E-COMMERCE ENVIRONMENTS AS 3D ELECTRONIC INSTITUTIONS

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ABSTRACT

Many researchers have paid close attention in the recent past to 3D product presentation in E-Commerce systems. Surprisingly, not many practical results have been shown. In this paper we outline the reasons for the lack of success and propose the use of 3D Virtual Worlds that not only offer natural ways of product presentation but also provide means to satisfy the social needs of customers, which are mostly neglected in nowadays E-Commerce solutions. Virtual Worlds are somewhat unregulated environments, which do not have the means to enforce technological norms and rules on their inhabitants. But these norms can be enforced with the help of the Electronic Institution methodology. It is shown how two metaphors, Virtual Worlds and Electronic Institutions are combined into a single metaphor, 3D Electronic Institution, while retaining the features and advantages of both, and how the 3D Electronic Institutions are generated.

KEYWORDS

E-Commerce, Electronic Institutions, 3D Virtual Worlds

1. INTRODUCTION

Electronic Commerce radically changed the way business is conducted around the world. It made possible to vastly increase the interactivity in the economy, helping small businesses and households reaching out to the world at large. It provided people with the means to do their business in a fast and convenient way, abolishing distances and altering the concept of community.

Individuals today are the product of a particularly mobile and entrepreneurial society. As a result, in everyday business activities, including E-Commerce, the individual is socially constituted and socially situated (Solomon 2004). Though researchers have pointed out that social needs of customers play a crucial role and are of great importance in E-Commerce applications (Preece & Maloney-Krichmar 2003), these needs are mostly neglected in nowadays systems, regardless of the business model that they implement (i.e. whether it is B2C, C2B or C2C). Most system analysts perceive E-Commerce systems from a purely technical viewpoint without trying to establish the social and business norms that companies and consumers abide by. A truly functional E-Commerce system that supports business activities cannot be obtained without taking care of social issues behind these activities (Hawkins et al, 1998).

3D Virtual Worlds provide a consistent and immersive environment which implicitly incorporates location awareness of other users and offers mechanisms for social interaction. Virtual Worlds support to a certain extent the way humans operate and interact in the real world. Such immersive environments integrate social context, allowing customers to meet and interact with other people, and have the potential to address the needs of both *rational* and *emotional* customers. Virtual Worlds go beyond the document and form based interface of the World Wide Web, embedding the customers as avatars (Damer 1998) and permitting them to operate, interact and communicate in a shared visual space, i.e. putting the human "in" the World Wide Web rather than "on" the World Wide Web. The underlying technology supporting these worlds has been created and hosted by a variety of companies, ranging from computing technology giants like Microsoft and Intel, and ending with relatively small start-ups like Active Worlds and Worlds Inc. Overall, the design and development of Virtual Worlds has emerged as a phenomenon shaped by the home computer user, rather than by the research and development in universities or companies. As a result, Virtual Worlds are somewhat unregulated environments, which do not have the means to enforce technological norms and rules on their inhabitants. Hence, Virtual Worlds do not address the central issue of security in E-Commerce. In order to address this issue and make use of the benefits of the Virtual Worlds we need to introduce methodologies on which reliable and secure E-Commerce systems build upon. Electronic Institutions, for instance, focus on taking control over security aspects. In particular, Electronic Institutions guarantee that participants adhere to institution rules and fulfill their obligations. Our major objective is to bridge the gap between the two metaphors, Electronic Institutions and Virtual Worlds, and combine them in the metaphor of 3D Electronic Institutions. Electronic Institutions enable the specification of highly regulated and well structured environments which contrast the mostly unregulated nature of Virtual Worlds. 3D Electronic Institutions are immersive environments that enable human activities and participation in Electronic Institutions. In order to achieve this goal we have developed a three-layered framework that enables consistent integration of the two metaphors, allowing E-Commerce customers to conduct business and interact efficiently.

This paper is structured as follows. Section 2 highlights the issues caused by the misuse of Virtual World technology in E-Commerce and the potential benefits that 3D Virtual Worlds could bring into E-Commerce. Section 3 outlines the framework for 3D Electronic Institutions. Some technical aspects regarding the semiautomatic generation of a 3D Electronic Institution are presented in Section 4. Finally, Section 5 summarizes the work so far and discusses future directions of this research.

