# Chapter 1
# Virtual Worlds: Definition, History and the Elements that Compose Them

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## ABSTRACT

*This chapter presents an introductory overview of virtual worlds. Its purpose is to give the reader a basic knowledge about what a virtual world is. It also discusses some open issues that, from the author's point of view, should be taken into account when new virtual worlds, or new applications running over existing virtual worlds, are designed. The chapter provides a general definition of a virtual world, presents a historic review of these systems and describes the main features and elements that they are composed of. The chapter aims to be useful to the non-technical readers in that it shall provide a clearer concept of virtual worlds. In the case of technical readers, it attempts to be a reference for further research.*

## BUT, WHAT IS A VIRTUAL WORLD?

Nowadays, most people when ask what is a Virtual World is can give a more or less clear answer. This question prompts most to think about general purpose virtual worlds such as *Second Life*® or There, or perhaps game-oriented worlds like World of Warcraft.

In this manner, we think of concepts related to them, such as multiuser capabilities, sense of presence, etc.

But, the truth is that an universally accepted definition of Virtual World does not exist. That is, there is no existing agreement about the concrete features that compose a virtual world and, and therefore the characteristics that distinguish it from other applications. Instead of this, there are

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several existing definitions that maintain basic concepts but present little differences. In each of these definitions the group of systems that can be understood as virtual worlds changes.

Therefore, the first step in this chapter will be the review and study of different definitions of virtual words. Then, a definition that compiles the terms and concepts that specify a virtual world, as considered by this book, will be proposed.

Definitions of virtual world have evolved through the years, much in the same way that virtual worlds have also evolved. Perhaps, one of the first definitions that is closed to the modern concept of virtual worlds is the definition which was established by Klastrup in 2003 (Klastrup, 2003). From Klastrup's point of view, a virtual world is a persistent on-line representation that offers the possibility of synchronous interaction between users, and between the users and the world, in the frame of a space designed as navigable universe.

In the same year, Bartle (Bartle, 2003) defined a virtual world as an environment where their inhabitants are auto-contented.

Both definitions although the evolution of virtual worlds from 2003 should be highlighted do not take into account important aspects of current virtual worlds.

In the case of Klastrup, the representation of users in a virtual world is not specified. That is, presence and co-presence features in the virtual world are not reflected the fact that the user has the illusion of being immerse in the virtual world and sees the rest of the users immersed too. It could perhaps be deduced from the term 'navigable universe', but it is not clear. In the case of Bartle, the definition is quite general. According to this definition, a literal interpretation would class a videoconferencing system as a virtual world also.

More recently, other authors such as Castronova (Castronova, 2006) have defined virtual worlds as artistic spaces in the computer that have been designed to contain containing a large number of people. On the other hand, Spence (Spence, 2008) defines them as persistent, tridimensional and not game-oriented spaces, and he further contends that they are mainly social spaces.

Another case is the work of Schroeder. He distinguishes between virtual reality, collaborative features and virtual worlds (R. Schroeder, 2008). In Schroeder's point of view, virtual reality is a computer generated viewer that allows users to have the illusion of being in an environment different to the environment where they are and to allow them interact with it; collaborative features are the virtual environments, that he defines as environments where users experiment with other users as present in the same environment and interact with them; and virtual worlds as online persistent spaces.

These definitions establish some common characteristics such as presence, persistence in the world, synchronous interaction, etc. but keep a social focus about virtual worlds.

The vision in the framework of this chapter is somewhat different. It is true that these environments have had a strong social focus until recent years and in many cases it remains so. However, there is a current trend foreseen by different European technological platforms that study the Future Internet. With this trend, virtual worlds will grow in functionality and services (Eiffel, 2009). That is, they will not be only social or leisure places, but they will become portals for accessing general purpose services.

