[[1]](#footnote-1)

Information Model for building Training Scenarios in Computer Simulated Maintenance Activities \*

First A. Author, Second B. Author, Jr., and Third C. Author, Member, IEEE

*Abstract*— Computer simulated scenarios for training operators in maintenance activities requires a lot of effort to be specified basically because they should consider prescribed and tolerated behaviors, violations of accepted behaviors, and their consequences. This paper presents a model containing required information for building training systems based on the notion of social organizations inspired in the Moise+ model. The requirements were captured by in site observation of operators during maintenance activities and by interviewing an engineer involved in maintenance of high-voltage electric power transmission lines. A case study presenting scenarios and possible inferences derived from the model show the potential uses of such model when one builds a training system.

# INTRODUCTION

Risky professional activities expose people to effects that can even cause death. Thus, training professionals before they have experiences in the field is an important issue. One can build physical models for training when the maintenance site is often the same, the cost to build a concrete model is not prohibitive, and knowledge learned in the physical model can be applied in real situations. Virtual reality models are another way to tackle this kind of training or, more generally, any kind of computer simulated scenarios can be used with different degrees of realism. Besides graphics, which allows the trainee to be immersed in the activity, team organization and relationships among artifacts, people, and actions are relevant information for providing realism and learning in training.

The goal of this paper is to build and assess a conceptual model. Model was built with information gathered from observing real teams in maintenance activities, interviewing a security engineer, and revising related approaches. We propose a conceptual model containing information that would allow a simulation engine to produce consequences when the trainee violate some prescribed norm for the maintenance team. The conceptual model was evaluated by means of a case study that shows possible derived inferences from represented information.

Next section presents some fundamental concepts in the domain of security, practical activities, and organizations. Following, section 3 presents the proposed model while section 4 shows a case study. We present related work in section 5 and final remarks in section 6.

# FUNDAMENTALS

## A. Agents

In order to model workers involved in maintenance activities, we have used the notion of agent. The most common accepted concept says an agent is rational, capable of autonomous behavior, and is situated in an environment where he/she acts proactively trough actuators and senses the environment to perceive its state and react to changes [1]. Besides, we have based our work on the Belief, Desire, Intention model of agents evidencing that agents have mental states [2], particularly, they have goals.

## B. ARTEFACTS

<explicar brevemente>

## C. Normative Organizations

A team of agents performing an activity compose an multiagent system. Each agent has the capabilities of communication, coordination, and cooperation. They form an organization and, according to the Moise+ model [X], an organization specification has three dimensions: structural, functional, and deontic.

*<explicar sumariamente o que é importante de Moise+: o que vai ser utilizado no modelo proposto*

*- actions*

*- normas, violações e sanções>*

## D. RISKS

Definir risco

BATU: isto não foi utilizado no trabalho – creio que é bom analisar como trabalho futuro

BCTU

# CONCEPTUAL MODEL FOR RISKY ACTIVITIES

This model was built upon the following knowledge engineering activities: in locus observation, interviews, gathering of information in technical and security documentation, and related work review.

In locus observation and interviews were used to get acquainted with the domain of maintenance (particularly, in electrical energy) and to understand the problem from the users’ point of view. Important concepts and relationships were defined and elicited in this phase. A complete maintenance procedure was defined (exemplified in the case study). Technical and security information available in private documents of an electrical energy company was used as complementary information. At the end of this initial phase, we obtained a list of important terms and their relations used in training activities.

With all this information in hands, we proceeded a review of related work searching for existing models that could represent all information we defined as relevant such as [X][X][X]. Finally, combining our information needs with existing models, we produced the model presented in the next sections.

## GENERAL VIEW

## MODULES OF INFORMATION

The model has the following modules: risk, tasks, entity, and environment. The risk module describes <explicar sucintamente o que cada módulo descreve>

## RISK AND CONDITION

<aspecto fundamental do modelo >

## REASONING WITH THE MODEL

<quais inferências são possíveis>

# CASE STUDY

We have taken a real case of maintenance from an electrical energy company. A team composed of one supervisor and six workers have the goal of replacing a pedestal insulator. Thus, we have seven instances of **Agent**, *{ag1, …, ag7}*, and two instances of **Roles**, *{supervisor, worker}*. The relationships among agents and roles are specified by the predicate *hasRole(ag, r).* For instance, *hasRole(ag1, supervisor)* designates that agent 1 plays the role of supervisor.

The artifacts available in this scenario are security apparels (gloves, boots), tools (rope, sockets, sticks, insulators), and screws and nuts, all instances of **Artifact**.

The maintenance activity is composed by a sequence of 20 sub-goals, starting with *clean, dry and test a rope* and ending with *arranging all the equipment in the van.* For the sake of simplicity, the **goals** are named *{g1, …, g20}.* To define that these goals are sequential, the predicate *nextGoal(gi, gj)* is instantiated several times: *nextGoal(g1, g2)* represents that g1 precedes g2, *nextGoal(g2, g3), …, nextGoal(g20, NULL).*

Weather conditions must hold for the team to achieve the maintenance goal: sunny, windless, no rain, and air humidity less than 70%. If any condition is violated, involved people risk a high-voltage electrocution causing death. Instantiation of the following predicates allows the representation of each condition associated to the risk and consequence in the case the condition is violated: *hasRisk(humidityLT70, electrical\_shock, death), hasRisk(sunny, electrical\_shock, death), hasRisk(no\_rain, electrical\_shock, death), hasRisk(windless, electrical\_shcok, death)*.

# RELATED WORK

# Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Appendix

Appendixes should appear before the acknowledgment.

Acknowledgment

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R. B. G.) thanks . . .” Instead, try “R. B. G. thanks”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References

1. M. Wooldridge, N. R. Jennings. “Intelligent agents: theory and practice,” *The Knowledge Engineering Review*, Cambridge University Press, v. 10, n. 2, p. 115–152, 1995.
2. A. Rao, M. P. Georgeff. “Modeling rational agents within a BDI-architecture.” *In: Proceedings of the Second International Conference on Principles of Knowledge Representation and Reasoning.* San Francisco, CA, USA: Morgan Kaufmann Publishers Inc., 1991. (KR’91), p. 473–484.

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   F. A. Author is with the National Institute of Standards and Technology, Boulder, CO 80305 USA (corresponding author to provide phone: 303-555-5555; fax: 303-555-5555; e-mail: author@ boulder.nist.gov).

   S. B. Author, Jr., was with Rice University, Houston, TX 77005 USA. He is now with the Department of Physics, Colorado State University, Fort Collins, CO 80523 USA (e-mail: author@lamar. colostate.edu).

   T. C. Author is with the Electrical Engineering Department, University of Colorado, Boulder, CO 80309 USA, on leave from the National Research Institute for Metals, Tsukuba, Japan (e-mail: author@nrim.go.jp). [↑](#footnote-ref-1)