2. VIRTUAL WORLDS IN E-COMMERCE

Inspired with the success of 3D graphical user interfaces on application domains such as computer games, CAD, CAE, medical and scientific visualization, researchers tried to apply this new technology to E-Commerce. The main focus of many industrial developments in this area was product visualization in virtual shops (Joyce 2000). Unfortunately, most of these industry projects haven't brought any satisfactory results. 3D experience in E-Commerce was rejected by many customers and criticized in the media (Hurst 2000). According to Hurst the reason for the lack of success is that most researchers took a technology-centered rather than a customer-centered approach. One argument given by e-tailors is that 3D technology was always too slow for consumer dialup modems. But now that 3D vendors have better compression technology, and some customers are getting online with faster modems, it finally makes sense to put 3D on the sites.

In contrast to focusing on technology, researchers at Creative Goods took customer's position and pointed out in their user study (Hurst 1999) that security and navigation are key issues in E-Commerce and are especially important to provide a good customer experience. The major factors concerning navigation are that it has to be quick and easy. So, increased download times and additional navigation skills required to observe 3D products may be major factors for the customers to reject the new technology, if not outweighed by something else. Daugherty et al. (2002) claim that a virtual experience has the potential to be richer than both direct and indirect experience for consumer learning because an experience can be simulated, framed, annotated and contextualized within virtual environments. They conducted a usability study where indirect experience (form-based web sites), virtual experience (web sites with 3D product presentation) and direct experience (direct product manipulation) were compared. The study showed that virtual experience can be as good as direct experience, and product knowledge and decision quality are both significantly higher from exposure to an interactive 3D product than a static product presented in a form-based way. This suggests that when the goal is to increase awareness and facilitate the decision process, marketers could be better served by a virtual experience than relying solely on indirect experience. On the other hand, when tactile affordances are the most relevant for the product (e.g. touching the laundry), a virtual experience is unable to influence consumer learning and has the same effect as indirect experience. Additionally, Edwards (2001) insists that one of the factors that makes virtual experience even more successful than direct experience is novelty of product presentations. In his opinion, people that have not been exposed to 3D presentations of products online may simply be more curious than if the information was presented in another medium or format.

Product presentation is not the only benefit 3D Virtual Worlds provide. Social interactions play an important role in real world commerce and will definitely be important factors in the future of E-Commerce (Preece and Maloney-Krichmar 2003). Some operators of E-Commerce Web sites even believe that online communities supporting social interactions serve the same function as the “sweet smell of baking cakes” does in a pastry shop. Both evoke images of comfort, warmth, happiness and maybe even trust. Unfortunately, these needs are mostly neglected in contemporary systems. There are some commercial solutions (LinkedIn.com, Ryze.com, Itsnotwhatyouknow.com) that provide business equivalents of the popular Web site Friendster.com, where people try to find new contacts with the help of other people they know and trust. Despite the fact that the question “whom do you know?” appears to be a key characteristic of a businessman's success in the real world, the functionality of finding reliable business partners is not yet integrated into any E-Commerce web site. Another attempt to design a form-based environment for fostering social interactions in electronic market places was done by Girgensohn & Lee (2002). Their environment incorporates a novel, spatially-organized and interactive site map which provides visibility of people, activities, and incorporates mechanisms for social interactions. In our opinion this interface is too overloaded, does not provide an immersive experience and is difficult to navigate. In contrast, 3D Virtual worlds offer a consistent and immersive experience and are easier to interact with, because they reflect the way humans interact in the real world. Additionally, most E-Commerce environments are designed with the assumption that customers’ buying style (or behavior) is *rational*, without much consideration of the needs of customers showing an *emotional* style of buying. Chittaro et al. (2004) argue that Virtual Worlds are able to satisfy the needs of *emotional* customers as well. Other advantages that pointed out by the authors are: the support of customer’s natural shopping actions, closer to the real world and therefore more familiar shopping environments, satisfaction of social needs by allowing customers to meet and interact with other customers or sales people.

