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Virtual Worlds: The Role of Rooms and Avatars in Virtual Teamwork

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ABSTRACT

Recently, virtual worlds have excited the interest of Computer Supported Cooperative Work (CSCW) researchers, as potential formal and informal meeting environments for virtual teams. We report an action research study of a locally distributed team of researchers using a dedicated environment within the virtual world Second Life to support their collaboration. We investigate, here, the benefits, challenges and opportunities of virtual worlds as collaboration tools. We found that effective collaboration can take place in virtual worlds but that, in respect of synchronous collaboration, there appears little additional value in the 3D spaces and avatars of virtual worlds over more traditional video-conferencing. The results suggest that the specific benefits of virtual worlds do not fully come into play in a synchronous teamwork context, but there is some evidence of value over longer periods of collaboration – support for projects – and for the looser collaborations which typify communities.

Keywords

Virtual collaboration, Second Life, virtual worlds, virtual reality, avatars, 3D, virtual rooms, informal communication, CSCW

INTRODUCTION

Teams undertaking very complex tasks like project and product development are increasingly ‘virtualised’ (Kirkman, Rosen, Tesluk and Gibson 2004; Leenders, Van Engelen and Kratzer 2003). Schwabe (2004) suggest that such tasks, characteristically ill-structured and ambiguous, need to be carried out using communication software that provides a high degree of media richness so meetings of these distributed “creative” teams have traditionally been held using media-rich tools like the video-conference environment.

An alternative to video-conferencing software is the so-called “virtual world”. Virtual worlds can be distinguished in games that resemble an interactive animation movie (e.g. World of Warcraft) and social worlds that serve as a platform to meet other people and find entertainment of various other forms in a 3D space. This paper treats the latter variant and in particular its most popular representative (Hut 2008) –namely Second Life (Linden Lab Inc. 2008), which allows users to immerse themselves as avatars into a 3D space. Within this world, multiple forms of communication with other avatars are available; these include audio and text chat, as well as non-verbal communication like gestures. In addition to the audio and visual cues that a video-conferencing environment can convey, virtual worlds also furnish information about the common space, creating a feeling of togetherness similar to that of face-to-face meetings in the real world. The 3D environment has the advantage of allowing avatars to jointly look at objects and manipulate them (Schroeder, Haldal and Tromp 2006). Being in a room in Second Life is almost like being in the same place in the real world: actors share the same context of what is around them and can see what the other actors are doing (Olivier and Pinkwart 2007).

What, then, are the “ingredients” that create this feeling of togetherness and the shared context? In general, virtual worlds are characterised by two essential features: customisable spaces/room and avatars. To understand how virtual worlds can be effectively used for collaboration, we have to understand the roles of both.

Spaces and Rooms

From a collaboration perspective, Pfister et. al note that rooms serve several purposes, very similar to the function of actual rooms in the real world:

- Rooms can be a means of structuring information; workers can put work artefacts in specific places for organisation (e.g., drawers, etc.);
- Rooms realise access control to information; for example, they can represent a team structure by assigning different rooms to different persons;
- Rooms can be a means of structuring collaboration: workers meet at a specific place to communicate and work together on shared artefacts;
- Rooms correspond to specific work types; for instance, an auditorium serves the purpose of one-to-many information transmission, whereas a group room is useful for collaboration (Pfister, Schuckmann, Beck-Wilson and Wessner 1997, pp. 109-110).

The last two points indicate that a space can be associated with a work type, task or a group of people. In everyday life we refer to spaces like this, that mean something to us, as “places”. A place is

“a space which is invested with understandings of behavioural appropriateness, cultural expectations, and so forth. We are located in ‘space’ but we act in ‘place’. [...] The distinction is rather like that between a ‘house’ and a ‘home’; a house might keep out the wind and rain, but a home is where we live” (Harrison and Dourish 1996, p. 3).

3D space is not always necessary for the human perception of “a place” (Pekkola 2002): a 2D space such as a Web forum can be a place which users associate with a certain group of people, task or work type. Thus, what influences our behaviour is more likely the sense of place than the structure of space (Harrison et al. 1996).

