ABSTRACT
As people interact more often with virtual environments, such as, for example, computer games, there has been a focus in the study of new ways to improve the user's interaction experience. One of the important factors for a successful experience is the believability of the social context of the environment. This can be achieved by having people interacting with other people (e.g. multi-player games) but this is not always possible or is even not the best solution in some cases. Thus, in many environments, users interact with autonomous characters. There has been much work to make these autonomous characters believable, but it is usually focus on the believability of the characters by themselves, and not in their believability in a social context, which translates into poor social environments, failing to attain a social “illusion of life”.

We believe that by giving to characters the ability to have deeper social interaction, not only between the user and characters, but also amongst characters, the user’s interaction experience could be improved. We propose a model to enrich such social interactions centred on the possibility of the agents to establish social relationships among themselves. Furthermore, we present a case study with a game that takes place on one of the most common scenarios of a Role Playing Game, a market, where our model was used to assess its effects on the user experience. In addition, we present the results of an experiment conducted with this game that showed that the suggested model has a positive effect in the users’ gaming experience.

Keywords
Social Believability, Social Behaviour, Relationships, Personality, Memory, Theory of Mind, Conversation, Information Transmission.

1. INTRODUCTION
As virtual environments become more and more popular and more people interact with/in them, researchers started to focus on how to improve the interaction experience of such users. This can be achieved by enhancing the believability of the environments.

There are several dimensions of believability to be considered, the work here presented has focused on one that has been particularly neglected: the social believability. For example, in game industry the focus has been higher on the creation of graphically believable environments, and only in recent years the industry started to focus on the creation of autonomous characters, as it starts to become the differentiating factor between games. This has been crucial in games such as Role Playing Games (RPGs). Two recent examples of games that have started to focus on creating believable characters are Fable [11] and The Elder Scrolls IV: Oblivion [4].

Nevertheless, although there has been an effort in creating believable characters, these characters are only individually believable, thus, not creating believable societies, which constrain the believability of the environment since there is no social “illusion of life” [3]. Even though there is interaction between the agents, it is very shallow. On the other hand, one could say that if we want extremely believable social environments, we can already obtain them in applications like Massively Multiplayer Online Games (MMOGs), which are games played with hundreds or even thousands of persons at a time. However, we believe that there will always be the need to have socially rich agents not only in simpler applications (e.g. single player games) but also in MMOGs, since fully human worlds can create situations that degrades the experience [5]. For example, players do not want to perform minor roles in a RPG environment (e.g. being the gate keeper, or a merchant).

We believe that by enriching the social capabilities of the autonomous agents, for example, by giving them the ability to relate with others and by using these establish relationships to influence their behaviour in the environment, the user experience can be improved.

In this paper we present a model that was developed to give the capability to relate with others to autonomous agents that can take the role of non-player characters in games such as RPGs. The model defines, apart from the concept of relation, a simple theory of mind, a model of conversation and a model for the transmission of information among agents. The idea behind is that non-player characters in RPGs interact with users, mostly to give them information about the game world. We believe that having the social context (e.g. the social relations) influence the way the information is propagated is a good method to improve how users to better understand the context (e.g. how they identify the relations established by the characters.).

This paper is organized as follows. First we will present the state of the art, followed by the proposal of our conceptual model. Afterwards, we will present the case study’s scenario followed by the user evaluation with this same scenario and the respective results. Finally, we present some conclusions and future work.

2. STATE OF THE ART
The issue of creating social believability and relationships in autonomous agents has already been considered by some authors. Usually their work focuses on one of two views of the problem: the user-to-agent interaction and the agent-to-agent interaction.

User-to-agent interaction has the objective of creating characters that look and fell more real when they interact with the user. Frequently, researchers look at other sciences, such as, psychology, to duplicate characteristics like personality and emotion, in order to make agents feel more alive to the users [3].
Agent-to-agent interaction began by focusing on the communication between agents [8], usually associated with simple tasks like trading agents – which started to get some attention from the community with the generalization of the Internet. Only recently researchers started to take a bigger interest in more complex agent-to-agent interaction, where the believability of the social interactions between every agent is important.

Furthermore, since we are focusing our work in multi-agent real-time systems the interact with users it was only natural to analyse some computer games that have an interesting work on AI, especially Role Playing Games, where the social dimension of the player’s experience is very important. We present two games – Fable [11] and The Elder Scrolls IV: Oblivion [4] – that, from the games reviewed, are the ones that have considered more carefully the creation of rich social interactions between characters throughout the game.