Each E-Commerce activity has two parties: buyers and sellers. To make a successful E-Commerce application both parties have to be satisfied! This implies that e.g. advertisement has to be an integral part of an E-Commerce experience. Virtual Worlds provide ways for *less conspicuous* advertisement techniques. The idea of animated products as a navigation aid for E-Commerce (where 3D models of different products walking around help users to find appropriate section in a supermarket) is a bright example of an innovative way of advertisement presentation (Chittaro et al. 2004). Advertisements in this case help buyers to improve navigation; they also bring entertainment and satisfy the demands of the sellers at the same time.

3. A FRAMEWORK FOR 3D ELECTRONIC INSTITUTIONS

Not only humans participate in E-Commerce. Most of the customers enjoy the fact of being able to delegate some of their activities to autonomous (software) agents. Our view on the interface relation between humans and software agents in a 3D Electronic Institution is illustrated in Figure 1.

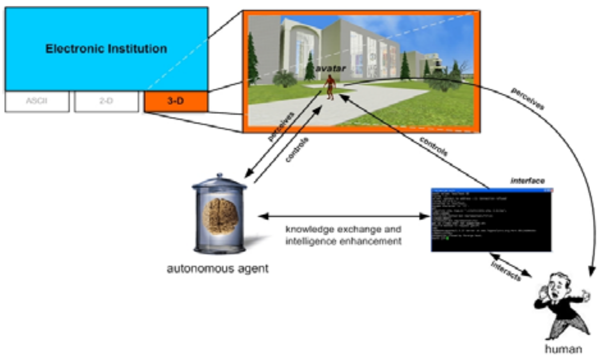

Figure 1. Interaction between software agents and their principals

The couple agent/principal is represented in a Virtual World as an avatar. Either a human or an agent may take full control over the avatar through the interface (metaphorically the interface is a sort of glove puppet that translates all decisions of its puppeteer into terms of the institution machine understandable language). The agent and the human co-operate in the solution of the tasks the human has to deal with. Representing autonomous agents as avatars in a 3D Electronic Institution provides humans with a natural way of perceiving the actions of the autonomous agents, helps to decide whether to intervene, to interact with the agents and to implement decisions in an easy way. We also want to allow other types of interaction among them, such as the human giving guidelines to the agent, or the agent suggesting potential solutions to the human (via the interface), in a sort of "expanded intelligence" mechanism similar to the "expanded reality" that nowadays virtual reality tools offer.

Adding new dimensions and new degrees of freedom to a user interface provides new opportunities for collecting information and learning. Interaction in 3D Virtual Worlds involves typical real-world actions such as moving, changing directions of movement, changing the point of view without changing the position (1st vs. 3D person view), turning around and inspecting objects, and so on. At each step on a trajectory in the world, there are a large number of possible actions which can be observed and imitated. The duality, agent/principal, permits the introduction of co-learning between software agents and humans. On the one hand, the software part can learn from the principal how to take decisions, and after some period of learning take autonomous decisions in the same way the human would have taken them. On the other hand, the autonomous agent can help the human to learn about the structure of the Electronic Institution. The autonomous agent can assist the user in learning institutional rules (expressed in a machine understandable language but made comprehensible to the human through the observation of the avatar controlled by the agent). Additionally, it can advise the human on certain decisions on the basis of the information the agent may have gathered from external sources or from the observation of other participants' behavior. Another aspect of learning impossible in traditional Electronic Institutions is the discovery of social networks. For example, the frequency analysis of conversational utterances of users (without analysis of communication content) can provide an initial structure of "connections" between these users. With a deeper analysis relating the structure of the network to the subject of activities of the Electronic Institution we can potentially identify some influence on the decision making.

To support the aforementioned vision and integrate social aspects together with better product presentation into E-Commerce systems, while relying on a strong methodology that may clearly address the security issues, we propose a framework which is based on two metaphors - Electronic Institutions and Virtual Worlds. Its essence is, on the one hand, opening Electronic Institutions to human users. On the other hand, providing sophisticated means for humans to interact and, most importantly, to perceive social context. Basically, the framework for 3D Electronic Institutions consists of three layers as depicted in Figure 2.

