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ABSTRACT
We are interested in using game technology to provide an engaging and immersive environment for experiential learning of workplace situations. Narrative intelligence will be used to provide the adventure. For authoring we provide an adaptive interface that allows the direct capture of the workplace situations and the knowledge driving the interaction. We describe our approach and an initial study.

Keywords
Narrative intelligence, adaptive interfaces, knowledge based systems, animation, training

INTRODUCTION
Games are becoming increasingly popular as platforms for learning due to the engagement and potential benefits they offer. Our project employs a game engine to create a training simulation in the style of an adventure game. Through playing the game we are attempting allow the learner to safely experience a situation encountered previously by a domain expert and in that way the expert passes on their knowledge to a novice. Since knowledge is always evolving we need to develop a virtual training environment that will allow the domain expert to enter scenarios and maintain the related knowledge. While our project also involves research into virtual environments, cognitive and behavioural modeling and language technology in this paper we focus on our work involving narrative intelligence and interactive authoring and maintenance of the various types of knowledge needed by the system. The paper also describes the first in a series of studies to determine the key features needed to allow virtual or "Unreal" technology to provide an environment for experiencing realistic workplace scenarios.

PROJECT DESCRIPTION
Our project involves the development of an approach and system for training simulations in the area of risk management. The use of games for training is not new and others have looked at the use of narrative intelligence for story generation. We, however, are seeking to build a system that is more interactive and adaptive than systems in the past. The goal of our approach is to allow a domain expert to pass on his experiences and the learning goals to a trainee. While initial scenarios would be developed by a games designer based on discussions with the domain expert/trainer, the latter will be able to interact with the system to produce a richer set experiences. The narrative,

or adventure, and the supporting knowledge will thus evolve within the context of a reality-based scenario. We see this as critical as knowledge is highly contextual and best passed on via hands-on experience, particularly in the case of tacit knowledge.
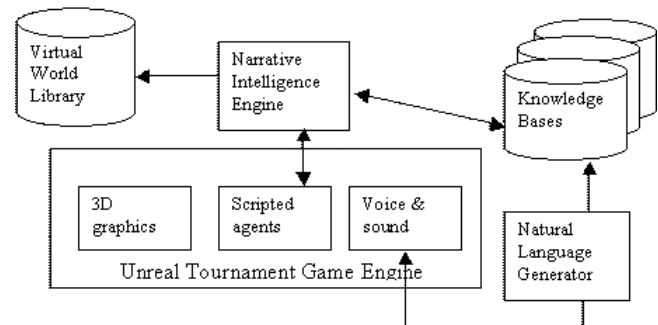

Fig. 1: Risk Management Training System Architecture

The initial architecture for our system is shown in Fig. 1. To-date the Virtual World Library contains a "Park World" and an "Airport World" created using the game engine Unreal Tournament (UT)[1]. A screen shot from a scenario in the Airport World is shown in Fig. 2. The game engine provides 3D graphics, scripted agents and voice and sound. Not shown, is a behavioural engine that translates the higher level concepts used by the Narrative Intelligence into the lower level instructions used by the UT game engine to control the agents, objects and training environment.

Our architecture includes a number of knowledge bases. The knowledge bases include rules on such things as how to detect a risky situation, what language or facial expression is appropriate, which character or storyline to introduce or when the game is over. The Natural Language Generator (NLG) will interface with the voice and sound component of UT to output conversation. Rules in a knowledge base will be applied to assist the NLG to determine the appropriate utterance. For example, if the character is a child they may answer "nup" whereas a mature lady would answer "no thank you". Other work within this project, but not reported here, involves research into the use of paraphrase and emotions within the NLG

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[1] http://www.unrealtournament.com/

which will replace the primitive approach shown in Fig. 2 where we use bubbles for language input by the user or generated by the game engine.

Generation of the story or adventure will be achieved using the Narrative Intelligence Engine (NIE). Narrative is a fundamental principle in human behavior found in everyday communication and part of our culture. At a deeper level, narrative acts as a means to structure knowledge [2]. Applying the concept of narrative to the computer is the core idea of the concept of Narrative Intelligence [4]. Narrative Intelligence is not restricted to stories simply displayed on a computer: It consists in structuring the interaction according to narrative principles.

An interactive narrative engine is capable of interpreting users' actions in narrative terms, and respond to them by generating appropriate events in the fictional world of the story. A narrative engine goes beyond a set of Intelligent Agents, because it also cares about how the actions and events form part of a global story. For example, in the context of a training simulation for risk assessment, if a security officer asks an expert to closely examine a passport, the latter will not give his answer immediately, possibly due to various external reasons. The delay will add the element of suspense to the narrative sequence.

Fig. 2: A scene from an airport training scenario

Our approach for a narrative engine for a training system is based on our previous work on Interactive Drama [7]. The approach is not based on branching narratives but on a set of more elementary and abstract units like goals, tasks and obstacles. These units are dynamically combined to create actions and events in the narrative. Through this decomposition/recomposition process, the system allows the user to choose among a large set of possibilities and feel a sense of *agency* in the virtual world [5]. For example, if a user is trained to be a security officer facing a passenger in an airport, if s/he wants to check the exactitude of some information, s/he is given a panel of options. S/he can choose one of these options, or several, either at the same time (parallel investigation) or successively, in any order and whenever s/he wants. The narrative engine is then responsible for responding to these various investigations, in a timely and narratively interesting manner.