Following this trend, there are recent definitions that are more specific and are not only focused on the virtual world's social features. This is the case of the definition established by Bell (Bell, 2008). He defines a virtual world as a synchronous and persistent network of people represented by avatars and supported by networks of computers. Moreover, Bell explains the terms that compose the definition. These terms are those that characterize a virtual world from his point of view:

1. **Synchronous.** Refers to the concept of common time that allows people to perform

coordinated and collaborative activities. Moreover, virtual worlds offer spatial sensation, distance and coexistence with other participants.

2. **Persistence.** In the sense that the virtual world does not pause. It continues to exist existing when a participant leaves the virtual world.
3. **Network of people.** People are the focus of the virtual world. They participate in it, communicate between themselves and interact with other people and the environment.
4. **Avatar representation.** An avatar is a digital representation (graphical or textual) with ability to take action and is controlled by a user in real-time.
5. **Supported by computer networks.** Without this characteristic, a table game, for example, could be understood as a virtual world.

In this article, this definition has been taken as basis of the final definition. It is complete and contains a set of terms that characterize a virtual world in a form coherent with the understanding of modern virtual worlds.

However, nowadays the concept of entities that are represented in a virtual world should be extended. They not only should be persons but also intelligent software agents. An intelligent software agent tries to faithfully simulate the interactions and intelligent behavior of a human being. This feature turns it into a component that inhabits the virtual world in the same way as the users. In this manner, we propose a new definition based on Bell's one:

A virtual world is a synchronous and persistent network of inhabitants, being users or autonomous software agents, represented by avatars and supported by computer networks.

Consequently the meaning of the terms should be extended to the concept of inhabitant.

We therefore should speak of a network of *inhabitants* as participative elements, and the synchronous collaboration, persistence and representation by means of avatars should be extended to users and intelligent software agents.

The following section gives an overview of virtual worlds from a historical point of view, starting from their birth until modern virtual worlds. Then, current functionalities of virtual worlds are explained. Taking into account these functionalities, a list of current virtual world is presented. Finally, the elements that they are composed of are explained.

## ONE STORY ABOUT VIRTUAL WORLDS

From a technological point of view, virtual worlds are provided by evolutions in different fields such robotics, artificial intelligence or computer graphics. Perhaps due to this situation, an agreement for considering a concrete prototype as the first virtual world does not exist. Instead of this, there exists a set of milestones that have given shape to this concept throughout the last 30 years.

The usual association made between virtual worlds and virtual reality is another factor that can contribute to the confusion. Both are research and development fields that have many features in common. In fact, virtual worlds feed from the advances in the field of virtual reality.

However the term '*virtual reality*' refers to virtual simulation of real world aspects. Its objective is that user has the illusion of being immersed in a virtual environment. The term 'virtual world', as it is understood today, is based on the presence and co-presence concepts (Slater, Steed, McCarthy, & Maringelli, 1998). That is, the user feels immersed in the world, but, at the same time, the user also feels immersed with the rest of users. Thus, one of the main differences with virtual reality is the multiuser feature.

While virtual reality has been studied since the birth of modern computers prototypes can be found from the 1960's, the milestones that have marked the advent of virtual worlds were passed some years later.

At the very beginning, virtual worlds, like many other technological developments, grew with the evolution of the video game. It is difficult to make a comprehensive study about the events that have guided the evolution of these applications. However due to the features they introduced, some of them cannot be omitted from any study.

In 1974, a game called *Maze War* appeared (Musseum, 2009). This is considered the first multiuser 3D shooter game. In this game, users were represented by spheres and they chased each other in a maze. The game was developed for a specific computer: the Imacs PDS-1.

Some years later, the predecessor of current MMORPGs (Massive Multiplayer Online Role Playing Game) appeared: the MUD.

Although in this type of game the user had no graphical representation – they were based on a text interface- they possessed some similarities to current virtual worlds: capacity for a large number of users and work over general purpose networks MUD was accessed via *telnet*. Afterwards, applications closer to the modern concept of virtual world began to be developed.