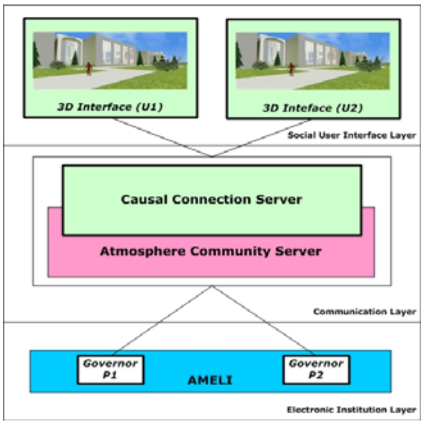

Figure 2. Framework for 3D Electronic Institutions

3.1 Electronic Institution Layer

Electronic Institutions are software systems composed of autonomous entities, i.e. agents, that interact according to predefined conventions on language and protocol and that guarantee that certain norms of behavior are enforced. This view permits that agents[1] behave autonomously and take their decisions freely up to the limits imposed by the set of norms of the institution. An Electronic Institution is in a sense a natural extension of the social concept of institutions as regulatory systems which shape human interactions (North 1990). The methodology of Electronic Institution acts as the basis of the framework and is determined along three types of conventions:

- *Conventions on language, the Dialogical Framework*. This dimension determines what language ontology and illocutionary particles agents should use. It also fixes the organizational structure of the society of agents, that is, which roles agents can play, and what the incompatibilities and relationships among the roles are.
- *Conventions on activities, the Performative Structure*. This dimension determines in which types of dialogues agents can engage. Each different activity an agent may perform is associated to a dialogue among the group of agents involved in that activity. These (structured) dialogues are called scenes. (The term is borrowed from theatre scripts, where actors incarnate characters and follow strictly pre-fixed dialogues). The Performative Structure fixes which protocol (possible dialogues) can be enacted in each scene, which sub-language of the overall institutional language can be used in each scene, and which conventions regulate the in and out flux of agents in scenes. Agents can join and leave scenes at certain points of the dialogue, for instance, at the end of a round in an auction scene. These points are marked as concrete states in the finite-state machine that represents the protocol. Arcs of the finite-state machine are labeled with illocutionary patterns that make the conversation state evolve when correctly matched agent illocutions are uttered. Finally, the minimum and maximum number of participants is limited by the specification of scenes. Scenes are interconnected to form a network in order to represent sequence of activities, concurrency of activities or dependencies among them. Agents leave scenes where they have been playing a given role and enter other scenes to play the same or a different role. This transit of agents is regulated by special (simple) scenes called transitions. Transitions are responsible for re-routing agents. They are also places where synchronization with other agents (if needed) occurs. Sometimes new scenes can only be enacted by a group of agents, or agents can only join scenes as members of a group.
- *Conventions on behavior, the Norms*. Institutions impose restrictions on the agents' actions within scenes. These actions are basically restricted to: illocutions and scene movements. Norms determine the commitments that agents acquire while talking within an institution. These commitments restrict future activities of the agent. They may limit the possible scenes to which agents can go, and the illocutions that can henceforth be uttered.

In order to support the specification, design and deployment of multi-agent systems as Electronic Institutions, EIDE (Electronic Institution Development Environment) is used[2]. EIDE is a set of tools whereof ISLANDER and AMELI are employed in the 3D Electronic Institutions framework. ISLANDER, as a graphical specification tool, provides a convenient means to design Electronic Institutions (Esteva et al. 2002). It supports the specification of a common ontology, the set of activities (scenes) that the agents can get involved in, the flow of agents within the institution, and the dialogues that govern the enactment of the different scenes. The tool also performs several verifications on the specified institution (integrity, protocol correctness, and norm correctness). AMELI, loads institution specifications and acts as the infrastructure that mediates the agent's interactions while enforcing institutional norms. Agents may be heterogeneous and self-interested, and we cannot rely on their correct behavior. AMELI is a domain independent component that supports the execution of such heterogeneous agents. To execute an Electronic Institution, AMELI is launched up-front and agents can subsequently join the institution through a simple connection to this infrastructure. Each agent that is connected to the infrastructure communicates in the Electronic Institution via a Governor. The Governor serves the purpose of "safe-guarding" the institutions, i.e. it checks whether a particular message is allowed to be said at the current stage or not.

