our collaborative ODD protocol.

4.2 ODD - Overview, Design concepts, and Details protocol

The ODD (Overview, Design concepts, and Details) protocol was introduced to standardize the description of individual - based and agent-based models (ABMs). It provides a domain expert friendly description to share knowledge about a model by pointing out scientific questions, the studied complex systems, model mechanisms, and so on [18].

ODD protocol distinguishes seven categories, organized into three main groups: Overview, Design concept and Details (see table 1). Each category determines the topic that designer has to provide.

The Overview group has three elements: Purpose, State variables and scales, Process overview and scheduling which give an overview of general purpose and structure of the model.

The second block (Design Concept) contains only one element, which talks about the general concepts theories, hypotheses, or modeling approaches of design of model. The Detail part consists of three elements: Initialization, Input, Sub-models which present the details that were omitted in the overview. More detail of ODD protocol can be found in [18].

Regarding to other complex system modeling languages, ODD has many advantages such as:

- Including fundamental characteristics of complex system models such as scales, environment [2].
- Taking into account domain issues and the modeling activity.

- Promoting a rigorous model formulation [18] : This protocol supports a common and identical way to formulate the model description.

- Supporting by a large community of users. By December 14, 2009, according to the Web of Science, there are 87 citations of the first publication of ODD - Grimm *et al.* (2006). 54 publications have used ODD protocol for their model; the other publications were reviews, addressing methods, or they just used Grimm *et al.* (2006)as a general reference to individual-based modeling [18]

Thus, the main quality conducting to choose ODD is the user-friendly, interdisciplinary of the approach. Because of complex models become the key in bridging various sciences, rigorous protocols are needed to ensure communication among disciplines [18]. Various complex system (in ecology, epidemiology, social sciences. . .) have been represented by ODD.

In summary, the actual ODD has satisfied a half of our proposed conditions about common representation in section 2.2 :

1. It is widely accepted and supported modelling and simulation of the complex system.

2. It is an interdisciplinary representation.

3. It presents the information of model.

In order to give a domain model that satisfies both a common representation among different scientists and a mechanism to introduce collaboration in simulation, we provide a new extension of ODD protocol.

4.3 CoODD - Collaborative ODD protocol

In order to support the information about collaboration in the modelling and simulation project, we have added four parts: Simulator, User's profile, Application aspect and Collaboration. The following section will present the template document for writing the new parts of collaborative ODD (CoODD).

Table 2: New collaborative ODD protocol

Overview	Purpose
	State variables and scales
	Process overview and scheduling
Design Concepts	Design Concepts
Detail	Initialization
	Input
	Submodels
Simulator	General information
	Input Parameters
	Output
User's profile	User's profile
Application aspect	Application aspect
Collaboration	Responsibilities
	Collaborator
	Permission
	Collaboration template

4.3.1 *Simulator*

The simulator could be assimilated as stand-alone software for which we want to determine a collaborative Graphical User Interface. A simulator is manipulated by users who are characterized by their own knowledge, abilities, and so on. Simulator is also viewed by users as software that they parameterize, execute and receive the results.

Thus, it could be considered as a black box qualified by inputs, outputs and an aim (the scientific question). Consequently, if there is no explanation about simulator's inputs/outputs, users (domain expert) would not be able to understand them, to change them and so to collaborate around them.

In order to describe with accuracy the simulator, we decided to add a "simulator" block. This block is composed of three elements: General information, Input parameters, and Output. The first element intends to define the general description of the simulator. The second one aims at determining inputs (parameters) of the simulator (goal, range, type). We distinguished two kinds of inputs: (i) Variables that are the model's parameters (numeric parameters, choice parameter); (ii) Actions that define events resulting from user actions (mouse click, button . . .). The last one, output element allows users to observe and understand simulated dynamics by various kinds of views (graph, monitors . . .). Such as inputs, a description (goal, type) should be defined for each output in order to determine aims of themselves.