For example, in 1986 *Habitat* was born (Morningstar & Farmer, 1991). It was created by Lucasfilm Games and Quantum Link. This virtual world can be considered as the basis of current virtual worlds. Its interface made use of 2D graphics and the user was represented by means of a configurable avatar. The world consisted of 20,000 connected regions a region was a screen in the world, and the users could interact with objects and communicate amongst themselves.

Perhaps one of the more surprising aspects of Habitat is the fact that it created a virtual currency for purchasing things in the world. This currency had no real value, but each time the world was accessed the user was given a new amount of currency. However, the similarities with current virtual worlds are surprising.

Later the evolution of virtual world's sped up. The Internet was no longer just a scientific or academic environment, but a core element in global communications. Thus, many virtual worlds started to appear. Each of them brought an added value over the previous one, and they presented a constant evolution in functionalities, user capacities and graphic quality.

For example, in 1993 Ericsson developed its first prototype of CyberTown as a proof of concept of a 3D online E-Commerce system (E-Spaces, 2009).

In 1994, the use of 3D avatars started to proliferate with the appearance of virtual communities such as *WorldsChat* developed by World Inc. and AlphaWorld (Inc., 2009). In the latter, the user could select among 12 possible avatars.

In 1995, ID Software launched Quake. This game changed the concept of online game playing, and became a massive phenomenon. In the same year, Fujitsu acquired the Habitat technology and developed a more advanced version of Habitat called WorldsAway (Damer, 1997). On the other hand, in the same year, Time Warner developed *The Palace* (Bumgardner, 2009), the first virtual community that was run on distributed servers rather than a single server. This way it was able to reduce the problems of an increasing number of users.

In the following years there was an exponential evolution and, in 2003, Second Life® was born (Life, 2009b). This virtual world has been able to change the concept of a virtual world. It has created not only a virtual environment where thousands of users can collaborate without looking for a common goal (because it integrates multiple applications), but moreover, it has generated a business model without precedent in this sector. However, the evolution of virtual worlds does not end with Second Life. In fact, its appearance has prompted the appearance of a many more virtual worlds. Some of the most relevant are described in following sections.

More information about the history and evolution of virtual worlds can be found at (Koster, 2009; Tampere, 2009).

## MAIN FEATURES OF A MODERN VIRTUAL WORLD

These are some of the main features that distinguish modern virtual worlds from other kind of applications:

- **Presence.** Refers to the ability of the virtual world to represent users or virtual software agents.
- **Communication.** Refers to the channels that a virtual world enables for users to enable communicating and interaction amongst themselves.
- **Collaborative capacity.** The ability to manage and allow interaction either more or less users simultaneously. One of the keys for allowing a high collaborative capacity will be the correct design of the network architecture that supports to the virtual world.

### Presence

The ability to configure avatars that represent users and distinguish them from other users is an important factor in current virtual worlds. In fact, several studies demonstrate that when users access a virtual world, they spend a lot of time configuring their avatar (Anderson, Ashraf, Douther, & Jack, 2001; Cheng, Farnham, & Stone, 2002).

Virtually all current virtual worlds allow the physical appearance of the avatar to be configured. For example, in the case of Second Life®, the user can specify features as granular as eye color or the size of the nose. Additionally, the avatar can be further personalized by means of models and accessories developed by third parties, either commercial or free.

The current negative aspects, -that research centres and companies are working on through different initiatives-, are the lack of definition of the avatar identity and interoperability.

Regarding identity, current virtual worlds do not allow, for example, the configuration of features such as personality. In any case, the necessity or advantage of creating a virtual identity is already an open discussion.

The other aspect is more important. Until now, there has been a lack of interoperability between virtual worlds. The clearest example is that if the user customizes an avatar for a specific virtual world, they must configure another from scratch to use in another world. There are several initiatives, such as the new MPEG-V standard that tries to address this lack of standardization (Consortium, retrieved in January 2009.).

### Communication

Instead of other computer-mediated communication systems, like traditional text-based chats, virtual worlds allow the simulation of the principal human-human communication channels, that is, the natural channels at least, potentially.

