A framework for observation and analysis of learners' behavior in a full-scope simulator of a nuclear power plant

Approach based on modelled traces

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***Abstract*- Our work deals with the subject of activity observation in full scope simulators. In this paper we present a Modelled Trace approach for designing a methodological framework and associated tools to manage the observation process and the corresponding analysis activity.**

Keywords- Modelled Traces; Transformations; Trace-Based Systems Framework; Full Scale simulator; observation and analysis help; Training

I. INTRODUCTION

The context of our research is Technology-Enhanced Learning (TEL) System; in particular the full scope simulators of EDF Group ("Electricité De France" in french) used for training and improvement of the Nuclear Power Plant (NPP) operators. In this context, observation and analysis of the individual and collective interaction of the trainees is critical and particularly difficult [3]. Indeed, these observations require attention and constant alertness of trainer(s) throughout the simulation. Thus, the aim of our work is to provide trainers with a **help on the observation and the analysis** of the trainees' behaviors during the simulation sessions and debriefings.

The key concepts of our approach are based on the theory of Modelled Trace, noted M-Trace, developed by the SILEX team [2]. By definition, a M-Trace is composed of *observed elements*, noted "obsels", representing the interaction between the user and the system. For managing modelled traces, SILEX team has defined the notion of Trace-Based Management System (TBMS) [2] [1].

Our goal is to use and extend this theory, their formalisms, the methods and tools necessary to describe, reason upon and exploit the interaction traces of the simulator's users. This work will thus allow us to infer, construct and reuse new high abstraction knowledge level in order to capitalize and share observation expertise.

II. A TRACE-BASED FRAMEWORK FOR OBSERVATION ACTIVITY IN NPP FULL SCOPE SIMULATOR TRAINING

Our first proposition was a Trace-Based framework for managing the observation process and the analysis activity in NPP Full scope simulator. This framework is a global approach having M-Trace as its center in all the steps of the full scope simulator trainings sessions as explained in Figure 1. For the reader to understand well our framework we describe it as follows: (1) a team of trainees interacts on the simulator to face up an incidental/accidental situation driven by the trainers. During this simulations trainees have to realize specific actions that are expected by the trainers. (2) During the simulation session, the user's interaction on the simulator is stored in the TBMS. This "Tracing activity" process consists of collecting and modelling a trace called the *primary trace* obtained during the training activity's session. (3) By using TBMS dedicated *Transformations* on M-Trace, the trainers are able to observe the trainees activities with a higher abstraction level in particular to detect realized or not realized high level « obsels ». A *Transformation process* performs transformations on M-Traces like applying filters, rewriting and aggregating elements, computing elements attributes, etc. so as to interpret and abstract the primary trace. Using the same principles, trainers can later analyse the reasons, be they individual or collective, of failure with a top-down investigation on all the abstraction levels of trainees M-Traces (4). Later, trainers can prepare and conduct the simulation's debriefing with the trainees (5). In this step, through TBMS, trainers can playback the M-Traces of the trainees, stored in TBMS, in order for instance to explain and focus on particular point of the course. At the end of the training course, the trainers exploit all the M-Traces of all the simulations sessions to raise a global synthesis of the trainee's skills (6) and underline progress to be made. The last step of the full scope simulators training loop allow expert trainers to establish statistics on the best and worst practices (7) to feed EXperience Feedback and improve contents of the future training courses at a national level (8).

III. M-TRACE MODEL OF SIMULATION

In a second part, to satisfy our objectives, we focused on the vocabulary of the activity that is carried on full scope simulators. For this, we participated in several sessions of simulation and debriefing. On the basis of this vocabulary and M-Trace Theory, we have proposed afterward several

