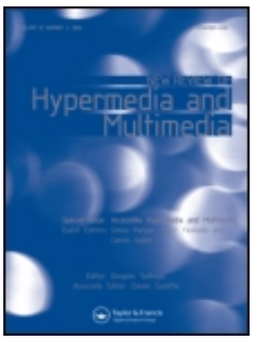

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Designing (for) experiences in photorealistic VR environments

FIONA CARROLL*
Department of Computing and Mathematical Sciences, University of Glamorgan, Pontypridd, Wales CF37 1DL, UK

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This paper investigates the role of aesthetics in the design of "intended" experiences in photorealistic virtual reality (VR) environments. It is motivated by the very notion that the aesthetic potential of photorealistic VR content is, and continues to be, underestimated whilst the emphasis on the development of newer and more efficient visualisation technologies to create new and exciting VR experiences increases. Challenging this, the paper looks beyond the technological (and the more traditional human computer interaction approaches that have primarily focused on the performance and efficiency issues of the technology) in order to explore more human values and the experiential side of VR. It focuses on the design of an "engaged interaction" and in doing so, implements a comparative study to explore how the strategic patterning of the aesthetic elements (particularly colour) within a photorealistic VR environment can allow for the design of a certain experience. In conclusion, the paper demonstrates that aesthetics and the "engaged interaction" can play an important role in getting to the heart of the photorealistic VR "user" experience. It highlights how we might design for (i.e. suggest, coax and guide) an "intended" VR experience.

Keywords: User experience; Virtual reality (VR); "Engaged interaction"; Strategic patterning aesthetic; Human computer interaction (HCI); Design

1. Introduction

In today's world virtual reality (VR) systems are reaching a certain maturity in that they are beginning to be seen more regularly in aspects of everyday life such as training, education, entertainment, health, communication and the military. As Gazzard (2007) says "they [virtual worlds] have become increasingly common and diverse in their forms", however, despite this continuing development, it seems that in terms of human values, VR is being quickly left behind. As Livingston *et al.* (2006, p. 301) point out, "there are limitations that have prevented many [VR] systems from being truly useful for participants. One reason is the need to overcome human factor issues". With regards to this and the realisation that human computer interaction (HCI) now needs to extend its approach to encompass how human desires, interests

*Email: fcarroll@glam.ac.uk

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and aspirations can be supported through technology (Harper *et al*. 2008), this paper is interested in exploring the more experiential side of photorealistic VR environments as a means of getting to the heart of the VR "user" experience. The main focus is on the aesthetic and demonstrating how it can be strategically patterned in a photorealistic VR environment to encourage "engaged interactions" and in doing so, significantly affect the user's interpretations and experiences of that VR environment. This paper aims to not only highlight the importance of the aesthetic in VR design but also the "engaged interaction" and how careful consideration of this, enables designers to anticipate and design for "intended" experiences (i.e. different interests, desires and ambitions) in the changing face of HCI design.

2. Moving from "physical" interactions to more "engaged interactions"

The main goal of HCI has always been to contribute to the development of more usable digital artefacts (Löwgren and Stolterman 2004). The term HCI stems back to around 1982 when the discipline officially emerged with two main foci: the first on the development of methods and techniques to improve usability; the second on inventing new and more usable software and tools (Carroll 2001). This focus on "usability" quickly became dominated by efficiency considerations such as those involving the physical interaction – objective performance criteria, time to learn, error rate and time to complete a task (Lavie and Tractinsky 2004). As a result, the attitude and satisfaction aspects of usability (Sutcliffe 1995) have been pushed to the side. However, in more recent times, these aspects have started to take on a new importance as the HCI field has become more and more interested in the design process. "As the field moves more toward considering systems that people value for purposes other than as tools, we are finding an increasing need to consider aesthetics and other factors that can contribute to the value of a system or an artefact" (Karat and Karat 2003). Indeed, as people's relationship with technology changes, it has now become apparent that HCI designers need to consider a more holistic approach to understand usability. They need to move from looking exclusively at performance and efficiency issues (i.e. the physical interaction) to think more about the overall user experience and in particular, the aesthetic and the "engaged interaction".

Csikszentmihalyi and Robinson (1990, p. 18) describe the aesthetic experience as "when information coming from the artwork [design] interacts with information already stored in the user's mind. The result of this conjunction might be a sudden expansion, recombination or ordering of previously accumulated information, which in turn produces a variety of emotions such as delight, joy, or awe". The strategic grouping of this information (i.e. the forms, lines, colours, spaces, textures, etc. of the artwork) establishes the distinctive character for the aesthetic experience (Collinson 1992). For years, artists and designers have found many different ways to group and control this information "to code pleasurable formal patterns, complex events, and subtle emotions" and in turn, by decoding such information

viewers have shared engaging experiences that would otherwise not be accessible to them (Csikszentmihalyi and Robinson 1990, p. 2). Following this train of thought, this paper promotes the idea of the "engaged interaction" as having close ties with the aesthetic experience. It is seen here as having "the power to engage the intuition, sensation, sentiment and cultural interpretation of the viewer/user and in doing so, support the design of the 'intended' experience".

