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Challenging Reality using Techniques from Interactive Drama to Support Social Simulations in Virtual Worlds

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ABSTRACT
Simulations of social situations have great potential to be applied to many of the social problems that we find in society and organisations. Social simulations can do more than provide experience and transfer current best practice; they may be used to transform current social realities. As many educationalists, organizations and researchers are finding, Virtual Worlds (VWs) provide an environment for conducting person to person social simulations. In this paper we consider a more challenging form of social simulation in VWs involving intelligent social interactions between humans and computer-based non-player characters in VWs, known as intelligent virtual agents (IVAs). However, using IVAs to simulate social behavior requires some reconsideration of the role that reality plays and challenges the definition of a simulation as a representation of reality. By bringing in the element of fiction (non-reality) often associated with drama, narrative and storytelling together with virtual worlds, we can relax some of the constraints associated with reality and go beyond reality. In beyond reality simulations, we actually use simulations to exaggerate aspects of the real world in order to emphasize a particular learning concept or even to break the rules, strategies, roles and operators which apply in the real world.

Categories and Subject Descriptors
D. Software D.m MISCELLANEOUS Software psychology; I.2.11 [Artificial Intelligence]: Distributed Artificial Intelligence—*Intelligent agents*

General Terms
Design, Human Factors.

Keywords
simulation, reality, beyond reality, interactive drama, agents, narrative, storytelling, virtual worlds.

1. INTRODUCTION
Virtual Worlds (VWs) support simulation of places, people, objects, events and activities which exist in the real world. Simulation has been classically defined as an “artificial representation of real conditions” [66]. Many categorizations of simulations have been offered. We are particularly interested in categories of simulations which assist training, that is, the acquisition of knowledge, skills and competencies by the learner. Farber (2004) recognized two overall categories: 1) symbolic simulations that depict the characteristics of a particular population, system or process through symbols; and 2) experimental simulations that place the learner in a particular scenario and assign the user a role within that scenario. Boyle [16] identified three types of simulations based on the level of learner activity required. The first of these is passive simulation, where the learner observes the operation of a simulation as it unfolds. The second, exploration simulation is an unfamiliar environment where a learner selects from multiple paths to navigate through. The third, task-based simulations, which are of greatest educational value, are where the learner interacts with objects or characters in realistic situations to achieve a specific goal. Davis [21] classified training simulations into three groups: virtual, constructive, and live simulations. In constructive simulations, tactical and strategic decisions are made testing the user’s ability to use the resources effectively. Live simulations allow users to practice the physical activities with the real equipment. In this paper we are only interested in the first type: virtual training simulations, where the user is immersed in a virtual world. Further, using the other above categorizations, we focus on experimental simulations that can be task-based and/or exploratory in line with the goals of virtual worlds for training purposes.

Traditionally training simulations involve human interaction with a model or environment. In the simplest case this involves selection of model parameters and/or which scenario to observe. In a flight simulator, the trainee pilot learns how the physical devices respond to their actions. The trainee is learning how to behave, but social interaction is not an element. While the trainee pilot might do worse as a result of being reprimanded by the flight instructor or distracted by an argument with their spouse earlier that morning, this is not part of the system. Due to the low cost of errors, behavioural training simulations are common. For example, police may use physical training simulators to a) improve hand-eye-coordination in high-risk situations, such as the apprehension of a criminal, using wall-to-wall screens and laser weaponry; b) practice high speed pursuit of offenders using simulators such as PatrolSim IV . At a more cognitive level, military simulations may focus on helping trainees understand the consequences of strategic decisions in high-risk situations which have been modelled in hyper-realistic virtual reality or true virtual reality (TVR). Examples include: Virtual Battlefield Simulator

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(VBS1) by Interactive Bohemia, Mission Rehearsal Exercise (MRE) [72] and Joint Conflict and Tactical Simulation (JCATS) by the United States Joint Forces Command . The civilian sector covers all simulations working outside the law enforcement and military sphere but commonly involves emergency first responder training, e.g. the HazMat training simulation for firemen, or the Weapons of Mass Destruction Decision Analysis Center (WMD-DAC) simulation by Sandia National Laboratories which trains city administration officials to handle terrorist incidents or natural disasters.