[1] For 3D Electronic Institutions agents should be understood as duals agent/principal
[2] http://e-institutor.iiia.csic.es

3.2 Communication Layer

The task of causally connecting Electronic Institution's runtime environment AMELI with a user interface is accomplished via the communication layer. A system is said to be "causally connected" to its representa-tion if whenever a change is made in the representation, the system itself changes to maintain a consistent state with the changed representation, and whenever the system evolves, its representation is modified to maintain a consistent relationship (Maes & Nardi 1988). Reflective systems are a particular case in which the representation of the system is part of the system itself. An Electronic Institution (execution) has a representation of itself in terms of a 3D environment where rooms represent scenes, avatars represent agents, doors represent connections etc. The 3D experience we propose allows two different types of interaction: sending messages to the Electronic Institution by a software agent or direct manipulation by the human through concrete actions on the 3D environment. These actions and the agent's actions within the institution have to be consistent. Therefore a causal connection between the Electronic Institution and the Virtual World is a must. This causal connection has to materialize in two directions. First, actions made by the agent in the institution have immediate impact on the 3D representation. Movements of the agent between scenes, for instance, must make the avatar "move" to corresponding rooms in the 3D world. Messages said by the agent in the institution must be considered as being said by the avatar in the Virtual World. Second, actions performed by an avatar in the Virtual World are understood as made by the agent in the institution. This has as a consequence that those actions that the agent is not allowed to perform in the current execution state of the institution cannot be permitted in the 3D environment. For instance, if an agent is not granted a permit to leave a scene, opening a door must be prohibited to the avatar. Those actions that are permitted in the current state and are actually performed by the human must have the same impact on the Electronic Institution infrastructure supporting the execution as if they were made by the software agent. For instance, if the human writes a message and the scene execution is in a state where this message is consistent with the protocol, the software agent and the infrastructure will change their state as if the message was said by the agent.

To address these issues, the communication layer features two components, namely the Causal Connection Server and the Atmosphere Community Server[3]. The latter one offers the functionality of sharing the 3D world among multiple participants and acts as the basis for the Causal Connection Server, i.e. it is built on top of the Atmosphere Community Server. Each user is associated with a Governor at the Electronic Institution layer. Consider, for example, user interface U1 in Figure 2 which is associated with Governor P1. All actions performed by a user are passed in terms of messages from the user interface to the communication layer. An action might be opening a door in the Virtual World or typing the price the user is willing to pay for an auctioned good. The requested action is not executed immediately. Before executing the action the Causal Connection Server generates the corresponding message and sends it to AMELI for "validation". More precisely, AMELI checks whether a particular message is in line with the Electronic Institution rules or not. If a positive validation response is given by AMELI, the requested action (represented by the message) gets the permission to be performed. This action is then reflected at the Social User Interface layer which is detailed in the next section.

3.3 Social User Interface Layer

Technically, the Social User Interface Layer consists of the Atmosphere Player[3] which is embedded into a Web Interface. JavaScript is used to control action execution in the 3D Virtual World. Conceptually, the embodied presence of the participants in the 3D environment creates additional possibilities to get people involved into social interactions due to the simple fact of their presence. Additionally, the ability of observing someone’s position and the direction of the eyesight gives information about the environment context of each user and helps other participants with finding a conversation topic. The embodiment also makes the environment more open and informal. People are more likely to ask questions that they will never ask in more formal environments (e.g. where e-mail is used for conversations). Social interactions may establish new business contacts for the participants, more information about the products and even new friends.