Avatars

In 3D space users interact via electronic images – the so-called “avatars”. Like places, avatars carry meanings and impressions (Pekkola 2002). Regardless of the authenticity of these meanings or impressions and the intention behind them, they influence users’ first impressions of each other, and the general perception and trustworthiness of the situation (Benford, Greenhalgh, Rodden and Pycock 2001). The appearance of an avatar can be changed by the user in order to represent his/her personality; so, unlike a real life situation, a person’s avatar can be configured according to desired physical characteristics and free of constraints. If preferred, the user can stay anonymous or explore new parts of identity – unlikely possibilities in real life (Junglas, Johnson, Steel, Abraham and Mac Loughlin 2007). However, a study by Vasalou et al. illustrates that many users alter their avatars to reflect their own appearance; such users experience a heightened self-awareness, which pervades social interaction (Vasalou, Joinson and Pitt 2007). Consequently, avatars are a means of conveying information about a person and may thus in the context of collaborative work reflect that person’s perception of her/his role in the group.

Research Question

The literature makes conflicting assumptions about purpose and meaning of avatars and 3D rooms in a collaboration setting. While for instance Pekkola’s (2002) theoretical analysis of 3D environments paints a rather pessimistic picture about the use of 3D rooms and avatars in teams, Hut’s (2008) report of experiences in a virtual world called Quaq (Qwaq Inc 2008) indicates that avatar interaction in 3D spaces can contribute to more natural ways of collaboration across geographic borders. However, as both papers do not evaluate collaboration in virtual worlds using a test group of professional and experienced team workers, less is known about the “real” impacts of rooms and avatars, in practice. The study will therefore, through a situated empirical study, attempt to contribute to answering the following questions:

- What are the purposes of rooms and avatars when collaborating in a team?
- What meanings do rooms and avatars carry for the team members?
- In what ways can rooms and avatars improve collaboration in a team?

OVERVIEW OF THE RESEARCH PROJECT

Research Method

An adequate typology to characterise research paradigms in Information Systems are the dimensions of research approach (DeLuca and Kock 2007), epistemology, methodology, axiology and ontology (Lincoln and Guba 2000). Consequently, our research paradigm can be characterised by using action research (research approach) from an interpretive stance

(epistemology) collecting and analysing qualitative data (methodology) from a professional team (ontology) in a natural environment (axiology).

Research Approach

We conducted the study using the action research method (Checkland 1991; Jonsson 1991; Wood-Harper 1992). The idea of action research is to yield an in-depth analysis of a specific context, which can be a definite problem within a single or series of events or organisations. Action research allows the researcher to be part of the subject under observation. Action research relies strongly on the researcher's capacity to shuttle between two perceptual frames: as a deeply involved participant, on the one hand, soaking up rich data; while, on the other hand, acting as a disinterested and objective analyst of that data. The strength of action research therefore lies in its capacity to gain deep insight from the researcher's involvement and provide practical outcomes (Wood-Harper 1985, 1992). Various forms of action research have evolved over the years. In our study we used the participatory action research method (Greenwood, Whyte and Harkavy 1993). Participatory action research is characterised by continuous cycles of evolutionary learning in which the researchers together with the studied subjects identify major issues, concerns and problems, plan actions, implement actions, evaluate the effects and specify the learning (Greenwood et al. 1993). For reasons of simplicity and better readability of the study the results of this action research project will be summarised and presented in one "block". Nonetheless, we emphasise that data was gathered in a series of iterative cycles.

Epistemology

Action research can be subsumed within the category of interpretive research approaches (Jonsson 1991; Wood-Harper 1992). Interpretative research reflects the world views of the studied subjects (Neuman 2003). On the one hand, this subjectivity of interpretative research limits the generalisability of results and the ability of researchers to be unbiased. On the other hand, the interpretivist paradigm allows for high flexibility, i.e. the analysis of many and complex variables, a detailed exploration of a problem, i.e. the generation of a rich picture of the studied situation and thus a high degree of realism, i.e. the observations and explanations of the studied phenomenon are strongly grounded in reality (Galliers 1992).

Methodology

Data collection took place in the form of observations of the researcher, interviews and a survey amongst the participants. To round out an action research project literature advocates the use of surveys in addition to interpretative methods (DeLuca et al. 2007; Lee 1991). The online survey used had the advantage that it can be filled out anonymously, wherefore questionnaire data is less likely to be biased by the researcher and the answers of the participants are rather honest (Gray 2004). In the study the survey results confirmed the findings in the interviews, which is why both data sources will not be distinguished in the findings section of this article.