Until recently, these physical and/or cognitive simulations have been the focus of most simulation applications and systems. This paper, however, focuses on simulations of social behaviours as they open up new uses and challenges for training simulations which are currently being considered in research into storytelling and drama. This is a new and exciting direction. From the list of training systems mentioned above, only MRE deals with social behaviours. In the simulation a military officer encounters a mother whose son has been injured. The military officer must decide whether to continue with his planned mission or to assist the mother. MRE attempts to combine research in intelligent tutoring, natural language recognition and generation, interactive narrative, emotional modeling, immersive graphics and audio, with the goal of creating realistic and compelling face-to-face social interactions with virtual characters. The system is designed to facilitate individual and squad-scale training of US military personnel in peace-keeping missions, e.g. in Bosnia. The user is presented with either a standard PC screen or a 150 degrees True Virtual Reality screen, and input devices vary from mouse plus keyboard to verbal only. The agents in the MRE system include virtual humans as autonomous agents which the user can enter into conversation with. The virtual humans have a deep process model of emotion, that drives the emotional state but also attempts to explain how the emotional state arose from features of the social and physical environment using the well known belief, desires and intentions (BDI) agent model [59]. MRE was the first of its kind and a multi-billion dollar project relying on teams of specialists, such as graphic artists, cognitive psychologists and computer scientists, and advanced hardware. Today Virtual World technology opens up entry into the development of social simulations at a small fraction of the cost to designers and requires minimal technology or technical expertise.

2. Social Simulations

Simulations of fictitious and yet engaging and thought provoking experiences are particularly relevant for learning how to behave in social situations. Simulations of social situations have great potential to be applied to many of the social problems that we find in society and organisations. For example, training a call-centre operator how to deal with an angry customer, a supervisor how to resolve an argument between two employees without taking sides, or a busy manager how to prioritise and rearrange tasks and meetings in a typical day of interruptions without becoming irate with your personal assistant. Social simulations can do more than provide experience and transfer current best practice; they may be used to transform current social realities. Thorngate and Tavakoli [78] note that simulations are conducted in order to form or change the beliefs and policies of policy makers. As a "rhetorical device" they become a "tool of social influence [78, p. 513].

The most common simulation method for learning about social behaviours is via role playing games (RPGs). Role playing games have been used for training in the workforce for decades. While in the past apprenticeships may have provided training over time through observation and hands on trial and error, role playing games allow the trial and error learning process to be sped up because the actors are playing or pretending and thus the risks and consequences of failure are much lower. RPGs involve a certain degree of imagination and often involve changing roles to get a better understanding of multiple perspectives of the same problem. At least until recently, the majority of social simulations did not involve a computer. For example, the non-computer based RPG developed by Sivasailam Thiagarajan [76] trains people to be facilitators, requiring a range of human social abilities such as empathic listening. A more common learning and social environment example is the foreign language classroom. In this situation participants are asked to leave their day-to-day reality and speak an alien, and for many participants, unnatural language. As part of learning the language they commonly take on roles that they do not have in real life and depending on the situation may never have. Sharrock and Watson [69] refer to such L2 (second language) simulations as reality construction and believe such stepping out of reality is natural as humans often choose or need to use our imagination in daily life. They found that participants were able to be someone in the simulation that they were not in reality by distinguishing between doing and being and the notion of role distance and detachment. They further note that participants were aware that they were playing a game and this awareness "gives the occasion a particular tone to establish, and maintain a certain attitude to the activities on hand; that is not to say the aims of the simulation are frivolous, but rather that they are not to be taken literally" [69, p. 198]. They found that practices and activities which result in "game realities" are also important and used in everyday activities e.g. 'are you ready to start?' to indicate when something starts. Such practices help us to frame the interaction just as a briefing activity can assist us to prepare and participate in the main activity. Sharrock and Watson [69] observed that people sought to create rules regarding how to behave in a simulation that they may follow in reality. They make an interesting point that simulations differ from reality in that reality 'occurs' or 'arises' but simulations are 'created'. Conversations and turn taking may be quite artificial in a simulation/game (or virtual world) using techniques such as setting time limits or closing the game down. They conclude that games and simulations are "phenomena in their own right" which do not have to match with "reality".

In the late 1970s, Richard Bartle and Roy Trubshaw of the University of Essex generated the first Multi-User Dungeon (MUD) to provide a platform for multi-player role-playing games to operate on computer networks [28], enabling people to create virtual realities cooperatively. Improvements in computer technology enabled further development of MUDs, leading to various human computer interfaces such as object-oriented MUDs (MOOs), Multi-User Virtual Environments (MUVEs), and massively multiplayer online role-playing games (MMORPGs) [25]. These technologies can more generally and collectively be termed Virtual Worlds (VWs). Many examples of serious applications of VWs can be found in education [25, 29], business [34] and health [62].