4.3.2 *User's profile*

The aim of this block is to identify profiles of users who may use the simulator. Users of a model are characterized by their scientific goal, their research, their knowledge, their experience and so on. Determining collaboration around a simulator intends to take advantage of specificities of each user to improve the experiment.

Therefore, an exhaustive list of user profile should be determined. Each user's profile defines a point of view about the simulation and a specific objective that the user tries to achieve. We also want to point out user's abilities to determine their role in the simulation and so to adapt the GUI.

4.3.3 *Application aspect*

This block describes the scientific goals of the collaborative model. The multidisciplinary simulator has several applications that depend on the objectives of the users. Therefore, it can be manipulated in different ways and many exchanging processes have been taking place (participatory, collaborative process . . .). In other words, an exchange process is defined by scientific objective of users and the manipulation method.

Thus, it is necessary to identify clearly the scientific questions that the thematician aims to respond to and the manipulation way of parameters to satisfy the questions.

4.3.4 *Collaboration*

The previous blocks have presented the basic part that is the necessary condition to establish a collaborative simulation. This block describes how to use this information in the exchanges among thematicians.

This block also responds to the following questions: What are the permissions of the thematician user? What are the available collaborative tools? What are the responsibilities of each user in the simulation?

It starts by a short description of collaboration in general terms. Following this analysis, the permission, the responsibilities, the collaborative tools ... are allocated to each user's profile. In other words, this block allows distinguishing the interface between users and methods to collaborate.

These new parts (Simulator, User's profile, Application aspect, and Collaboration) will help researchers to have an overall view about the collaboration between them. After reading these descriptions, they can work better together. With this, the CoODD now is really a common representation for the experimental work after simulator building.

In order to create a good CoODD, we need the assistance of the collaborative tools (see 2.2) allowing the participation of actors with different competencies. Therefore, we have developed an online collaborative editor that allows editing in real-time and collaboratively a document for groups, teams and specially supporting CoODD template. This editor is based on the open source online editor Etherpad [1]

5. CASE STUDY: OPEN RESCUE

In this section, an application of new collaborative ODD protocol with the online collaborative editor will be illustrated. This work allows to describe the collaboration of a multidisciplinary simulation project: the rescue simulations of T.Q.Chu *et al* [8, 7] .

5.1 The open rescue model

In order to support a spatial decision support system in emergency management, T.Q. Chu *et al* [8, 7] (see the example in section 2.1) has developed a model: the Open Rescue model. This model has a triple objectives: (i) observing the behavior of emergency responders; (ii) training practitioners (e.g. police-force, ambulance, and firefighter) or citizens to learn how to deal with crisis situations; and (iii) supporting a decision system to help the decision-makers collaborating in organizing the real-time emergency.

The first objective tends to better understanding the behavior of participants, and therefore, to validate a hypothesis, to answer a specific question or to improve the reality of the model. The decision-makers, practitioners who are expert in emergency management play the role of rescue agents in games to limit the toll of human life and properties of simulation. The obtained result (i.e. the behaviors of participants) is used to answer the predefined question of emergency response, and therefore, it can improve the reality and efficiency of model's rescue activities.

In emergency management, the preparedness is an important phase. It includes actions taken in advance of disasters to deal with anticipated problems of response and recovery. It aims to improve readiness; development of response and recovery plans; development and maintenance of systems used for disaster management; and information programs for households and public agencies. Training is the efficient method for this phase; however, training in realistic situations is expensive. The second objective may resolve it.

The last objective supports a spatial decision-support system that can be used during the occurrence of a catastrophic event. It helps the decision-makers in giving the responses for a disaster situation.

The model has various types of user. They can be decision makers, experts in emergency domain, the emergence responders, the practitioners (e.g. police-force, ambulance, and firefighter) or even the normal citizens. Each user has a different point of view about the simulation, for example, the practitioners only have the partial knowledge of it while the experts completely understand the simulation. This multidisciplinary character makes the collaboration between them difficult to achieve.