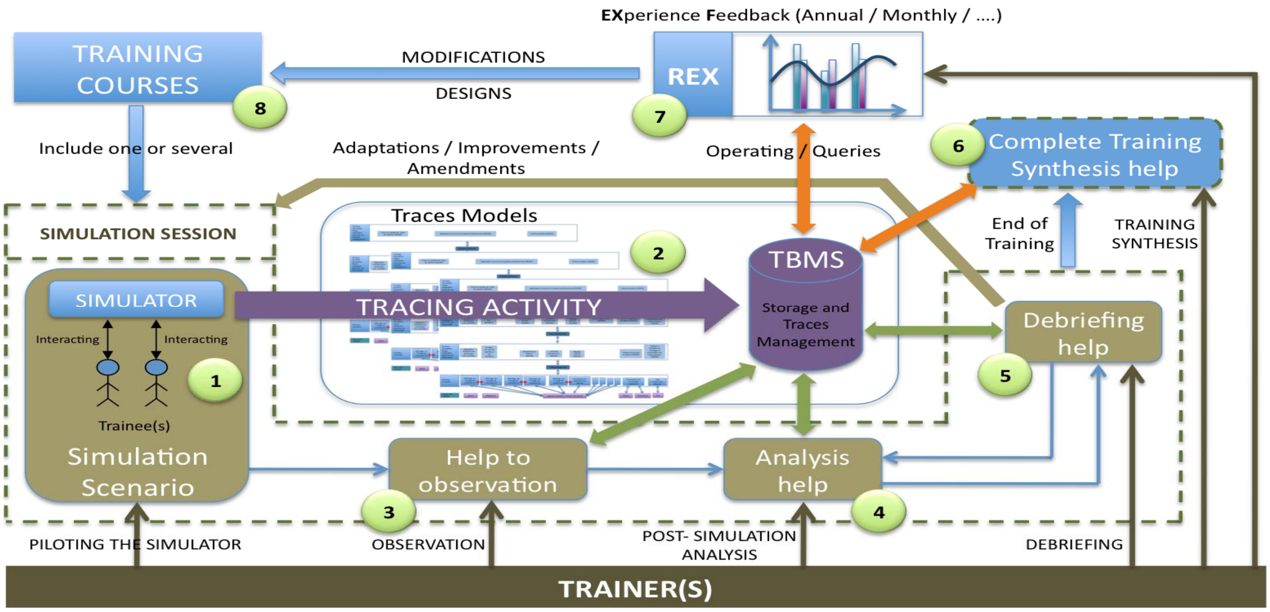

Figure 1. Trace-Based Framework for Observation Activity in NPP Full Scope Simulator Training.

models for the M-Traces to be used in our system. Each model represents an abstraction level corresponding to the progress of the simulation session (Figure 2).

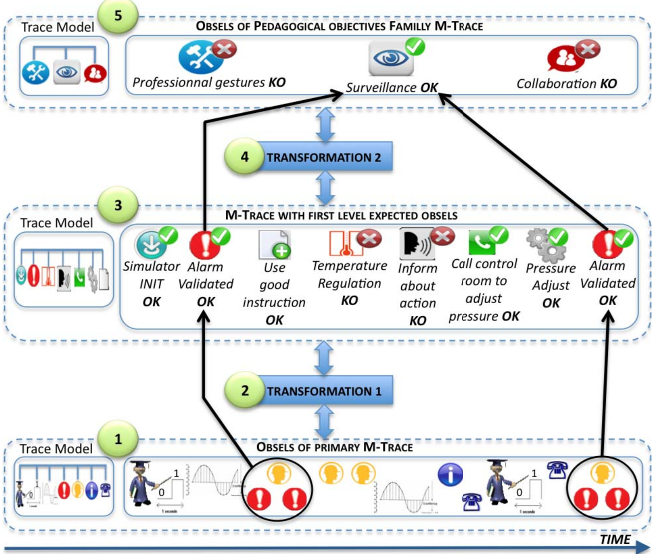

Figure 2. M-Trace Model based on the simulation activity vocabulary.

(1) The interaction traces of the users (operators and instructors) with the simulator are collected to create the obsels of the Primary M-Trace. By using a first transformation process, based on rules (2), we construct a new M-Trace (3), which represent the first level of expected "obsels" that trainees have to realize and trainers to check. This trace offers a high abstraction level that facilitates observation and understanding of activity for the trainers. Once this trace of the first "expected obsels" is created, the second transformation (4) allows the creation of a third M-Trace (5). This higher level M-Trace shows obsels that describes *pedagogical objectives family* as expressions of the trainees' capacities.

Such structure allows trainers to explore, analyze and understand well possible reasons of failure to prepare and conduct the session's debriefing with trainers. It's also possible to help young trainers to rise in skills by helping them in observing obsels of high abstraction knowledge.

IV. CONCLUSIONS AND FUTURE WORK

In a short term, our future work concerns the improvement and the validation by the experts of our transformation model based on rules. Our purpose with longer term is to create a dedicated prototype in order to help experts' trainers to capitalize their observation expertise through transformation pattern in a way of transfer of knowledge.

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