As many educationalists, organizations and researchers are finding (e.g. [22]), there are many potential benefits of using a Virtual World for social simulations. Virtual Worlds allow difficult situations to be safely explored. In the real world, a new employee might have to wait months for sufficient numbers to warrant being put through the necessary live training exercise. In contrast, a virtual training simulation may allow the user to get involved in a believable environment to test out their knowledge and responses and to learn appropriate responses at more convenient times and/or locations. A simulation system would allow an engaged couple to explore a number of different hypotheticals regarding their future which may be less costly and be seen to be less intrusive than using a pre-marriage counselor. The goal of such a system would not be to test if the two are compatible or that the relationship is likely to last, but to allow both parties to learn more about each other and themselves. Further, there can be less risk of embarrassment or social inhibition in a virtual world than in a live role play involving others with whom you work, study or live when VW participants are able to maintain anonymity while taking on a role, particularly an unfamiliar one.

In social situations involving decision making, unexpected events are common and the choices made are affected by the social setting and a person's emotions, personality and background. It is therefore important to include these elements if we want to use technology to assist with knowledge and skill acquisition in these areas. Due to the complexity of modeling human behaviours, MMORPGs avoid the problem of modeling human behaviour by using geographically dispersed humans to take on characters in the online game. Similarly, in MUVEs or VWs such as Second Life, humans interact with one another via their avatar/persona.

Learning social behaviours requires social interaction. However, requiring humans to play the roles in social RPGs, places limits on when such training can occur and relies on adequate knowledge and role-playing skills of the humans involved. Also, for experimental or other purposes which require careful control of the environment and situation factors, humans may be less desirable than an environment in which the variables are managed by the computer. Thus, we are interested in VWs which support intelligent social interactions between humans and computer-based non-player characters (NPCs) known as intelligent virtual agents (IVAs), embodied conversational agents (ECAs), artificial intelligences (AIs), or simply agents which challenge our goals and expectations for VWs.

Using agents within a VW to manage a training simulation takes advantage of their characteristics, including being autonomous, reactive and proactive and having social ability. An autonomous characteristic means that agents can operate without the direct intervention of humans. Reactivity means that agents can perceive their environment and respond in a timely fashion to changes that occur in it. Pro-activeness enables agents to not simply act in response to their environment, but be able to exhibit goal-directed behaviour by taking the initiative. Social ability means that they can interact with other agents. Agents are currently being applied in domains as diverse as computer games and interactive cinema, information retrieval and filtering, user interface design, electronic commerce, autonomous vehicles and spacecraft, and industrial process control.

In the area of social behavioural simulations we have found two main bodies of agent-based work: one that focuses on how to create characters or agents which exhibit social skills (discussed further in section 3); a second whose goal is the use of agents to teach the human how to behave in social situations (see section 4). However, using agents to simulate social behavior requires some reconsideration of the role that reality plays and challenges the definition of a simulation as a representation of reality. In the next section we explore the role of realism by considering the requirements and constraints to providing realism. In section four we look at how narrative allows the constraints to be relaxed. The final section concludes with future directions and challenges.

3. Dimensions, Goals and Limits of Realism

Virtual representations of real situations is a characteristic of games [20]. Due to the limits of providing realism in particular with respect to the characters within the virtual world, it is necessary for players/participants to imagine many aspects of the simulation and create their own reality, in much the same way as an immersed reader creates a reality which may incorporate a visualization of the place and characters unique to each reader.

Simulating social behaviour is more concerned with believability than realism. Believability seeks to develop affinity between the user and the character/s in the simulation. This is useful to increase engagement and satisfaction, factors that will enhance the simulation regardless of whether the goal is model exploration, experiential learning or leisure. Believability is closely tied to creating the illusion of life, not to be confused with something being lifelike or realistic. "By creating the illusion of life, dynamically animated agents have the potential to significantly increase the time that people seek to spend with educational software" [36, p. 70]. For over a decade there has been interest in creating animated agents with believable, lifelike qualities [9, 15, 33, 38, 45, 79].