CoODD will help to overcome this problem by supporting complete information about the collaborative simulation that will be realized. In the next section, we will demonstrate how the CoODD is used to solve this problem.

5.2 The CoODD description

The structure of this model has 11 elements as shown in table 3. The information about model, simulator and collaborative process will be completely represented (for this application, we discuss only the new parts of CoODD).

Table 3: CoODD structure

Open rescue model
1. Purpose
2. Entities, state variables and scales
3. Process overview and scheduling
4. Design Concepts
5. Initialization
6. Input
7. Submodels
8. Simulator
9. User's profile
10. Application aspect
11. Collaboration

Each user of the open rescue model has different knowledge about the simulator. The experts usually can manipulate / interpret all input parameters/outputs, while the practitioners master only several of them, and the normal citizen does not understand at all. Thus, their knowledge is not homogeneous and it makes the collaboration between them more difficult.

The Simulator part will support the necessary information to well understand open rescue simulator, such as the language, the specific technique, the different inputs, outputs, its meaning and so on. For example, the information of GAMA, GIS, input/output of the rescue simulator will be presented.

In User's Profile part, the identification of different groups of users will help them to well know each other. In the training and decision support systems objective, these users will work together. If some users don't really know who they work with, and how their partners can do, the collaboration cans be time-consuming and not efficient.

In the open rescue project, the simulator is used for three objectives: (1) improving the knowledge of system in disaster response; (2) improving the knowledge of user in the disaster situation; and (3) searching for a solution to respond to a disaster situation. Based on these objectives, we identified four user profiles. Concretely, profile 1 - Practitioner tends to the first and second objective. They have knowledge in reducing life-threatening conditions, providing life-sustaining aid, and stopping additional damage to property.

User profile 2 - Decision-maker corresponds to third objective. They are responsible for giving the commands, the