The representation by means of an avatar can allow the simulation of both verbal and gestural communication and through the use of certain peripherals, e.g. haptics, senses such as touch can also be stimulated.

As Schroeder points out (Ralph Schroeder, 2002), to allow a total sensory simulation, there exists peripherals that stimulate the senses of taste and smell. But these systems are in a prototype stage and have yet to show satisfactory results. It is unlikely that this situation will be improved in the medium-term. Following Schroeder's thinking, the loss of these two senses causes an absence of multimedia richness and cues in interpersonal relations. However, it is currently not possible solve this problem with technology.

On the other hand and although opinions may differ, several studies such as Robertson *et al*. (Robertson, Card, & MacKinlay, 1993) conclude that people are more accustomed to using desktop computers than complex immersive systems and for this reason first ones decrease the physical and psychological stress.

Almost all virtual worlds that present multimodal communication capabilities are focused on

exploiting typical communication channels that are enabled by means of the sense of sight and hearing. That is, sight, gesticulation, speech and hearing. The application of these channels does not require costly specialized hardware as is the case with haptics, but the use of standard peripherals as a monitor, headphones, etc. are sufficient.

For example, regarding channels that are perceptible by the ear, a pioneering and representative case is that developed in 2002 by DiPaola and Collins (DiPaola & Collins, 2002): OnLive Traveller, a 3D environment for chatting by voice.

In this environment, users are represented by 3D talking head avatars. In order to give a better illusion of immersion, the audio corresponding to the speech of each user is synchronized with the Avatar's lips.

The objective of this project was the use of the natural communication channels so that users have experience a more satisfactory interaction with other users. As they can use voice for chatting, they are free to move about in the environment simultaneously, instead of typing comments.

Regarding sight, almost all commercial virtual worlds that use avatars for representing users allow the user to gesture with the avatar. More advanced studies are focused on the automatization of these gestures and their emotional coherence. That is, not to launch a set of movements explicitly during the course of a conversation, but to generate the gestures that composes the non-verbal language. For example, the Miralab centre has conducted several studies for generating non-verbal language with emotional traits (Egges & Magnenat-Thalmann, 2005).

## Collaborative Capacity

One of the main functional features of a virtual world is that it allows simultaneous access to a large number of users from different locations. Therefore, one of the key factors in a virtual world will be the network structure that supports it. Joslin et al. (Joslin, Giacomo, & Magnenat-Thalmann, 2004) have defined five basic aspects that should be taken into account for the design of a network structure that supports both virtual world and collaborative environments:

- **Network Topology.** There are three basic topologies:
  - *Peer-to-peer.* The information transmission is between clients.
  - *Client/Server.* Clients send the information to a central server. This server is responsible for distributing the information to the other clients.
  - *Multicast.* Each client sends the information to a specific IP address that implies all of the other connected clients receive it.

Current topologies should be based on one of these topologies or a combination of them.

- **Dead Reckoning.** It is a technique for reducing the message flow among clients or between client and server. The client sends changes of state in the avatar instead of continuous movements.
- **Area of Interest Management.** This technique defines a visibility area around the client avatar that is shown with higher detail. The rest of the virtual world is optimized.
- **Scene Segmentation.** It is the same idea as that of the Area of Interest, but each area is managed by a different server.
- **Compression.** It implies the compression of the messages between clients and server. Nowadays, almost all worlds use this kind of technique.

A special case is Second Life® which has been overloaded due to its success. The developers have started to implement a new network architecture that divides its client/server architecture in two domains: agents and regions. The first will be

responsible for managing all information about avatars and users (profile, personal data, inventory, access data…) and the second will be responsible for the virtual world regions management (Life, 2009a).

## CURRENT VIRTUAL WORLDS: APPLICATION ENVIRONMENTS

As has been previously mentioned, in recent years, and above all, after the success of Second Life®, many more virtual worlds has appeared. The most significant worlds are shown in this chapter. For achieve this, and due to large number of virtual worlds that have reached certain level of popularity, these worlds have been categorized by their objectives.