2.1.1 Avatar Arena
Avatar Arena [22] is a system in which a task is delegated to an autonomous agent (i.e. character). The task in this case is a negotiation between the characters (i.e. avatars’). The idea was to create a system that resembled a human-human negotiation, in which not only rational argumentation but also the social context and the personalities of the negotiating parties need to be taken into account.

The authors focused on how social relationships could impact a character’s behaviour.

This system uses Heider’s Balance Theory [9] and Festinger’s Theory of Cognitive Dissonance [7]. It creates a Theory of Mind, which means that one agent has some beliefs about another but also creates a mental model of what s/he thinks that are the beliefs of the other. Then the relationships are adjusted towards the idea of balance.

The personality is based on the Five Factor Model (FFM) [15], using three of its dimensions: Extraversion and Neuroticism, because they claim that are found in most of the psychological theories, and Agreeableness.

2.1.2 PsychSim
PsychSim is a multiagent-based simulation tool for modelling interactions and influence among groups or individuals [19].

Error! Reference source not found. It is based on the fact that the message exchanged between two agents, like in human communication, depends not only on its content but also on the way we see our communicator. Therefore, our actions take into consideration our view of the communicator and also the reaction we expect from her/him. For this reason the concept of Theory of Mind takes a central role in this application and is further explored compared to Avatar Arena.

2.1.3 Social Role Awareness
Social Role Awareness was the work of Prendinger and Ishizuka [18], in which they propose that animated agents should have a notion of social roles when interacting with other agents, and adjust their behaviour accordingly.

Humans do not act always the same way; they choose their actions according to their personality but also to the context where they are inserted. For example, a secretary may address the cleaning woman in a whole different way than she addresses her boss.

The goal of the authors work was to create autonomous agents that would be much more interesting conversational partners for language conversation training.

These agents have a standard theory of reasoning about emotions – the model of Ortony, Clore and Collins [17], also known as the OCC model – and a simple model of personality. They implemented Moulin and Rousseau’s [16] approach to model and simulate conversations.

As for personality, they considered only two dimensions from the FFM model – which according to André et al. [1] are essential for social interaction – to keep things simple: Extraversion and Agreeableness.

The core of the authors work is basically a social filter. Before choosing a particular action (e.g. express an emotional state), it will go by the social filter and will determine the agent’s behaviour based on her/his personality and social role.

2.1.4 The µ-SIC System
The µ-SIC System [13] was developed as a part of a bigger project, an Agent Architecture for Proactive Persistent Non Player Characters [12], where Mac Namee and Cunningham propose an approach for agent architecture.

The µ-SIC System is a social module that consists in an Artificial Neural Network (ANN) responsible for determining which interactions an agent should choose when engaging with another agent.

The µ-SIC System uses three psychological models: Eysenck’s personality model [6], Lang’s mood model [10] and the relationship model which has its psychological basis on the work of Wish et al [23].

The µ-SIC System was the first work analysed that focused specifically on computer games (i.e. more intensive applications, with many agents interacting in real-time).

2.1.5 Demonstrate!
In Demonstrate! Rhalibi, Baker and Marebi [21] create an agent architecture that would be able to represent teamwork dynamics through the representations of emotions, beliefs, and relationships.

The authors’ architecture was based on Abraham Maslow’s Hierarchy of Needs [14], and was then used to develop a game entitled Demonstrate!, which consists in a political street demonstration.

The agents’ emotional reasoning was based on the OCC model [17], and their interactions and relationships were modelled based on the Iterated Prisoner’s Dilemma [2].

2.1.6 Fable
Fable is an action RPG developed by Lionhead Studios [11]. To represent the relationships between the user and the characters (i.e. agents) in the game, a love/hate axis is used, which will balance towards each side depending on the actions we choose.

However, these relationships do not influence the story of the game, and it is basically only important when we are trying to get a wife, which also will not have a major influence in the user experience.
It is clear that the user is an “especial character” in the eyes of the other characters, since they are hugely influenced by her/his presence. If the user is around, the characters will talk about the user and even stop doing tasks and give her/him their full attention.

The character-to-character interactions are simulated in some situations, like in the case of conversations spawned between characters, however these conversations do not transmit a notion of relationship between them. The case that better transmits relationship between characters is the fact that some of them live in the same house, although even in that situation the interactions are very limited.