Axiology and Ontology

In general, then, action research is particularly suited for exploratory research into phenomena in which it is suspected that the context in which the phenomenon occurs is suspected to have significant influence on the nature of the phenomenon. The work of creative teams is poorly understood (Nguyen and Swatman 2003; Nguyen, Swatman and Shanks 1999; Raisey, Swatman, Tan, Blackburn and Nguyen 2006) and has been shown to be highly context dependent (Suchman 1987). Access to real situations – in our case, "real" team workers collaborating for professional purposes – is a perennial problem for action researchers. In this instance, however, we had, ready to hand and accessible an established team of researchers who were three years into a long term programme of research.

In the context of CSCW, collaboration in virtual worlds has been simulated in several settings, and opinions about their application as collaboration tools are divided. However, most studies used test groups of students with no experience of professional teamwork – as did, for example, (Dickey 2005; Kock 2008; Vogel, Kong, China, Guo, Zhou, Tian, Zhang and Suzhou 2008). Our approach complements such experimental studies (offering the potential for a degree of triangulation) and contributing enhanced richness and situatedness at the expense of a lesser degree of experimental control.

Test Team and Task

A team of seven researchers – including the two authors – agreed to adopt the experimental Second Life meeting environment, developed as a part of this study, as one of their communication channels: the core of the team had been working together on the programme of research into supporting creative teamwork for more than three years; all test

participants had worked for at least four months in the team. The team was, therefore fully established – team members were professionally experienced, both individually and as a group; and the team was socially well integrated.

Like most research groups, in addition to undertaking research, they also needed to attend to the ongoing task of finding research sponsors and of building the research team itself. The team task which was selected as a focus of this study was the development of a “capability statement”. Exactly what form the capability statement should take was not well defined at the outset – the idea was simply to develop some way to showcase the team and its ideas, which might both encourage potential project and research students within the University to contribute their time to the team’s research programme and might encourage potential research funders.

As the team worked on the task, they evolved the idea of developing a 3D representation of the team and an exhibition of the work of the team within the Second Life environment. One of the authors – the “Action Researcher” was already familiar with the functions of and opportunities within Second Life. He took the role of Second Life software engineer – and of second life expert/advisor/educator to the team – participating with the team as they collaboratively developed their requirements for the capability statement, then implementing these requirements. All synchronous collaboration on this task was undertaken within the evolving Second Life Meeting environment – “evolving” because the team decided that the meeting space itself would form a part of the capability statement and thus became interested in its design and the facilities it needed to offer. Thus, a creative process similar to requirements engineering took place inside Second Life. The team specified – within a fairly ad hoc evolutionary process – both how they wanted to work in the Second Life environment and how they wanted their research work to be represented.

Configuration of Second Life

The meeting environment in Second Life consists of a so-called parcel of land with a building, which can be seen in Figure 1. The building has two levels: downstairs is a large hall and upstairs are two rooms, a hallway and a meeting room. The large hall downstairs was used as the “exhibition room” and contained all objects from the capability-statement related 3D presentation that was to be built. The virtual meeting room - like any normal meeting room- has a table and chairs, a whiteboard, and a screen for presenting images.

Unfortunately, Second Life lacks support for application-sharing. The presentation screen offers a workaround for presenting slides – through PowerPoint, for instance. Screen captures of slides can be taken and saved as pictures in a format supported by Second Life (eg. jpg or bmp); the pictures can then be uploaded for the costs of 10 Linden Dollars (about US\$ 02) per picture and put onto the presentation screen. In this way, the slides can be seen by all avatars in the meeting room.



Figure 1: The CreWS Project in Second Life

Limitations and Rationale of Research Design

Within the context of CSCW, the research was designed to contribute to the body of knowledge about virtual worlds as collaboration tools. A strong point of this project is the use of a real life team as a test team. The use of virtual worlds in collaboration situations has not, so far, been very well explored and, in particular, no studies exist of professional team workers over a several weeks timeframe.

The test runs only “simulate” the setting of a geographically dispersed team. As only one participant was permanently remote and the others frequently met in the office, team members could for example meet in the hallway and have a chat and thus did not necessarily have to be in Second Life to communicate. Also the functional limitations of Second Life as a collaboration platform – primarily the lack of application sharing – hamper the practice of “real” team work in this virtual world.