Believability can be measured along two distinct dimensions: visual appearance and behaviour. Animators such as Bates [8] have long recognized that visual fidelity is less important than behavioural believability. Johnson and Rickel [36] list the following factors related to believability: situated liveness (the character appears aware of their environment); controlled visual impact (the extent of the movement/change); complex behavior patterns (simple behaviour is uninteresting and seemingly mechanical); natural unobtrusive behavior (like blinking or breathing). When the purpose of the simulation is learning rather than leisure, believability enhancing behaviours must be aligned to the pedagogic goals and thus they compete with one another for the right to be exhibited [39]. This means that we need to be careful what gains a student's attention and what will be remembered. Otherwise irrelevant aspects such as what someone is wearing might be noticed and the fact that they expressed sadness, relevant to learning appropriate social responses, is overlooked.

Loyall [42] has defined a set of characteristics of believable agents which includes: personality, emotion, self-motivation, change, social relationships, consistency of expression and the appearance of being alive as evidenced by being reactive, responsive, situation aware, and goal-driven. Additionally, many researchers see that a key to believability is embodiment requiring congruent body gestures, facial expressions, intonation, gaze, posture and language [19]. Lester et al. [39] discuss deictic believability which involves the agent being context aware and situated within the student's world and using that knowledge to behave using gesture, motion and speech in natural ways.

There is a significant body of work in the area of believable characters which may be known as pedagogical agents, embodied conversational agents, intelligent virtual agents, talking heads, empathic or listening agents depending on their function, level of sophistication or the particular research focus such as emotion and appraisal systems or language technology. Given the complexity of these agents and the large amount of research activity, there are number of initiatives which seek to draw this work together to enable researchers to focus on their key goals. Such initiatives include EU-funded SAIBA , eCIRCUS , LIREC2 , Humaine , Semaine ; US-based projects such as Virtual Human Toolkit , NECA , KSL's Inference Web (McGuiness and Pinheiro da Silva, 2004); joint EU and US projects such as COMPANIONS (Intelligent, Persistent, Personalised Multimodal Interfaces) ; and generalised intelligent agent architectures such as ION [80]. Many of these projects focus on issues relating to cultural awareness (e.g. [6]) and social issues such as bullying [5] and weight loss [14].

Creating a social simulation requires creating an environment and the characters who populate the environment. However, we can see that the majority of work on social simulations seeks to enhance the believability of the characters rather than the environment or devices/objects in the simulation. Furthermore, the work to date is concerned with expressing social capabilities that can be recognized by the human user. If we are only concerned with the human believing, potentially leading to experiencing the desired feeling (such as encouragement, sympathy or happiness) the creators of IVAs or ECAs only have to worry about the appearance or illusion of social ability, personality and/or intelligence. The much more difficult task is for social characters to be able to recognize the behaviours in another simulated character (or even a human) and to act accordingly. The following section considers how to move simulations to this next level of social capability.

4. Beyond reality: From character simulation to narrative educational simulations

In the previous section, we discussed the need for IVAs to depart from realism such as graphic fidelity in order to achieve a proper level of believability. Do these non realistic but believable characters need to evolve in a functionally realistic environment to achieve the pedagogical goals of the virtual world? Should the decisions of non playing characters strictly follow the rules underlying the corresponding model of human decision-making? Should the virtual world react to the user's actions similarly to the real world it simulates? In fact, we will show that even at the functional level of high level decisions, current trends of behavioral and social simulations indicate that the beyond reality perspective are already implicitly or explicitly adopted in these simulations.

At a first level, reality does not strictly need to be modeled, for pedagogical efficiency reasons. For example, suppose that the user is taking a risky decision in a simulation, for which, say, there is a 5% risk of catastrophic consequence. The simulation should not apply this probability but trigger the negative consequence with a much higher probability. This distortion of reality is not specific to behavioral and social simulations, but it is particularly relevant given the real-time nature of these simulations. The simulation would be inefficient and boring if it totally mimics the conditions of real people in real life situations.

A typical case however of the beyond reality perspective concerns narrative. The general principles of narrative-based simulations consist in structuring the interaction of the user with the virtual world as a narrative, instead of solely simulating the underlying physical, psychological and social model. It is interesting to note that several researchers who focused on pedagogical agents during the nineties (for example, [1, 40]) have progressively moved towards the narrative environments in the years 2000 onwards (for example, Klesen, et al. [37] and Mott and Lester [54], respectively).