2.1.7 The Elder Scrolls IV: Oblivion

The Elder Scrolls IV: Oblivion is the fourth chapter of this saga released by Bethesda Softworks [4]. In Oblivion the user-to-character relationships are not that strong. Basically we only notice them when we do something that a character disapproves, like stealing from her/him, although there are some problems in these situations, since the character may start to get upset or even call the guards if s/he sees us stealing, but if we start a conversation with her/him, s/he will treat us just like nothing happened – there is no social context when in conversations. With some luck we can even break into a character’s house at night and start having a conversation with him/her without like nothing happened.

In the case of character-to-character interactions, it does also simulate conversations, however, it does something more interesting that in the case of Fable – it permits the user to eavesdrop on conversations that the characters are having, although these seem very shallow, usually explicit tips for the user, not seeming that the conversation is relevant to each of the characters. Anyway, characters do not establish explicitly relationships.

2.1.8 Discussion

By reviewing other systems we have found some very interesting ideas, namely ideas around how to represent personality and relationships, and how the concept of Theory of Mind is important for social believability. Taking a look at computer games we see that they are making an effort to create user-to-agent relationships, but still lacks interesting agent-to-agent relationships.

3. CONCEPTUAL MODEL

There is still much to be done to attain believable social behaviour in virtual environments in general and computer games in particular. As mentioned in section 1, we propose to improve the social interaction of autonomous agents by introducing relationships between them.

However, we consider that there have to be some additional concepts to help create rich social interactions between the agents: personality to obtain individual believability, memory to retain information from their interactions, theory of mind to be able to have a mental representation of each agent, conversation to be able to communicate with each other, and information transmission to propagate information.

In figure 1 we can see a representation of a character, which contains the concepts of personality, memory, relationships and theory of mind, and how they are connected.

Figure 1 - Representation of Character A.

The conceptual model proposed is not meant to accurately map social behaviour such as humans have, but it is a model to see if just the basis of this social behaviour will have an influence on the user’s experience. If users prefer a system with this basic social behaviour, the next step is to expand this model, especially in terms of creating dynamic social behaviour.

Although it is not the focus of our conceptual model, we believe that this model also allows for the creation of non-linear events, since that if we change some of the parameters (e.g. relationship between two agents), we will have a different set of events. For example, if we have two agents that love each other, one objective could be to ruin their relationship, or if they hated each other the objective could be to bring them together. It would add a much bigger replay value to the users, since the experience could vary much more each time.

However, such a system or emergent behaviour would have to be carefully analysed, since it could, for example, ruin the storyline in a game; if the main storyline was that the user had to protect the princess, and we decided to make every character with the ability to kill the princess, such a system would have to constrain any assassination attempts to situations where the user would have the ability to stop them.

In the following sections we will explain all these concepts and why we believe that all of them are necessary to improve social behaviour.

3.1 Relationships

We consider relationships the most important concept because it represents the characters’ social connection with each other, it influences how characters interact with each other, and without them there is no believable social behaviour. In games we only have a glimpse of relationships in scripted events, like cut-scenes, which, besides being pre-defined, are scattered along the story and do not create a continuous social behaviour.

Some of the recent games try to give a notion of relationships. One common case is characters living in the same house, although we do not see behaviour such as the man, which we assume that is the husband, kiss the woman before going out.

For the representation of relationship we consider a simplification of the relationship model proposed by Wish et al [23], which may be extended in a future version. We only considered one dimension, Likes/Dislike axis, since we consider it to be one of the most expressive and easily understandable dimensions. A high value in this axis can be easily understood as a positive relationship between two characters (i.e. A likes B), and the opposite for a low value. We acknowledge that only this axis is not sufficient to accurately map the gamut of relationships, but our focus at this moment is not to accurately map relationships but instead to see if a minimum of relationships will affect the user’s experience.
Our implementation of relationships has Heider’s Theory of Balance [9] as a basis, in which the relationships are a ternary association between two persons and a concept. This means that when interacting, not only the character’s relationship with the other character s/he is interacting with matters, but also the relationship with the concept of the conversation (e.g. a third character that we are talking about). For example, if John is asking Peter if he knows Mary, Peter’s answer will depend on his relationships with both John and Mary, and if he likes both of them, he will tell John who is Mary and where he can find her, but if he does not, he might omit some facts, like where she can be found.

3.2 Personality
In real life, not everyone acts or reacts the same way. For example, if a bully starts beating up a kid in school, it is not sure that everyone will back off or stay and see the fight. Some might also engage in the fight, others might go and find help. Furthermore, not everyone will see the event the same way, some will stay on the bully’s side, some will stay on the victim’s side, and others will not even care about the incident. Of course there are other factors that influence where we stand, but our personality is at the core of how we might react in a given situation.