Notwithstanding these limitations, a task was created that both requires the users to be in Second Life – and which forms a part of the real work of the team. Not only did the team-members need to be in the virtual environment in order to create Second Life content, but also the objects had to exist/be represented there, to provide the context for their discussions. Thus, when building a Second Life presentation, there was no question whether to meet in the real meeting room or in a virtual room in Second Life: the participants all used Second Life because their tools were there.

The test setting allowed an in-depth investigation of the roles of rooms and spaces and of avatars. The participants had rooms and the space outside the building where they could meet and work together, and they could move freely anywhere in Second Life. Also they could request from the action researcher and Second Life expert to build rooms or objects if needed for enhancing team work. As each test participant was assigned a different avatar, each participant had the opportunity to experiment with her/his avatar and interact with the personalised avatars of the other members.

RESEARCH FINDINGS

All team members preferred discussing the presentation where it was being created – in the virtual 3D space. The researchers defined where they wanted to put up their project posters and what content they wanted to have posted. The ground floor was

equipped with a series of exhibition boards where project posters were put up for each researcher. The outcome of the teamwork can be seen in Figure 2.



Figure 2: Avatar view of the interactive 3D Presentation

Spaces and Rooms

Within this collaboration setting, the 3D space and the 3D objects made sense because the focal collaboration artefact was the 3D presentation itself. Nonetheless, this 3D presentation was composed of numerous 2D artefacts in the form of snapshots of Office Documents. These snapshots or picture files were then uploaded to Second Life and animated with scripts. The scripts allowed receiving a Second Life notecard, playing a movie or opening a link in the internal or external browser.

When choosing the room in which to place the 3D exhibition, the team decided to put their project materials in one room instead of having one room for each person. Thus, the idea of the ‘virtual office’ – a specific room for every team-member for the purpose of exhibiting materials related to their work and meeting with other team member, was rejected. Most required neither a personal exhibition room in the 3D space nor felt they needed a private “office” space there.

Although they didn’t want/need a personal office in Second Life – which suggested that Second Life had no appeal for solitary work – the test participants were not at all reluctant to post their project materials in the virtual world. The participants were found to have a preference to place out-world content rather than in-world content in Second Life. The value placed on creating 3D objects was rather low, as opposed to the usefulness of putting 2D documents into Second Life – which was perceived as medium-high.

Avatars

Unlike in 3D computer games, the appearance of the avatar in a teamwork setting appears rather unimportant, since the actors know each other from the real life. Although some members took effort to customise their avatars, the perception of the

electronic representation of other group members did not have any significant influence on group work. The appearance in the 3D space did not convey any important information about an already known person's personality – real-life perceptions carried across, apparently unchanged. There was, however, one occasion when the opposite was observed: an unknown avatar entered the building to have a look at the presentation. In that case the avatar indeed significantly influenced the impression that the unknown visitor made upon a team member. It could be observed that the team member tried to link optical details of the avatar with the personal traits of the owner. Thus, evidence was found that the perception of avatars is in fact important when the virtual world users do not know each other from the real life. In that case avatar appearance is associated with character traits and takes significant influence on social interaction and indirectly on teamwork. The results do not provide enough evidence for us to make conclusions regarding how and why people associate certain avatars with certain character traits and how and why the making of meaning of avatars impacts collaboration.

We observed that, the test participants exhibited no reluctance in making contact with strangers in their virtual world. Most group-members agreed that the meeting space in Second Life should be accessible to the public; that they would like to share information on their work area with other Second Life users; that they would like to know when somebody was looking on their work; and that they would use the virtual world to get to know other people working on a similar topic. In a sense, we can argue that the possibility to exchange knowledge with others outside the research team motivated the evolution of the form of the “capability statement”.

One affirmative finding was that the naturally understood correspondence of avatars and rooms in Second Life to colleagues and rooms in reality can have positive effects on collaboration protocols. We noted that breaks in team meetings allowed sub-groups of the team to “break out” into smaller conversation groups, sometimes making use of small nearby rooms. Conversations in these smaller groups were sometimes related to the specific task being studied here but were also sometimes from purely social or relating to an entirely different task within the programme. That is, they were surprisingly analogous to opportunistic “by the coffee machine” conversations.