It is true that many virtual worlds maintain a strong social character, but more and more worlds are appearing with different objectives other than social.

These are the most significant virtual worlds classified by their application environment:

- **Developers.** Due to the popularity of virtual worlds, there are companies that are focused on the creation of virtual worlds for other companies. Some well known examples are Muse, OpenSim or Open Cobalt.
- **Leisure.** Almost all virtual worlds –although not necessarily the most popular-, are focused only on leisure. Leisure refers to social relations they are basically 3D chats or games. Examples of these worlds are CyberTown, Dreamville, The Manor, Moove, Playdo, The Sims Online, TowerChat, Traveler, Virtual Ibiza or VPChat. A technologically eye-catching development is Sora, which accesses by mobile phone.
- **General Purpose.** In general, this field is where most popular virtual worlds lay. They do not present a particular focus, but they simulate different aspects of real life. They may even have an economic and monetary system based on a virtual currency that can be purchased with real money. The most popular examples are Active Worlds, Second Life®, Habbo Hotel or There.
- **Promotional.** Some companies, seeing the popularity of virtual worlds, have created environments whose goals are to promote their products or events. Examples of these worlds are Coke Studios, created by the Coca Cola Company, Disney's Toontown Online and Virtual Magic Kingdom, created by Disney, and Dubit, a world with a big commercial focus where several companies are represented.
- **Educational.** Apart from the case of general purpose worlds such as Second Life®, where a large number of educational institutes are represented in the case of Second Life®, Harvard University and Imperial College London, to centers for medical or astronomy (Educational, 2009)-, virtual worlds with a complete educational focus also exist. Some examples are Mokitown (Mokitown, 2009) for child road traffic education or Whyville (Whyville, 2009), a virtual world focused on teaching the sciences to children.

More information about existing virtual worlds can be found in (Review, 2009).

## MAIN ELEMENTS THAT COMPOSES A VIRTUAL WORLD

There is no existing common and universal agreement of the main elements that compose a virtual world. Therefore we present a description, as valid or invalid as any other, with the objective

of obtaining a better understanding of the common elements that may appear in a virtual world.

From our point of view there are four main elements that play the role functionality containers in the virtual world. They are the user, the avatar, the intelligent software agent and the virtual world itself. They can be schematized as shown in Figure 1.

The following sections detail each element and their function in the virtual world environment.

## The User

The user is the main element in the virtual world system. Virtual worlds, like most other computer applications are focused on offering services to users either directly or indirectly. In this schema, services can be both part of the virtual world –as its own content- or offered to the user through software agents.

The user is an intelligent element that interacts through their avatar. The communication between user and avatar is made by means of input/output devices.

The definition of all the aspects that characterizes a human being is beyond the scope of this work. However, the basic aspects that are necessary for representing a person in a virtual world have been compiled. That is, a minimum set of traits that make two persons different and can be represented in a virtual world.

A Human being is composed of body and mind (Carolis, Carofiglio, Bilvi, & Pelachaud, 2002). Body features are related by appearance and movements. The aspects of the mind related by emotions, mood and personality (Gebhard, 2005).

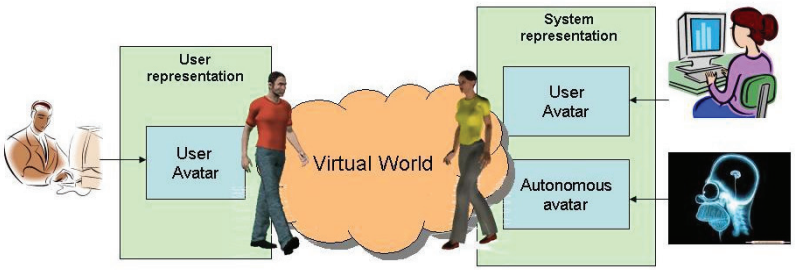
In general, personality affects the way a person perceives the world; emotions are precise personality modifiers that depend on the environmental conditions; while mood is a mid-point between emotions and personality. They are personality modifiers with longer duration than emotions and they are usually caused by the addition of several emotions (Gebhard, 2005; Kasap & Magnenat-Thalmann, 2007).