Also in games, personality is one of the main differences between the primary (e.g. plot/quest related) and secondary characters. It is not common to find the same personality that a primary character has on another character, but the personalities of secondary characters appear quite often replicated (e.g. all the merchants have the same personality).

This means that the personality is the core of our individuality, and to create believable social behaviour, we need to create believable individual behaviour, which has its basis in personality.

We based our concept of personality on a simplified version of the FFM [15], only considering one of its dimensions, Agreeableness.

We chose only this dimension for the same reasons that we chose only one dimension for representing relationships, we want a dimension that is easy to understand and measure (i.e. a higher Agreeableness value represents a friendlier personality, and a lower value represents the opposite), and because our focus is not accurately represent all of human personalities, but see if just by adding a simple notion of this concept, the users will believe that their experience is improved.

We do not consider that only this dimension is suitable for representing personality, and we believe that it would have to at least include the dimensions present in Eysenck model [6], Extraversion and Neuroticism, since there seems to be a consensus that they are fundamental in implementing relationships [1] [13] [22].

3.3 Memory
The memory is a concept that serves as a support for all of the other concepts, except for personality, and it works as a repository of information. Each character has its own memory, and populates it with the information learned from the world and the other characters (see section 3.6).

The information stored in the memory can be searched and new information deduced. For example, if we have a representation of a character (e.g. name, age, gender) that contains a reference to a profession, we need to be able to go from that character’s info and get to the character info of all that have the same profession.

The individual memory is important because it reflects the way agents interact with each other. For example, if we talk with a person we will remember her name, and when we see her again we will remember that we have already talked to them, we remember past conversations, which are not isolated events. Thus, agents create a mental representation of the others, which we will explore next.

3.4 Theory of Mind
An agent has a theory of mind when it is able to have a mental representation about other agents’ beliefs.

In our conceptual model we use a theory of mind with a single level, which means that characters have beliefs about the other characters’ beliefs (see figure 2). For example, we may believe that Peter likes Mary.

![Figure 2 - Level 1 of Theory of Mind.](image)

We don't include deeper levels of theory of mind, e.g. A believes that B believes that C believes, since a single level is enough to use Heider’s Theory of Balance [9], one of the main mechanisms to create the believability of the agents’ relationships.

We are interested in using theory of mind in each character for her/him to keep information about the other characters and their relationships, and also information pertinent to the context to which the characters belong.

3.5 Conversation
Conversations are the simplest way to transmit information from the characters to the users, however we propose that this concept is extended to all characters, allowing for conversations between the agents. We consider that a conversation implies the transfer of information between the characters (see section 3.6), since it will allow for the propagation of information throughout the virtual world, which will create emergent behaviour.

We consider that a conversation is a group of messages exchanged between two characters, which provide a flow of information between them (the information may be something as simple as two characters saying hello to each other).

A message has the following fields:

- Sender – who sent the message;
- Receiver – to whom is the message;
- Performative – what kind of message it is;
- Text – the text shown to the player in-game;
- Object – an object associated with the message.

Some of the fields are self-explanatory, like the sender, receiver and text.

The performative is a way to tell what is the meaning of the message. For example, one performative could be “buy-item”; when received, the receiver would know that the sender wants to buy an item from him.
The object is the “focus” of the performative. Sometimes, the performative focuses on an object, which can be an item, a place, a character, information, etc., and we must have a way to convey that information in our message. Taking the previous example, the object of the performative “buy-item” would be the name of the item that we want to buy.

The conversations also have to allow the initiation to be made by a message with any performative. For example, when addressing to a merchant we could start a conversation by greeting the merchant, or skip that part and tell him right away that we want to buy an item. It is important to allow a conversation to start anyway we want, because this kind of behaviour also has an influence on the relationships between the characters (e.g. if we do not start a conversation by greeting someone, we might be seen as being rude).

Messages can be grouped and sent together. If messages are sent only one at a time, alternating between each speaker, it is an action-reaction system, with the second speaker being a passive element. By allowing to send two or more messages at a time, we are able to create situations like A asks B about X, and then B answers about X but also asks Y to A (see figure 3).

A conversation also has to maintain a context, which may be something just as simple as the history of messages during a conversation. When a character is talking, s/he will take into account not just the message s/he just received, but also messages received previously during that conversation.