Interactive narrative environments are intended to provide engaging interactions that are interesting and leave a lasting impression. For example, the virtual experience can leave the participant sad or even depressed in real life particularly if personal conflicts arise as in the case of Façade [49]. However, providing environments which are also fun serves a number of functions. Dormann and Biddle [27] review the role of play, humour and laughter. Humour is found to have a social function and provide relief from stress, tension and pressure in incongruous situations. In effect humour can be seen as an escape from reality. Within a game, humour can smooth, enhance intrinsic motivation and sustain game mechanics. We suggest that beyond reality characters (such as cartoon-like avatars lacking visual fidelity) provide humour just as we laugh at fools, ludicrous behaviour or appearance and when something goes wrong or unexpected happens. When it comes to teaching social skills, humour is particularly important as it can assist with social awareness, justice and political change by challenging norms and beliefs [27]. A beyond reality social simulation can particularly challenge norms and beliefs because it goes outside of them.

Narrative is going beyond reality in the sense that some events are triggered rather than others in order to satisfy narrative constraints such as "maintain interest", "create suspense", "increase identification with the character", "maintain balance between scenes, acts" etc. In considering why narrative principles should be used to structure and thus alter the realistic simulation, two main reasons are usually advocated, one is related to emotion the other is related to cognition [54].

From an emotional point of view, stories are engaging and potentially increase the motivation to initiate interaction and to continue interacting with the simulation. By increasing motivation, learning is facilitated. Dobson and Ha [26] note that motivating experiences offer aspects of challenge, curiosity, fantasy, and control. These are features commonly used to describe games. Furthermore, stories, by a process of identification, can trigger specific emotions such as surprise, disgust or anger [56], especially if they are conveyed in a dramatic form [18, 75]. These specific emotions can have a positive role in learning, as described previously in Section 3.

From a cognitive point of view, stories constitute a fundamental principle for acquiring and processing knowledge. Since the beginning of time storytelling has been used by humans to first acquire knowledge from and later pass knowledge to other humans. Stories not only are an important socio-cultural phenomenon, they are supposed to be the way people build their own knowledge. In his article entitled "the narrative construction of reality", Bruner [17a] considers stories as a unique way people structure their own knowledge. Laboratory experiments have shown that in a story, elements belonging to the main causal chain of events were better memorized than events not causally connected [32]. Thus, it is expected that knowledge acquired through stories are remembered and operationalised (put to use) more easily. In his book on narrative and intelligence which discusses the primacy of stories, Schank argues that "telling is remembering" [68]. This idea was applied into organizations in the form of narrative-based information systems (NBIS) which were offered as an alternative presentation mode to the user. Mason and Mitroff [48] appear to be the first to suggest stories as a presentation mode. Mitroff et al. [50] suggest that data only becomes information when "tied to an appropriate story that has personal meaning to the individual who needs the information, the organization in which he is located, and the type of problem that he faces". They call such a system a Management Myth-Information System. In Knowledge Management, the trend of Storytelling consists in using stories as the essential knowledge to be stored, used and manipulated through the use of sophisticated computer tools [71]. In the defense forces and emergency services, the notion of scenario-based, rather than story-based, training simulations such as MRE are well established. More recently we see scenario-based MUVEs, such as Quest Atlantis [7], River City [24], and Virtual Singapura [35], that are underpinned by a scenario and are more akin to a role-playing game than a virtual lecture or meeting room. These scenario-based VWs embed pedagogical content within the context of a story which provides the opportunity to greatly improve the retention of knowledge.

One of the first pedagogical interactive virtual worlds to be narratively structured was the multimedia title called Carmen's Bright IDEAS [47]. The pedagogical goal is to help mothers of pediatric cancer patients to solve their everyday life problems. The user plays the mother while a non player character is a counselor. The system is based on the simulation of agents who are able to dialog with each other via recorded sentences and who have and express emotions via facial expression and body gesture. One priority of the designers was to create a dramatic experience for the learner, in order to make learning more efficient. Therefore, the high level decisions of the agents are driven by a dramatic plot, initially created by a professional scriptwriter. In this system, the interrelationship between the realistic component (counseling methodology, emotional behavior, etc.) is mixed with the entertainment component, that is the narrative and dramatic writing. The beyond reality dimension is thus clearly expressed in Carmen's Bright IDEAS. However, the simulation is mostly used to generate appropriate events on the screen, not to process the user input. The actions of the learner are limited to a few choices in the story.

The Interactive Fiction genre [51], a very rudimentary form of VWs known as a textual world in which the user interacts by typing free text, has also been used in an educational context. In the game Stranded for example, the learner plays a school boy and needs to learn how to navigate through a library in order to find his way home [10]. Interactive Fiction contains simulation elements, although the story is mostly determined in advance by the series of enigma that the learner has to solve.