These factors should be taken into account for representing a user in a virtual world. This will faithfully represent the user in a virtual world from the rest of the users' points of view.

Another factor to be taken into account will be the user communication features. A user could have the ability for some specific way of communicating (for example, via text or via voice). The importance of this factor is increased when it is transformed into a necessity. A user with some type of disability would not to be able to use a particular channel and thus depends on other means of communication.

In fact, according to a press report written by Gartner, an important ICT consultancy, in 2011

*Figure 1. Elements that composes a virtual world*



80% of Internet users will have a Second Life® in virtual worlds. Such forecasted growth that does not consider accessibility would create a new digital gap. Users with disabilities who cannot access virtual worlds in their current conception, will exclude from using these future virtual worlds.

There have been some recent initiatives for increasing the accessibility of current virtual worlds by means of external devices and plug-ins. Hansen has compiled most significant of these tools in (Hansen, 2008).

On the other hand Trewin et al. (S. Trewin, Hanson, Laff, & Cavender, 2008; S. M. Trewin, Laff, Cavender, & Hanson, 2008) have studied the possibility of developing accessible virtual worlds. They have tested their efficiency using a multiuser game due to its technological similarity to a virtual world.

They present two types of existing applications for users with disabilities: Developments that are for the disabled exclusively and developments for the general public that take accessibility into consideration. In their study, they highlight the need for research into the second type of application to avoid the growth of a new digital gap.

There is currently some directives and recommendations for the management of each type of disability in a 3D virtual world. However, they have yet to be implemented in real scenarios.

## The Agent

Agents are software applications that are mainly related to the field of Artificial Intelligence. Their base characteristics are autonomy and sociability. The autonomy refers to their ability to decide on tasks to do to obtain their objectives. Sociability is related to the need to collaborate with other agents to carry out their goals (Morales, 2008).

Although, different classifications of agents exist, one of the classic and extended divisions depends on their form of reasoning. That is deliberative, reactive and hybrid agents (Morales, 2008; Moya & Tolk, 2007; Nwana, 1996):

- **Deliberative Agents.** They have a symbolic representation of the world, including objects and intentions. Based on this world knowledge, they take decisions through inference mechanisms.
- **Reactive Agents.** They contain an internal representation of the virtual world where they are that is very simplistic. The intelligence of the agents comes from interaction between them.
- **Hybrid Agents.** Are agents that are not pure reactive or hybrid, but they have subsystems of both kinds.

This system of classification is appropriate for any kind of agent, that is, any kind of application that works autonomously.

In the case of virtual worlds, we define an agent as a subset of these systems whose objective is the simulation of human behavior in a virtual world in an autonomous manner. That is, systems that are part of the artificial life field –or *ALife*- (Bedau, 2003). In a virtual world other kinds of agents could exist that act as content search robots, for example. However, they will be dependent on the content of each particular virtual world.

The definition of agent as a main virtual world element is closer to that of AVA –Autonomous Virtual Agent-, defined by Luengo (González, 2005). Luengo defines these three features as characteristics of an AVA:

- Its natural place is a 3D graphically simulated world.
- It has a graphic representation of the world that it inhabits, and it is able to perceive, adapt and react to the environment, exhibits a human-like graphical behavior.
- It is an independent software entity that is conscious of environmental changes and is able to response to them autonomously, that is without need of external instructions or control.

Some examples of these kinds of agents can be found, usually represented by means of avatars. As an example, as early as 1995, Maes et al. (Maes, Darrell, Blumberg, & Pentland, 1995) developed an agents system using mixed reality with some validation scenarios called ALIVE. One of the scenarios was an agent represented by a puppet-like avatar.