So what does this mean for VR? This paper suggests that aspects of a new richer HCI could also play an intrinsic role within the design of photorealistic VR environments. Aspects including "broader conceptions of usability to encompass enjoyment, engagement, identity, trust and loyalty" (Blythe *et al.* 2006, p. 1692) have the potential to greatly enhance while also sway user's VR experiences in certain directions. Therefore, VR designers need to think beyond the efficiency issues and the bare cognitive processes of the physical interaction and consider other processes of interaction like the "engaged interaction", which focus more on the deeper interactions between people and technology, and then the experiences that result. As the following study highlights, the role of aesthetics in a VR environment holds huge importance in how it affects and influences users' interpretations and hence overall experiences of that environment.

3. Study: designing "engaged interactions" in photorealistic virtual reality (VR) environments

The objective of this study is to illustrate how a photorealistic VR environment can be visually constructed (i.e. strategically patterned) to encourage participants to aesthetically engage and interact with certain areas of the environment. The aim is to promote a situation where "engaged interactions" lead participants in specific directions and towards "intended" experiences. To attempt this, the study will focus on comparing two versions of the same photorealistic virtual environment (i.e. two VR environments of the same interior space). Version 1 (Environment A – figure 1) is a photorealistic static mosaic (in full colour) of the interior of a couple's old Victorian flat in Edinburgh, which allows the participant to look 360 degrees around, up and down the room, when wearing a head mounted display (HMD). Version 2 (Environment B) is the exact same static mosaic (in full colour) of the room. However, this time the colour in certain areas of the room has been further saturated using Adobe Photoshop. The aim is to not only encourage the participant to look 360 degrees around, up and down the environment but also to engage in certain areas and hence certain "intended" experiences (see figure 2).

The concept of "strategic patterning" is defined here as "the careful and considered organisation and arrangement of aesthetic elements in the photorealistic VR environment". In detail, the colour of certain areas (and objects) in Environment B (i.e. the rugby shirt, dumbbell, shoes, hat, paintings, flag, etc.) is saturated to form an overall strategic pattern to entice

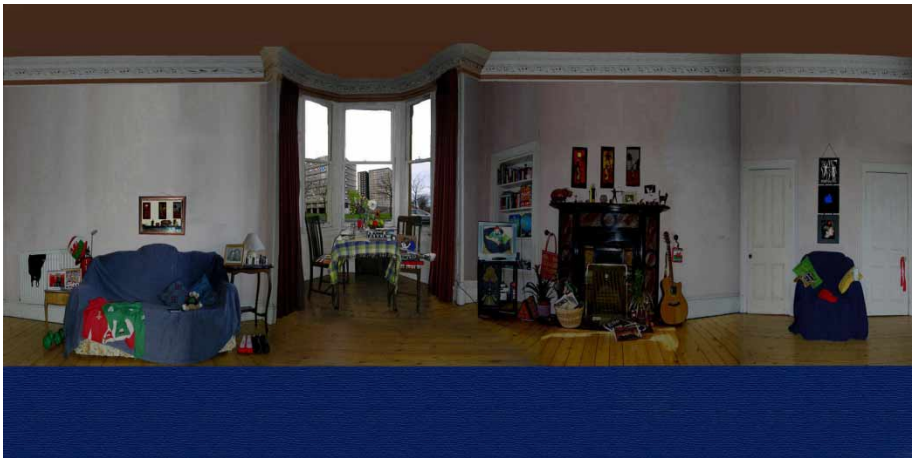

Figure 1. Environment A of Edinburgh flat.

the user to look around the room and in doing so to fully engage in the VR experience and also the creation of a specific visual narrative.

3.1 Building strategic patterns in a photorealistic virtual reality (VR) environment

A visual narrative can be defined as pictures that tell a story. These pictures do not depend on a literary component, but are made up of an image or a set of visual elements, which are interwoven with a narrative intent (Coulter-Smith 2000). To strategically pattern aesthetic elements in Environment B, a visual-narrative model is implemented (Carroll 2005). This model allows the photorealistic VR Environment B to be designed in such a way so that it encourages participants to be drawn into the creation of a visual narrative. In

Figure 2. Environment B of Edinburgh flat (circles mark areas of saturated colour).

detail, Environment A represents a couple's room full of different objects, moods and interests; everything is a mishmash and it is difficult to distinguish who likes what and who does what. Environment B, on the other hand, is more of a biographical account – inspired by the autobiographical work "My Bed" (1998) by artist Tracey Emin and the photographic narrative "View from an Apartment" (2004–2005) by photographer Jeff Wall – of the female partner. It shows a couple's room full of objects (identical to Environment A) but this time the environment is strategically designed (using the visual-narrative model) to encourage the participant to sensuously "engage" in specific colours and hence specific interests, emotions and moods (Anderson Feisner 2000) in order to build up "intended" feelings and thoughts about the *female* character that lives there.