A key feature of such a narrative engine is the model of the user. In order to be able to recompose dynamically a narrative sequence, the system must estimate the impact of each possible action or event to the user. A few user models for Interactive Narrative have been proposed so far (e.g. [7, 8]. In the case of the risk assessment simulation, we intend to develop a specific user model customized for the learning domain. In the current architecture the NIE references user models that are maintained via the game engine interface. The NIE will use three types of rules concerning: the socio-psychological world; the narrative experience and the learning objectives.

One of our key design issues is to build a system where the domain knowledge can be maintained by the domain expert without the need for a knowledge engineer. To provide easy user driven knowledge acquisition and to avoid the problems associated with verification and validation of traditional rule-based systems as they grow in size, we will use the Ripple-Down Rules (RDR) [5] knowledge acquisition and representation technique. This technique is based on a situated view of knowledge where knowledge is "made-up" to fit the particular context. Knowledge is patched in the local context of a rule that misfires producing decision lists of exceptions. Context is provided by cases. In our training simulation the current state of the world will be treated as the current case.

In accordance with the RDR approach, knowledge acquisition and maintenance will occur when a domain expert is playing the game and finds that they want to introduce a new situation or find that the current situation is not satisfactory. For instance, when playing the game if there is some aspect of the environment that is seen to be inappropriate, such as the presence of some piece of furniture, the level of lighting, the tone of voice, etc, the domain expert will be able to interrupt the game and add a rule which captures the current situation, and allows a rule to be added which then changes something in the current situation. Additionally, a rule conclusion may be added which indicates a particular action to take in that context. Such a use of RDR is novel and further research is needed to determine what modifications are needed to the current algorithm and method.

Similarly, the interface will be highly interactive from the player's point of view. The game will be configurable to allow the level of system feedback to be controlled by the trainee and/or trainer. Depending on what options are taken, the trainee will be able to ask why they were asked a question or why a certain thing happened so that they discover the knowledge behind the interface and scenario contained in the various rule-bases. The trainee will be able to select various parameters that will guide the narrative that unfolds and will be able to conduct self assessment tasks such as responding to a request from the system to indicate the perceived current level of risk. The response of the trainee will be evaluated against the rules in the Risk Assessment Knowledge Base to allow a critiquing mode of interaction with the system. Again, based on the results the trainee may choose to query the various rule bases further to understand the underlying knowledge.

3 Evaluation Studies

We are conducting a number of trials so that we can focus our research effort on the more essential aspects of the simulation for learning. For example, how critical for learning about risk situations is body language, speech, believable characters or the display of emotions? Further, use of a game engine assumes that adults are willing and able to learn when confronted with characters that are cartoon-like or action figures. Our first trial (status=completed) was aimed at testing this basic premise. Our second trial (status=in progress) concerns the importance of interactivity and the third trial (status=future) will focus on the role of language and emotions.

As described, our approach relies on the capture, use and reuse of knowledge concerning different aspects of the training scenarios and environment. Gaining access to domain experts and their knowledge is always difficult. This is definitely true in the area of risk assessment for crime and terrorism. As an initial source of relevant scenarios we are using video recordings from the Australian Channel 7 reality TV program "Border Security". In the first trial our goal was to determine whether watching a video recording of a risk-based scenario involving humans produced better, worse or the same results as a simulation of a similar scenario created in a game engine with animated characters, that is, can we learn from game characters. Both scenarios were taken from "Border Security". 74 third year Computer Graphics students were involved in the study. After watching the video they completed a survey with nine questions about the scenario. Likewise, after watching the game demonstration they completed another survey with nine questions of similar difficulty but related to the second scenario. The questions sought to compare the effect of the media on the participants' attention, memory and reasoning. The number of correct answers varied between questions, however when compared to the corresponding question in the alternative scenario, the level of accuracy and detail recalled were almost identical for both situations. The results have encouraged us to believe that while the game demonstration had little in common with reality, the participants were still able to pick up the key details and draw reasonable conclusions regarding the scenario. More detail on the study is provided in [6].

Given that the students had just completed studying computer graphics with a game component in it, we were interested in finding out their overall impressions and suggestions. Question 10 asked *"Do you see potential in the approach for training simulations? Why?"* 32 said Yes, 19 said No, others were either undecided or did not answer the question. The positive responses (frequency given in brackets) included: (5) potential to recreate a lot of scenarios, (3) easy to understand the problem, cost-effective, (2) funny, clearer, no expressions other than voice, unrealistic movement of characters, (1) free to make mistakes, able to try new things, practice time is not limited, text is helpful and safer. The negative responses included: (4) not realistic, (3) too easy, (2) too simple, (1) boring, more expensive.

Question 11 asked *"What additional features could be added to the Virtual Reality demo to make it better and in what way?"* responses included: (16) more realistic movements, (12) add interaction, (9) change characters, (8) increase realism, (2) add background noise, better voices.

As can be seen, the comments and suggestions are varied. Given that the game demonstration was very primitive, the results are promising. As expected many students commented that interactivity and more realism was necessary. Our next study will evaluate if these elements are in fact needed for learning as studies (e.g. [1]) have shown that humans are able to suspend belief and engage with unrealistic characters. Realism does not equal believability or level of captivity. Our next study will compare the results of using the game demonstration with a number of alternative interactive versions of the same scenario. The interactive versions we are currently building include: a human game master as the controller; a narrative engine; and a menu-driven interaction mode based on the rules in an RDR knowledge base. These studies will provide feedback on the value of interaction as well as provide us with some feedback on the various components of the proposed approach that we have touched on in this paper.

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