In the interactive virtual world called Crystal Island [54], the learner is immersed in an island where a mysterious disease has appeared. She has to investigate to find the origin of the disease. On her way, she learns several concepts concerning microbiology. Contrary to the previous example, the range of interaction is quite large. The island is itself a simulated 3D environment, where the user can navigate, meet other characters, ask them questions, conduct experiments to check her hypothesis, etc. The challenge of these simulations is that even if there exist several paths that are efficient in terms of learning, there is no guarantee that the learner will find one of them. Often, she will be lost, stuck, or reach the story goal but avoid significant learning parts. Guidance is needed, and researchers seek to provide automated guidance, without human intervention during the simulation. In these systems, guidance is given inside the diegetic world, either via physical changes in the world (a zone is made inaccessible, an object is put in a drawer to help the learner, etc.) or via non player character intervention. Thus, the guidance seems to be part of a realistic simulation of a digital world, but it is not: the simulation is biased by pedagogical goals, or narrative goals or both. In Crystal Island, a story is defined by several significant events, that are partially oriented, forming what is called a plot graph [53]. Because the order is partial, there is a lot of possible variation in the final order. Furthermore, events not in the plot graph are inserted in the user experience, because the user is creating his own events in the simulated environment. The storytelling engine intervenes to decide which events from the plot graph to inject and at which moment. This decision is based on the realistic rules of the environments (otherwise strange behaviors might occur) but also according to narrative constraints such as the plot progress or the narrative flow (the fact that the story is not constantly jumping from one topic to another). In that case, it is considered that the learning goal is achieved if the story ends, via the structure of the plot graph. In order to allow for more variability in the plot, it is also possible to define the pedagogical goals and narrative goals within an automatic planning system, so that the events are recalculated on the fly, according to the user's action. This possibility is investigated in Crystal Island [54].

In the two previous systems a story was designed by predefining story events along with ordering conditions for these story events. In contrast, the approach followed in the FearNot! Project is based on unscripted characters [3, 4]. FearNot! is aimed at assisting school children to identify and handle the social dilemma of bullying. By engaging with the cartoon characters in FearNot! students can recognize when bullying is occurring and test out alternative strategies for dealing with it. Characters are based on the latest research in artificial intelligence and human modeling. They use a precise cognitive and emotional model of human behaviour. It is expected that from the interaction between these complex characters emerges a global story, without any central management of the story. It could be expected that this approach, often referred to as narrative emergence [2], adopts a realistic view of simulations in which the "beyond reality" perspective is absent. However, the narrative emergence approach is faced with the issue of producing ineffective stories, both at the narrative level and the educational level. At the narrative level, narrative emergence only occurs occasionally. Indeed, in the typical case of narrative emergence used by Aylett [2], the football match, many sequences are not narrative, only some of them are. To solve this, at least partially, a solution consists in choosing goals and situations appropriate to trigger interesting dramatic events. Such strategies are effectively in use in RPGs and reality TV, and the design of unscripted characters has been inspired by these types of non digital participative drama [41]. This strategy might not be sufficient however to guarantee that proper educational goals are reached. As Aylett and colleagues put it: "This is like the real world, but an educational application is more constrained than the real world" [4]. The solution has to be found outside the actual simulation of characters, in the "Stage Manager", responsible for initializing autonomous episodes. In another publication related to the FearNot! Project [31], this stage manager explicitly includes some form of explicit narrative control, since each episode is triggered when some conditions are met, and scripted sequences of events are also inserted. In other words, the reality view of characters is combined with a "beyond reality" view of drama management.

The same issue of combining pedagogical goals and realistic simulation has been the focus of IN-TALE [65]. IN-TALE is a training system for soldiers to acquire skills such as cultural awareness and decision taking in missions involving interaction with foreigner civilians. The system is composed of two subsystems. An experience manager ensures that a relevant story is generated during the interaction. The relevance of the story, defined in terms of narrative and pedagogical quality, is specified by both an exemplar story, that is a story written by an author as a satisfying sequence of events, and a set of specific states that must be reached during the experience. Because of interactivity, the exemplar story is rarely followed. An AI-based planning mechanism is then used to generate a new sequence of events that reaches the final outcome of the story while guaranteeing that the specific states mentioned above are reached during the experience. Such a re-planning mechanism replaces the branching narratives and enables more interactivity, compared to a system such as Carmen's Bright IDEAS [47]. The steps calculated by the experience manager are then sent to a set of intelligent computer agents who are responsible for finding a plan to fulfill the goal corresponding to the step. The characters can use their own personality and repertoire of actions to execute their behaviors, leading to greater realism and variability. Note also that some actions that they might perform are blocked by the experience manager, in order not to deviate from the current planned story.