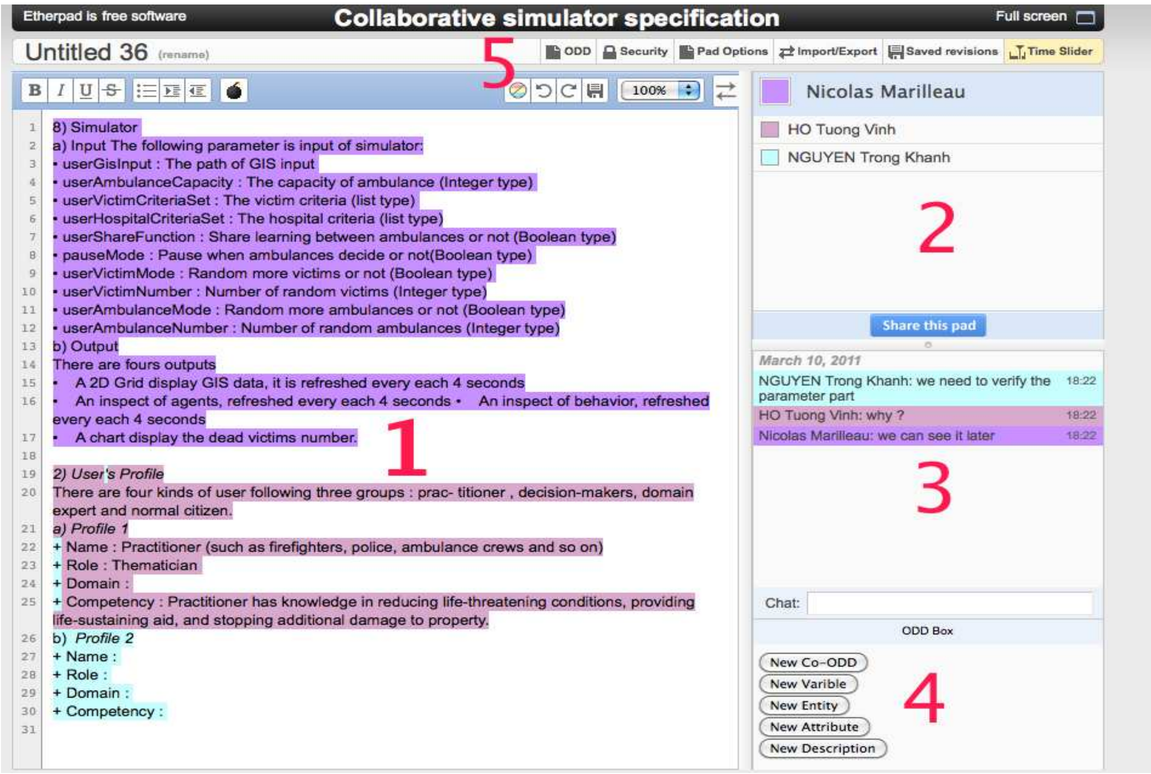

Figure 3: The online editor Etherpad. (1): the space for inputting the text; (2): Participant list, (3): Chat box; (4): ODD support function; (5): Function menu.

solutions to resolve the disaster. Profile 3 - Domain expert has uniquely the first objective. Not like profile 1 who expert only on a specific theme, profile 3 is expert in the catastrophe response domain. Their knowledge helps to improve the system. As profile 3, the last one - Normal citizens have only the second objective. They use the model to improve their knowledge in the catastrophe situation.

A main reason that defines the different user's profiles is their scientific goal in using of the simulator. It also results in the different application aspect of simulator. In the open rescue simulator, we identify three applications: (i) observing the behavior of emergency responders; (ii) training practitioners (e.g. police-force, ambulance, and firefighter) or citizens to learn how to deal with crisis situations; and (iii) supporting a decision system to help the decision-makers collaborating in organizing the real-time emergency.

With each application aspect, there is a proper way to realize, which is chartered by different parameters and exchanging process. For example, the first application tends to better understanding the behavior of participants, and therefore, to validate a hypothesis, to answer a specific question or to improve the reality of the model. The decision-maker, practitioners who have experiences in emergency management play the role of rescue agents in games to limit the toll of human life and properties of simulation. The result obtained (i.e. the behaviors of participants) answers the predefined question of emergency response, and as a result, we can improve the reality and efficiency of model's rescue activities. The concerned parameters: userAmbulanceCapacity, userVictimCriteriaSet, userHospitalCriteriaSet, userShareFunction, pauseMode, userVictimNumber, userAmbulanceNumber.

The collaboration in utilization of this model is obvious. However, there is no specification which clearly shows how it carries out. Therefore, the Collaboration part will help to well understand it. This collaboration will be presented by responding to the following questions: why and how do they need to collaborate? Which difficulties they encounter? What are responsibilities and permission of the profiles in simulation? Which profiles need to collaborate and why?

For example, with the third application aspect of the open rescue project in supporting of profile 2 in the real-time emergency, the collaboration is highly needed. When the disaster happens, he/she will launch the simulation in order to find a solution for the actual situation. It is a very complex task with the participation of many elements. The profile 1 has an important role in collecting the data on the scene (the number, the condition of victim, ambulance...). The data will be sent to profile 2 who runs the simulation. With the help of the profile 3, the profile 2 compares the obtained results and chose the best solution. These works are as fast as possible to reduce the damage. Thus, the coordination and collaboration among these actors are most important to overcome the problem.

Thus, the collaboration around this model is completely described by our collaborative ODD protocol. The table 4 is an illustration of part 11 - Collaboration. For the full version, you can refer at this address: http://vmeoddcollab-dev.mpl.ird.fr:9000/MRCctgIU41 .