IMPLICATIONS OF RESEARCH FINDINGS

Generally, the study demonstrates that teamwork in virtual worlds is possible, though we cannot say that it is necessarily more efficient or effective than in other, more conventional, collaboration alternatives such as audio or video conferencing. It was noted that a high level of media-richness — a central property of virtual worlds — does not necessarily enhance virtual collaboration. This finding conflicts with Schwabe (2004) which motivated our use of Second Life as a media rich collaboration tool. However, Vogel et al. (2008) support this statement and add that sometimes more important than media-richness are familiarity and simplicity of the communication tools. The informal conversations between pairs of team members or subgroups of the team which occurred do, however, offer some cause for optimism and suggest a hypothesis that barriers to natural action, rather than barriers to understanding the actions of others, might explain the results reported by, e.g. Vogel et al. (2008).

In the following we will elaborate on why rooms and avatars failed to improve virtual teamwork significantly and why they may still be useful in the setting of a larger group – namely a community.

The role of rooms and avatars

We were unable to find evidence through observation that the three-dimensionality of the virtual world added value to collaboration in a team, nor did our questionnaire or interview results indicate that team members perceived significant benefit.

It was found that rooms structure collaboration in the sense that team members like to use their surroundings as the context of their discussion: test participants enjoyed discussing the 3D presentation while looking at it in the exhibition room. But as all the artefacts stored in that room were originally 2D artefacts no value was added to the process of teamwork.

Participants did not use rooms as a means for structuring information or realising access control to information. Also the correspondence of rooms to specific work times was limited. In this experiment, members met mostly in the same virtual place and did not associate any room with a specific activity. Rather, members associated the whole building with the artificially-created activity ‘meeting in Second Life’. Thus, the All members of the team already knew each other well, beforehand; so the virtual embodiment of the team members as avatars did not provide new information about a team member's personality.

Teams vs communities

Rooms and avatars may, however, make sense within the context of a community. Where community members are distributed and do not know each other well: then interaction by avatars in the 3D space is analogous to interactions in the real world and, thus, the features of Second Life support our intuitions. Indeed, opportunistic conversations were a positive feature identified in our study and, in the community context, 3D space does appear to offer an opportunity for incidental communication, in the sense that avatars might coincidentally ‘bump into’ each other and spontaneously start a conversation.

Arguing that much of the collaboration that occurs in collocated teams is informal and opportunistic, Gutwin et. al. introduce the idea of *communityware*, in which groupware is organised around groups of individuals collaborating independently, rather than sharing artefacts or virtual places. Communityware is meant to support informal communication by providing awareness or a context for conjoint interactions, supporting lightweight means of initiating interactions, and having the ability to move into closely-coupled collaboration when necessary (Gutwin, Greenberg, Blum, Dyck, Tee and McEwan 2008). In fact virtual worlds seem to perfectly match these characteristics:

Providing awareness or context

Exhibitions in the virtual world may be a key to providing awareness about community members. Our research demonstrates that the presentation of artefacts in the 3D space can be an effective way of providing awareness of the progress of projects in a team. This idea can be applied to a community context: all artefacts generated by community members can be organised in the 3D space. Virtual worlds provide a very simple and natural interface for interaction with objects or artefacts. As in the real world – if the user is interested in the content – s/he can simply take the object and add it to her/his collection of objects (in Second Life the inventory) or give it to a friend. So far it can be argued that common collaborative workspace systems (e.g. Microsoft Groove and Basic Work Support for Cooperative Work (BSCW 2008) system) can organise and manage collaboration artefacts in a 2D manner as effectively as virtual worlds can in a 3D manner. Nonetheless, it is not only much more enjoyable to walk through an 3D exhibition and wander through other people’s like in a museum, but also virtual worlds allow people to discuss the objects with another person that happened to be at the same time in the same place. Hence, the objects provide a context for starting a conversation. We therefore do not see the advantage of the 3D presentation of information in conveying information more effectively, but in providing a context for opportunistic and informal communication.

Lightweight means of initiating interactions

Lightweight means of initiating interaction are provided by mechanisms similar to personal interaction in the real world: an avatar can approach another avatar and indicate by facing the avatar or with gestures that a conversation may begin. Similarly, virtual world residents can chat (through text messages) or send notecards to invite somebody to a conversation. The question is whether team workers need to have so many communication possibilities or whether they would even prefer to have a single function e.g. sending a chat invitation for reasons of simplicity and familiarity. We believe that human interaction is more complex and therefore requires a broader range of functions for initiating communication.

The ability to move into closely-coupled collaboration when necessary

Moving into closely-coupled collaboration is very easy in virtual worlds: avatars simply have to meet in the same room. To meet in the same place avatars can walk, run or fly or even teleport to a place.