Finally, we believe that this is not a final approach to conversations. We believe that this concept should be extended at least to provide two additional features: multiple character conversations, and the ability to eavesdrop on conversations. The multiple character conversation is not just to be able to have conversations between three or more characters, but also being able to intrude on conversations. For example, two characters are talking and we start talking to one of them, which will introduce us to the other interventen.

The eavesdropping feature is simply the idea that any character, not just the user, will be able to hear conversations, in which they are not taking any part of. This feature is already present in some games [4], although only the player can eavesdrop on characters.

3.6 Information Transmission
Information transmission is the main reason to make all the characters have “real” conversations, instead of just creating an illusion that a conversation is happening (e.g. two characters facing each other and making some facial animations).

In conjunction with the fact that every character has its own memory, this will allow for the information to flow in an emergent way through the virtual world. The only way for a character to know something is if s/he is present when it happens, or if another character tells her/him in a conversation.

We propose that the information transmitted should be based on the personality, the relationship with the receiver of our message and the relationship with the object (which can be a concept, an item, a person, etc.) of our message (see figure 4).

![Figure 3 - Conversation between two agents.](image)

![Figure 4 - Constrains of information transmission.](image)

However, we need to take into account that our model is designed specifically for games, and this means that there needs to be a simple way for game developers to define what information with each combination of these variables. To resolve this problem, we propose that the three variables are transformed into two in order to be able to map them in a two-dimensional graphic that is easy to visualize and define. The two variables are the personality and the sum of both relationships (see Figure 5).

![Figure 5 - Personality vs. Sum of Relationships plot.](image)
Table 1 - Possible combinations of the sum of the relationships.

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<th>Likes (1)</th>
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<th>Dislikes (-1)</th>
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For example, if character A is talking to character B about character C, and A is friendly, dislikes B and is neutral towards C, the information transmitted will be the one that is returned from the pair (friendly, dislikes), since the sum of both relationships returns dislikes.

4. CASE STUDY: ZION’S MARKET

In order to test our proposal we developed a small game that takes place in a market.

The user had a malfunction in her/his shuttle and crashed on planet Zion, and s/he has to get some items to repair her/his shuttle. In order to complete this task, the user has to find a mechanic to tell her/him what items s/he needs, buy the items from the merchants, and then hire the mechanic to repair her/his shuttle.

The game has six autonomous agents (i.e. characters), three are merchants, one is a mechanic, and the other two are customers just like the user.

The merchants and the mechanic are standing in their own stands waiting for customers. The two autonomous agents that are customers have the ability to enter/leave the scenario (through their shuttles) and trade items with the merchants.

To complete her/his objective, the user has to find out who is the mechanic, what merchants sell the specific items, and buy these items. All this tasks are done through conversations with each of the characters.

Figure 6 shows a screenshot of the game.

Figure 6 - Screenshot of Zion’s Market.

For example, if Patrick (i.e. one of the customers) buys items from John (i.e. one of the merchant), he will know what items he has. Patrick will create a mental representation of John, and if another character asks if he knows who sells the item that John sells, he will already be present. For example, in Figure 6 we see that the user this will not influence her/his actions but it will influence her/his dialog options (e.g. if a character told the user that s/he can buy an item from John, when s/he talks to John that dialog option will already be present). For example, in Figure 6 we see that the user started a conversation with the merchant John, and asked him if he knew who had energy cells. At this point the user does not know John’s name, since he did not tell him, but he did however say that he sells energy cells, which makes the “user’s memory” be filled with the information that this character is a merchant and that he sells energy cells (that is why we see the chat option to buy the energy cells).

However, the user also discovers three additional things: first, the merchant tells her/him that there is another merchant called Jeff that also sells the energy cells, which means that the user now believes that Jeff sells energy cells; second, the user now believes that John believes that Jeff has energy cells to sell; and third, that John dislikes Jeff (i.e. has a negative relationship with Jeff). We can also see a glimpse of John’s personality in his dialogs.

5. USER EVALUATION

This section describes the experiment that we conducted in order to test if social relationships could create a richer social behaviour in autonomous agents that could improve the user’s experience.

In this experiment we used the game Zion’s Market.

The evaluation was done based on a questionnaire that was given to the users with some questions about the existence and identification of the personalities and the relationships of the characters. The logs created from the interaction that the user had with the characters (e.g. number of conversations with each character, number of items bought from each merchant) were also saved.

The users played the game twice: one with the model here proposed and the other without (i.e. mimicking the way markets are usually done in games, each agent is not “aware” of the others).