[3] http://www.adobe.com

4. GENERATING THE E-COMMERCE ENVIRONMENTS

We use the Electronic Institution specification generated with ISLANDER (Esteva 2003) in order to create the 3D Virtual World. Every Electronic Institution component corresponds to a 3D object in the Virtual World. At the interface layer the Electronic Institution specification determines the architecture and layout of the Virtual World as well as the institutional map. At the Electronic Institution layer the specification serves as the basis for the execution of the infrastructure, assigning governors to each participant, limiting the interaction protocols, conversations, and permissions for different roles. It does not contain any information related to user interfaces and visualization of the institution. Despite this fact, the Virtual World can be generated in a fully automatic way. In this case the rooms in the newly created 3D Electronic Institution are unfurnished; however, the doors, transitions, door labels, and governors are present. This institution is fully functional, which means that all security issues are imposed (e.g. permissions, protocols, and obligations). The agents are able to freely interact and take part in conversations. The consistency of those conversations and interactions with the institutional rules is guaranteed by the infrastructure.

Generally, institutions with unfurnished rooms are not appealing for end users. To enrich the immersion an Annotation Editor tool helps to *prettify* the institution. The Annotation Editor is build on top of the ISLANDER tool and adds the possibility to annotate institution concepts with URIs of actions or objects in the 3D World. Adobe Atmosphere[4] (responsible for rendering) easily operates with URIs as the pointer to any resource type. For instance, the URI of the 3D model of the furnished room can be added as the annotation to the corresponding scene in the specification. Once the annotation is finished the Virtual World is generated on the basis of the annotated specification. During the generation of the Virtual World the 3D model of each room will be reshaped to reflect the required size (the size is determined by the maximum number of participants in the room). The position of each door is calculated during the generation of the 3D Virtual World, so that adjacent rooms are connected.

Figure 3. Graffiti poster auction: an example of an E-commerce 3D Electronic Institution environment

To highlight the social aspects of the 3D Electronic Institutions and describe the interface we use the example of the graffiti poster auction, where the artist has the possibility to talk to the customers and auction the paintings, Figure 3. In the generated environment the scenes are represented as rooms, transitions mapped onto special types of rooms between scenes (visible on the map). Connections are represented as doors. The graffiti auction scene is visualized as a Virtual World gallery that reproduces a *cosy* atmosphere of a real world gallery. The participants of the gallery are embodied as avatars. In addition to the 3D elements there are some 2D parts present in the interface: a chat window for communication between participants, the map

[4] http://www.adobe.com/products/atmosphere

of the institution to ease the navigation of the customers and a rucksack with obligations to remind about obligations towards the institution. This combination of the 2D and 3D elements is still a consistent and immersive interface, which stimulates social interactions of embodied customers.

5. CONCLUSION AND FUTURE WORK

In this paper we analyzed previous attempts to make E-Commerce go 3D and outlined the reasons for the lack of practical success in the area. The rejection of the 3D experience by the E-Commerce customers was caused by the technology-centered, rather that customer-centered approach taken by most of the developers. Researchers didn't pay enough attention to the social issues, which are very important in the real world commerce, but are not yet present in E-Commerce. We proposed the use of the community-oriented Virtual Worlds technology to address those issues. Better product presentation, immersive experience and satisfaction of social needs are, in our opinion, the most important advantages the new generation E-Commerce solutions have to offer.

The use of the Electronic Institution methodology helps to make Virtual Worlds based E-Commerce environments more secure, despite the well known fact of the unregulated nature of Virtual Worlds. We described the 3D Electronic Institution framework, which combines Electronic Institutions with Virtual Worlds, and addressed its implementation details. The 3D Electronic Institution concept was illustrated by means of a graffiti poster auction. It was pointed out in which way better product presentation and satisfaction of social needs can be achieved, while relying on a strong methodology that helps to regulate institutional norms, protocols and security aspects of E-Commerce activities. It was also shown how 3D Electronic Institutions are generated from the Electronic Institutions specification.

Our future research includes further implementation of the Causal Connection Server and Annotation Editor. We are going to investigate the co-learning aspects between software agents and their principals that appear with the new possibilities emerging with social and spatial interactions. Additionally, we plan to examine advanced user modeling techniques within Virtual Worlds and research the utilization of gestures and other social cues in 3D Electronic Institutions.

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