Thanks to CoODD, we have provided a standard mechanism that allows a common project's exploration. It does not only help the practitioner, decision-maker, and domain

Table 4: Collaboration part

11. Collaboration The experimentation of this model requires collaboration of above profiles. In respect to the first application, observing the behavior of emergency responders, which is often realized by profile 3 (domain experts). They help the model improve its capacity by remember the behavior of expert in each concrete situation. The profile 3 creates scenarios and experiment it. For individual behavior, one actor is enough but for the collective behavior, it needs the collaboration of several actors. Regarding the training object, the presentation and collaboration of all participant are also needed. Because, for a such experimentation (about emergency), it is just efficient, when it closes to reality. Thus, collaborative experimentation of profile 1 (practitioner), profile 2 (decision maker) and (may be) profile 3 (domain expert) will make it valuable. The knowledge of people in emergency management is improved. Specially, with the third application aspect in supporting of profile 2 in a real-time emergency, the collaboration is highly needed. When the disaster happens, a simulation will be launched in order to help profile 2 in responding. It is a very complex task with the participants of many elements. The profile 1 has an important role in collecting the data on the scene (the number, condition of victim, ambulance . . .). The data will be sent to profile 2 who runs the simulation. With the help of profile 3, the profile 2 compares the obtained results and choice the best solution. These works are must as fast as possible to reduce the damage. Thus, the coordination, collaboration between these actors is most important to overcome the problem. However, these actors are usually geographical separations, and in a disaster situation the communication is difficult, while the response solution must be as soon as possible in order to reduce the damage. Therefore, they need an efficient collaboration method in experimentation. **a) Resonsibilities** All above profiles have a same responsibility in simulation with this model: improve their knowledge about management. In addition, profiles 1, profiles 2 and profiles 3 help the model in collecting data relating to the contextual behaviors. That will improve the capacity of a decision support system. Regarding profiles 2, they are responsible to test potential resource allocation and planning options in a real-life emergency. They formulate prospective actions, monitor the effectiveness and progress of response activities by running different scenarios, analyzing result and choice the best response solution. **b) Collaborators** The profile 1 (practitioner) collaborates with: • Profile 2 (Decision maker): Profile 1 collaborates with Profile 2 to receive order, and to help the profile 2 master the actual situation of emergency. • Profile 3 (Domain expert): Profile 1 collaborates with profile 3 to improve their knowledge in emergency management. • Profile 4 (Citizen): Profile 1 collaborates with profile 4 to help them in training. **c) Permission** In respect to the parameters, profiles 2 and profiles 3 usually take care for all above parameters. Profiles 1 are interesting only in parameters relatedtheir capacity and object in district level: userAmbulanceCapacity, userVictimCriteriaSet, userHospitalCriteriaSet, userShareFunction, userAmbulanceNumber. The citizen cannot modify the parameters.

expert and normal citizen well understand each other and project, but also the designer who builds the collaborative simulator after in determining the ideals of conception and the practice of thematicians.

6. CONCLUSION

We have argued in this paper that the simulation of the complex systems is by nature a collaborative and multidisciplinary task: it needs the participation of various domain experts who are usually geographically separated. We have also highlighted the collaboration after implementation of the simulator. Several researchers with different competencies play the simulation together. They need to collaborate to associate their points of view, skills and knowledge.

In order to support the collaboration in a simulation project, we identify the need of a common representation for collaboration. Based on the ODD protocol, we have developed a collaborative protocol CoODD that responds to the common representation. The new protocol is also the domain model of our methodology in collaboration identification process.

We have also developed an online collaborative editor for the creation of CoODD. The editor has a typical interface of the collaborative editor. Thanks to a simple interface, different researchers can easily familiarize them-self with the editor. The capability of fast synchronism and the slight characteristic of JavaScript language have successfully supported an efficient collaborative tool.

To demonstrate our approach, we have applied it to resolved the lacks of a collaboration specification in the project of T.Q. Chu *et al* [8, 7].

In the future, we will apply the new ODD protocol with other models. This work will help us in collecting the requirement of different scientists about collaborative simulation. It will allow us to: (i) refine our collaborative simulator meta-model and (ii) elaborate a process to realize collaborative simulation.

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