5.1 Method

The evaluation was done with a total of twenty users. There was no time limit, the game ended when the user finished the objective of the game, i.e. hire a mechanic after buying all the items needed to repair the shuttle. The process was divided into 4 parts:

1. Users were given a version of the scenario to play;
2. Users were given a questionnaire to answer some questions about the version they played;
3. Users were then given the other version of the scenario to play;
4. Finally, users answered the same questionnaire but this time about the second version they played.
The whole process took between 20 to 40 minutes with each user. The version with which the users would start with was evenly distributed, with ten of them starting with version 1, which does not contain our model, and the other ten starting with version 2, which contains our model, having already played the game and answered the questionnaire when they had to play for the second time.

The limitations of version 1 were that the characters were not aware of each other; they did not know each other (i.e. have memory of each other), hence they did not have relationships with each other.

Before they started the experiment, the game’s objective was explained to them.

The users were not told which of the versions had the model. The questionnaire had a few questions about the personal information (e.g. gender, age), characters’ personalities (if they thought that the characters had different personalities, and what kind of personality was) and relationships (if they thought that the characters had relationships between them, and what kind of relationship was), and a question for them to rate the experience of each scenario. Finally, they were asked what version they preferred.

5.2 Results
This section presents the analysis of the data retrieved from the questionnaire and from the logs of each version of the game that the users played.

We identified that there was a big difference between the ratings that was given to each version (Z=3.207, p=0.001), with version 2 (with the model) receiving a mean rating of 3.45 and version 1 (without the model) receiving 2.85.

The questionnaires showed that 80% of the users preferred version 2. Of the users that play RPGs (a type of game with a very big social component, since the user needs to interact extensively with the agents in order to progress in the story), 82% also preferred version 2. One interesting fact is that 100% of the users that played version 1 first preferred version 2 (N=20, r=0.5, p<0.05).

We analysed if there was a significant difference between both versions. The results show that there is a significant difference regarding the existence of relationships in both versions (Z=-3.464, p=0.001), which we were expecting since it is the differentiating factor between the two versions. In version 1, 40% of the users answered that the characters had social relationships, although they would generally not remember which characters had them, nor what kind of relationships they were; approximately 93%, when asked what kind of relationship was, answered that they did not know.

In version 2, 100% of the users answered that the characters had social relationships between them.

There was also a big difference between the number of relationships they identified in the merchants and the mechanic, which makes sense given the fact that the users interacted more with the merchants (a mean of 1.59 conversations\(^2\) with each) and the mechanic (a mean of 2.25 conversations) than with the customers (a mean of 0.82 conversations with each).

It is also worth mentioning that the number of conversations between the user and the merchants is a bit higher in version 2, with 1.65 conversations with each merchant versus 1.53 in version 1. The number of messages exchanged between them is really much higher in version 2 (9.67 with each character, versus 6.33 in version 1), as it also was expected, since the users can ask information about the other characters.

We also found some interesting results, like the users remembering better the agents that had the personalities in the limits of the personality axis (friendly 65% and unfriendly 77.5%).

6. CONCLUSIONS
Clearly with the maturing of the computer games’ market, game studios start doing more elaborate games. Like with the progression of graphical quality, it is only natural that developers start to focus on areas yet to release their full potential, like in the case of character behaviour.

The purpose of this work is to test the hypothesis that if we enrich the social behaviour of the autonomous agents by implementing social relationships, the user’s experience can improve.

To test this hypothesis, a conceptual model was developed taking into account the concepts of relationship, personality, memory, theory of mind, conversation and information transmission. An implementation of this model was then used to develop a game that was evaluated by users.

The users played both versions of the game, one with social relationships and the other one without, and in the end 80% of all users preferred the version with social behaviour.

Although we believe that this could be the basis for more believable social behaviour, we also believe that much is still to be done. One of the main features that we believe to be missing is a dynamic mechanism for the creation of social relationships, currently they influence the behaviour of the agents but they do not change while they interact. We are considering the integration of rules based on Heider’s Balance Theory [9] and Festinger’s Theory of Cognitive Dissonance [7] for this purpose. These theories are based on the principle that the stability of the relationships is important, and when unbalanced, the people will re-evaluate their relationships in order to regain balance. The relationships would be affected based on events that can be performed by either the user or the agents, and the impact that these events have would be calculated based on the personality and the current relationships of the agents.

The addition of such a system would be especially suitable for trust-earning situations, like in the case of some games, where the user has to do some task to get some item/information.

7. REFERENCES