The two components of IN-TALE, the set of intelligent characters and the experience manager, correspond respectively to the realistic and beyond reality perspectives discussed in this paper. As in FearNot!, a pure simulation reality-based approach, with only a simulation of characters, would not achieve the pedagogical goals while a purely directed approach, with the experience manager only (e.g [81]), would not offer life-likeness.

These few examples of narrative-based interactive learning VWs clearly illustrate a tension between reality (realistic simulation of characters' behaviors) and beyond reality (experience driven by narrative and pedagogical constraints). However, it seems that the way these two dimensions are combined will be subject to much improvement in the future. We envision narrative simulations where characters' behaviors and higher level constraints management (narrative, pedagogical), instead of constituting two hierarchical sub systems, would be more interwoven, as suggested in [73].

5. Challenges, Trends and the Future

A model is by definition an abstraction and/or representation. The limits of the model will impose limits on the level of reality that are captured and demonstrated in the model. We note that when learning is the goal of the simulation the lack of fidelity with the real world combined with the user's belief and sense of immersion in the virtual world poses issues for knowledge and skills transfer and can even result in disaster in the real world (e.g. plane crash). Currently, to counter the gap between the simulation and real world, debriefing is a common strategy so that the differences between the real and artificial worlds are made explicit before the new skills and knowledge are put into action. Likewise, briefing and debriefing strategies will be essential for social simulations to ensure appropriate transfer of knowledge and behaviours to similar real-world social dilemnas. Where social change is the goal, adequate preparation and consideration of the issues before hand and reflective post-activities will probably be more important than the actual simulation in the Virtual World.

Bizzocchi and Woodbury discuss the "basic contradiction between a state of narrative immersion (the classic suspension of disbelief) and the process of interaction" [14a, p. 550]. In narrative what is sought is a willing, and in that sense active rather than passive, surrender to the world of the story in which the reader/viewer "ignores the objective reality of the conditions of reception". On the other hand, interactivity concerns choice and control. While in a book the reader controls the story by choosing to turn the page, in an interactive narrative the level of interaction and expression of choice is central to the experience. The conscious act of reviewing and making a choice leads to inevitable disruption. The consequence of this dilemma is an imperative to carefully design and evaluate appropriate user interfaces that provide a level of interactivity that will support the desired level of immersion and even reconsideration of whether interactivity is actually necessary to achieve the desired learning effects [62]. Mimicking reality becomes less important and allows the design decisions to consider options beyond reality.

In the future we will see the notions of beyond reality extended. Hybrid reality and location-based gaming combines elements of reality and virtual reality blurring them together [23]. Through the use of GPS systems and real-time mobile systems, players can move about and actually see other real players, not just as a character on the screen, in real time and space. This is a very different scenario to playing an MMORPG with a group of individuals who have selected a persona and virtual/fantasy location. Merging game space with serious life activities raises interesting security, anonymity, privacy and safety issues [23]. In an online game there is safety in anonymity. Often in such situations, rather than reality we would prefer to have a pseudo-identity to put on or switch off as we choose. Hybrid reality raises issues of the relationship between play and serious life and merges imagination (the game narrative) with real spaces. For example in reality you can't be two places at once, but with hybrid reality you can. Hybrid reality "challenges the way we understand trust and safety in today's society" [23, p. 18].

The lack of distinction between the game and reality also exists in pervasive learning games and is what Thomas [77] calls hybrid educational gamescapes. Thomas refers to classic works (e.g. Huizinga) on play which see play as separate to reality. Unlike in real-life, traditional games start and stop and were restricted to certain spaces. However, pervasive learning games can change this. Thomas [77] believes that in order to be successful, pervasive scenario technology must recede into the background and not require attention. As for interactive learning narrative, in which immersion is disrupted when interacting, the learner must be aware of the fiction when interacting in pervasive environments. We can expect that in the future we will see more pervasive, ubiquitous and ambient learning with less distinction between game reality and mixed/augmented reality.