## The Avatar

Nowadays the use of avatars for representing users or intelligent software agents in virtual worlds is very common. Their advantages or disadvantages are a topic of open field of discussion. However, there is a set of studies who have concluded that they have more advantages than disadvantages. Some of these, compiled in the work of Ortiz (Ortiz, 2008) are:

- **It Facilitates Social Interaction with the Machine.** Prendinger et al. in (Prendinger, Ma, Yingzi, Nakasone, & Ishizuka, 2005) stated that the individual interactions of computer users are fundamentally social. Also they included that the user hopes to obtain the same type of social behavior. Therefore, they proposed to give the interface personality aspects and voice synthesis to improve the human machine interaction.
- **The User then Considers the System to be more Reliable and Credible.** A user needs to believe in an agent's reliability in order to have the confidence to delegate certain tasks to it. There are evaluations that demonstrate that confidence and credibility increase with the personification of the agent, in other words, by giving it a face, eyes, body or voice. If the aspect of the character is also realistic, the agent is seen to be more intelligent and friendly (Koda & Maes, 1996).
- **The Commitment of the User Increases.** Personifying the agents increases the user's commitment to the application (Kim, 2004).
- **It Catches the Attention of the User.** Hongpaisanwiwat et al. (Hongpaisanwiwat & Lewis, 2003) concluded that the avatar is capable of catching the user's attention and this increases if the avatar is credible, as it generates the illusion of life in the system.
- **It Focuses the User's Attention.** An avatar can be used to focus the user's attention on points of interest (Prendinger et al., 2005).

Moreover, Casanueva (Casanueva, 2000) states that a virtual collaborative environment that is seen as being satisfactory and usable to users, should create a grand illusion of presence and interaction with other users.

Slater et al. (Slater et al., 1998; Slater et al., 1996) divided this illusion of presence into two components: the personal presence and the shared presence, or co-presence. The first refers to the subjective feeling of being in the virtual world, and the second, to the feeling that the rest of the users are in the virtual world. The better these factors are fulfilled, the more effective and satisfactory the virtual world will be.

The user representation elements improve this feeling of presence. In fact, numerous studies (Benford, Bowers, Fahlén, Greenhalgh, & Snowdon, 1995; Slater & Usoh, 1994; Snowdon & Jaa-Aro, 1996; Vilhjalmsson, 1997) conclude that having a visual representation of users improves the feeling of presence and especially the feeling of co-presence. More specifically, evaluations in the work of Casanueva (Casanueva, 2000) state that the use of a realistic avatar, both in appearance and in movement, improves this feeling even more.

Therefore, we define an avatar as an important element of the virtual world that represents

intelligent entities (Figure 2) and enables, at least potentially, these communication channels:

- **Verbal.** The avatar enables the possibility of verbal communication in a similar way to human-human communication. This means of communication is possible without the need for an avatar. But the avatar provides the possibility of synchronizing verbal communication with lip animation, creating the illusion of seeing and hearing a person speaking.
- **Gestural.** On the other hand, the avatar allows the transmission of gestural information, information that is part of non-verbal communication.

Authors as Mehrabian (Mehrabian, 1968), and Bickmore and Cassells (Bickmore & Cassell, 2001) highlight the importance of this kind of communication for transmitting a message. More exactly, Mehrabian states that the acceptance of a message transmitted face-to-face depends on the acceptance of words used at 7%, acceptance on the way the voice is used at 38% and acceptance of gestures at 55%. This kind of gesturing is divided in four types depending on the purpose of the gestures (Cassell et al., 1994):