We conclude that the features of communityware are already well-implemented in virtual worlds. However, a prerequisite of this is that the community member is logged onto the virtual world and regularly visits the rooms of her/his work community. If the user is offline there is no awareness of the virtual community, i.e. the user is not kept up-to-date about changes of the artefacts of the community or meetings of other community members. This problem was quite clearly in our study since team members saw no benefit in working in isolation (having an office) within Second Life. In a forthcoming paper, we will describe the potential contribution of “awareness ITs” such as Twitter to long-term coordination and communication.

CONCLUSION AND FUTURE WORK

Our situated study of Second Life as a virtual teamwork collaboration environment indicates that its technological shortcomings (e.g. high bandwidth requirements, poor synchronisation of speech occasional time lag and use of costly hardware) and its understandable lack of specific team support features (even basic tools such as MS-Office cannot be used within the environment) are currently so great as to overshadow its conceptual benefits and shortcomings. We have seen that virtual worlds do have potential in virtual teamwork support:

- A major problem of video-conferencing approaches (the advantage held by those participants co-located with the meeting chair) is eliminated: all relationships in a virtual world are naturally peer-to-peer through personal avatars
- Support for opportunistic conversations exists – and thus potentially offers some support for social development within the group.
- A virtual world can contain representations of both artefacts and actor
- A virtual world allows the sort of continuity over time that a physical office location provides – artefacts stay wherever they were put until someone moves them

While some recent studies (e.g. Vogel et al., 2008) have identified that there is participant resistance to the use of current virtual worlds as collaboration support, we have found evidence of potential benefits. We suggest, the following hypothesis, as an agenda for further research in this area:

Virtual worlds improve informal communication over longer periods of collaboration for the looser collaborations settings which typify communities and project teams.

This hypothesis can be concretised in a set of sub-hypotheses. We will first state each hypothesis and then state possible scenarios for testing it.

- *Virtual worlds can improve informal communication as they allow for a more natural way for changing between communication styles than video-conferencing, i.e. they enable natural peer-to-peer communication that facilitates the transitions from one-to-one to one-to-many interactions.*

We believe that peer-to-peer communication might be particularly advantageous for larger groups of people. We therefore suggest exploring the potential of one-to-many communication of e.g. a speaker on a conference as well as one-to-one communications among various people in the conference audience. Hut (2008) observes that conferences and even university lectures already take place in Second Life. Nonetheless, no studies exist about the effectiveness of collaboration in virtual worlds of such large groups.

- *A 3D repository of collaboration objects enhances informal communication by providing a context for starting conversations in the virtual world.*

The experience from our research shows that testing this hypothesis with current virtual world environments (e.g. Second Life) is problematic. Creating content is very cumbersome for the novice user: the 3D space offers so many possibilities to configure an object that the user can be simply overwhelmed by the complexity. Moreover, our study showed that most users would like to import their 2D objects from outside the virtual worlds into the 3D space. Standard upload mechanisms such as those seen on sites like Flickr (2008) or Facebook (2008) might, perhaps, be provided; or following a virtual collaboration environment called Qwaq (Qwaq Inc 2008) office documents might be directly dragged on to objects in the 3D space.

In addition, driven by our insights about communication among avatars we hypothesise:

- *Avatars and their communication mechanism in virtual worlds enhance networking and relationship building in virtual communities by providing lightweight means of initiating interactions and the ability to move into closely-coupled collaboration when necessary.*

Testing this hypothesis requires a group of workers who do not know each other at the start of the project, but get to know each other in the virtual world after the project is formed. It would be particularly interesting to explore culturally diverse backgrounds within this frame. In that context, light should be shed on the factors that influence networking and relationship building – e.g. trust and cohesion among members of a community.

Finally, we identified the problem that virtual world users always have to be logged onto the environment in order to be informed about other users activities; we assume that:

- *Providing awareness about the user's activities and changes in the virtual world enhances informal collaboration by improving awareness in a group.*

We suggest that virtual worlds as a tool for synchronous communication should be advanced by a set of messaging functions that inform offline users about events and activities in the virtual environment. This hypothesis is the focus of a forthcoming article by the authors.

Summarising the aforementioned, we emphasise that our research is not aimed at showing that collaboration in the 3D space should completely substitute 2D technologies, but rather complement it with the informal and opportunistic elements, which are essential to creative teamwork.

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