To provide simulations which train humans for social situations, improvements are needed in human-computer interaction. The work on empathic agents (e.g. [44, 55, 57, 58]) is relevant and found to deliver improved interactions. Another emerging area is the notion of listening agents in recognition that IVAs need to do more than passively sit or stand when a human user speaks since listener behaviour will impact the speaker. Maatman, Gratch and Marsella [43] note that current speech understanding systems are limited because they are unable to process and respond to input until the utterance is complete. Listener behaviours such as head nods, gaze or random movements are common but can result in misinterpretation by the human. Maatman, Gratch and Marsella [43] have implemented a number of rules based on behaviours of human listeners such as backchannel continuers (confirmation of communication), disfluency (e.g. repetition, pauses), mimicry of speaker behaviour which was found by observers in an evaluation study to produce more autonomous and natural IVAs. Similarly, Bevacqua et al. [13] have developed a system which computes listening agent behaviour in real-time.

While we agree that listening behaviours are important for authentic human-agent interactions the focus in this body of work is on simulating believable behaviour, rather than actual understanding of what the human is saying. Such approaches re-open the debate on whether AI technologies should/could replicate human behaviours or simply mimic them. With respect to social simulations the position taken will depend on the goal/s; is the system seeking to model the real world so that what is modeled is better understood; is the model/simulation seeking to provide an experience; or is the simulation seeking to change current (perceived/accepted) social reality?

In an article concerning the ethics of social robots – emotional agents, Becker [11] warns that viewing social robots (such as humanoid robots and emotionally embodied agents) as independent actors is "highly questionable" and anthropomorphisation of such agents is "irrelevant". Instead, Becker suggests that instead of viewing

> virtual agents, ECAs and robots as human-like interaction partners … they could take on specific tasks with a relational behavioural concept, which would accord them an empowerment to act which is limited to this task. This would do justice to the potential of these supposedly "intelligent" artefacts while allowing their limitations." [11, p. 44].

A key open issue for systems involving interactive drama is authoring [17]. This issue includes the need for intensive effort and specialist involvement, the need to find a representation that is sufficiently expressive and a means to manage control and flow of the storyline. Computer based stories require not only creative story writing ability but also technical skills. To create a visually rich environment inhabited by intelligent agents that behave in ways similar to humans requires the effort of many specialists from numerous disciplines. How will the classroom teacher be able to put their knowledge into such complex learning environments? Perhaps something similar to expert system shells which were developed to allow domain experts to enter and maintain their own knowledge as a means to address the knowledge acquisition bottleneck is needed. We have offered two alternative approaches targeting this issue: one which enables the trainer/teacher to create numerous alternative training scenarios by modifying a base scenario by changing selected characters, dialog, objects and actions (Richards and Taylor, 2011); the other allows knowledge to be captured as the trainer experiences a scenario as a means to tap into their tacit knowledge as they exercise knowledge-in-action (Richards and Taylor, 2010). These approaches offer initial and simple solutions to this complex issue by reducing authoring and knowledge acquisition to modifying the story or the domain knowledge in the context of the situation on hand.

Within the virtual and embodied agents community there is currently particular interest in advancing the technology to support cultural and social-based applications as evidences in the focus in 2011 on Language and Culture. VWs have the potential to bring about social change because they allow us to encounter different people and situations to what we may have access to in real life. In ORIENT (Overcoming Refugee Integration with Empathic Novel Technology) a mythical planet populated by Sprytes, contact theory, the idea that inter-group prejudice can be reduced through contact between the groups under specific conditions, and Bennett's [12] Development Model of Intercultural Sensitivity, are used to change the attitudes of 13-14 year olds to their refugee classmates [6]. Changing the attitudes of the majority population is a radical alternative, and complementary, solution to running induction programs for the newcomers. Creating a beyond reality virtual world inhabited by fantasy aliens, allows the issue of cultural differences (such as attitudes to hierarchy and use of culture-specific symbols and rituals) to be explored without prejudicing, restricting or needing to characterize a limited and defined set of actual cultures. This work clearly goes beyond reality but in so doing allows reality itself to change. In the future we will increasingly see IVAs and computer-based companions, used in place of humans to help us, for example, quit smoking, lose weight, be environmentally responsible and learn about our neighbours as they can be less confronting or judgemental and more fun and reliable than the real thing. However, while these IVAs and the VWs in which they live will become sites for social and cultural innovation, they will succeed in bringing about positive societal change only if they are able to embody what makes us human: being able to reason, feel, communicate, empathise and live in community with one another. To achieve this, research must continue.

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6. REFERENCES

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