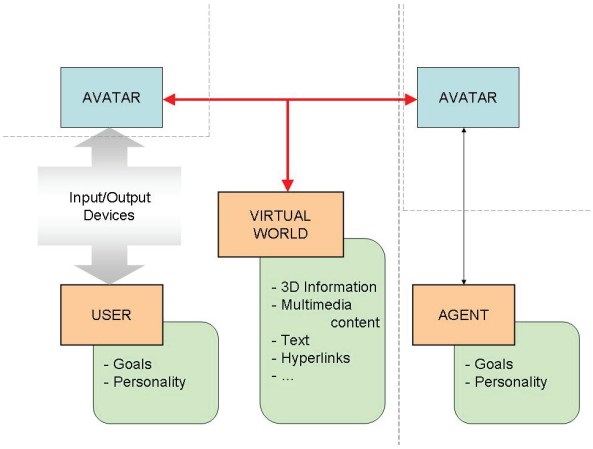
- *Iconics.* Represent something concrete about the conversation.
- *Metaphorics.* Represent an abstract feature about the conversation
- *Deitics.* Indicate a point in space (people, places…)
- *Beats.* Soft movements that emphasizes parts of the dialog.

Moreover, although voice and gestures do not express the same idea, they always express complementary information. The avatar gives the potential to reproduce these four types of gestures.

Until this point, in case of user representation, the features that the avatar enables, do not give an overall added value, for example, a video conferencing system. However, to take advantage of the virtual world potential it is important to exploit the illusion of presence. That is, users consider that both they and the rest of users are contained in the virtual worlds. Regarding this, the avatar provides two additional functionalities that would be barely applicable with other kind of representation:

- **Navigation in the Environment.** The avatar provides the entity that it represents movement in the environment. This is an

*Figure 2. Representation by means an avatar*



important point because this way the rest of the entities can see this entity as contained within the virtual world, as in the real world.

- **Interaction with Other Elements.** The avatar allows object manipulation and interaction with other avatars in a similar way as happens in the real world.

In summary, the avatar is an interactive element of the virtual world system that provides verbal and non-verbal communication channels, and enables functionalities for navigation and interaction with objects.

## The Virtual World

The concept of the virtual world, as contemplated in this scheme, involves the interaction issues not directly related to users, agents or avatars. It includes the terms content and medium that Straaten defines in his categorization of virtual worlds (Straaten, 2000).

The virtual world in this schema is the medium that channels the interactions that takes place, including content and rules that drive the application. Its specific features are:

- **Functionalities**
  - *Interactions channeling.* The virtual world is the element that allows interactions amongst avatars to take place. Although an avatar is the element that allows interaction amongst users, and between users and agents, this interaction cannot take place without a medium that allows it. This is one of the main functionalities of the 'virtual world' element in the schema
  - *Physical rules*. These are the rules that drive the avatar interactions. They can be realistic rules such as 'an avatar cannot go through a wall', or not as is the case with the Second Life® avatars that can fly. Each virtual world will establish its own rules and physical laws that condition the interactions.
  - *Logical rules*. Refer to the objectives or goals of a virtual world and they are dependent on each specific virtual world.
- **Additional Features: Content**
  - *3D objects.* Dynamic or static 3D objects, in the sense they have an associated behavior or not. They include those from the models that compose the environment and those that the user or agent can interact with. The behavior the object has –let suppose a virtual pen that an avatar can use for writing- will be defined by the same object or by virtual world rules. Actions are usually defined in the object itself and the avatar and the virtual world does not need to know all the possible actions with all possible objects. The object 'tells' the avatar or the virtual world which the possible actions are. This technique was developed at the end of 90s and is known as Smart Objects (Goncalves, Kallmann, & Thalmann, 2001).
  - *Information.* This is general information. It can be static or dynamic. Static information can be text, videos, images, etc. Dynamic information might be for example, a mapping of Google search engien in the virtual world. This dynamism is driven by virtual world rules or by an agent not represented by an avatar.

In summary, the virtual world allows the interactions among avatars to take place and offers users services and information.

## CONCLUSION AND FUTURE TRENDS

The objective of this article has been to provide an overview of what virtual worlds are, what their functionalities are, and what elements they are composed of.

Future trends in virtual worlds are principally focused on obtaining interoperability between them. In the same way, Web portals for E-Commerce can be accessed by means of different Web browsers maintaining a unique client account; virtual worlds should also allow the same. From the author's point of view, this is a key factor in order to create a tool that establishes a new evolution in Internet and E-Commerce tools.

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