Similar to Antonioni's film *Red Desert* (1964), the aim is to use colour to give a greater insight into the main character of the story (Brown 2002). Therefore, the colours used in Environment B highlight two main categories, which include physical presence (i.e. personal details, interests, and occupation of the female partner) and geographical location. The colours are chosen and strategically placed to coax and guide the participant through the narrative by allowing them to create direct links between the objects (i.e. there is a direct link between the red shoes, red bag, red ribbon, etc.). In addition, the warm colours are also used intently to encourage participants to arouse youthful, happy, energetic and friendly feelings about the female person. There are certain areas of Environment B that are overlapped or heavily dominated with colour to attract the eye and engage the participant in deeper thoughts and feelings. The goal is to design a photorealistic VR environment that entices participants into "engaged interactions" (i.e. an environment that triggers certain thoughts and feelings) and in doing so assists participants in making connections and interpretations about the people living there (and in this case the female character).

3.2 Participants and procedure

Twenty participants (13 male and seven female) from a mixed academic background (i.e. working/studying in different subject areas) took part in the study. On arriving at the location of the test, all participants were asked to familiarise themselves with the VR experience especially the HMD and the equipment. To ensure that all participants had overcome the novelty of a first time VR experience, they were asked to try a sample unrelated VR environment for a few minutes. They were then told briefly about the nature of the test (i.e. informed that it would last at the most 30 minutes), they were asked to fill in some personal details and then to complete a standard Ishihara Test for colour blindness.

It was decided to use qualitative methods (i.e. a combination of the think-aloud method and the semi-structured interview) as a means of gathering data about the users experiences of both VR environments. The rationale for a combined approach is to ensure that participants' real-time thoughts and

feelings are captured as they are actually experiencing both VR environments (i.e. think-aloud) as well as their reflections on and feelings towards both VR environments (i.e. semi-structured interview). To start, the participants were told that they would experience two VR environments and that each VR trial was to last for 5–10 minutes. The order in which they experienced the environments alternated with each participant. They were then informed of the "Through the Keyhole" scenario (based on the popular UK Television show *Through the Keyhole*); they were asked to enter each environment and to look around for clues, which might help them to identify the type and character of the person/people that live/s there. In detail, each participant was asked to think-aloud about the following: "what do you know about the person/people who lives/live in the flat? What is his/her/their profession? What are his/her/their interests? Where does/do he/she/they live?" This think-aloud was recorded using the digital audio tape (DAT) and later transcribed.

After each trial, they were asked to answer in writing the following two questions: "Did you enjoy the experience? Why? Were you 'engaged' in the environment? Why? (i.e. Did it catch your attention and get you involved in the experience?)". In asking the participants to write down their answers, the aim was to encourage them to gather their thoughts and then reflect more deeply on the individual VR environment that they had just experienced. The final section of the study focused on using the semi-structured interview to compare the two VR environments. Each participant was, again, briefly shown both environments and then elaborating on the previous written questions, they were asked two similar questions which were recorded using the DAT (i.e. "Which one did you enjoy the most? Which environment did you find more engaging?"). The overall aim was to determine the effect (if any) that the strategic patterning of aesthetic elements in Environment B had on participants when compared to Environment A. In particular, the focus was on the "engaged interaction" and the role this played in channelling participants towards "intended" VR experiences.

3.3 Results

The data gathered was individually analysed and cross-referenced to identify themes that would best describe participants' experiences of both VR environments. In detail, each participant's think-aloud experiences were categorised into themes based on what types of narratives they experienced whilst in both environments. As Table 1 highlights, themes such as "female narrative", "couple narrative", "male and female narrative", "male narrative", "family narrative" and "unsure" have emerged. As these results show, 11 out of the 20 participants who experienced Environment B were inclined towards a female narrative, compared to only four participants out of the 20 for Environment A. This leads us to believe that the saturated colours in Environment B have had some impact on influencing participants' thoughts, feelings and intuitions about the person living in the flat. It is important to note here that all the participants passed the colour blindness test.

Table 1. Overview of results from the think-aloud.

	Female narrative	Couple narrative	Male and female narrative	Male narrative	Family narrative	Unsure
Environment A	4	7	6	2	N/A	1
Environment B	11	3	2	2	1	1

Even though both Environments A and B were almost identical, the 11 participants who experienced Environment B were more inclined towards more female-orientated thoughts and feelings (with only five participants in Environment B feeling a couple/male and female narrative). These comments from the think-aloud data gathered in Environment B include:

- "Definitely a woman, it's real easy just like the flowers and the painting on the wall which are not things men have, it's really, there is a bag, definitely a woman here ..." (Participant 1).
- "a girl, not definitely sure, because I see a bag" (Participant 3).
- "a female definitely ..." (Participant 5).
- "I would say definitely that maybe a girl lives here" (Participant 6).
- "Female I would say, just because of the bag, the bag is a female bag, definitely the clothes ..." (Participant 7).
- "Maybe it's female there is a bunch of flowers on the flower ... ya, I would probably say a girl ..." (Participant 9).
- "I would probably say the same young female" (Participant 10).
- "um maybe a girls room because it looks clean if a boy maybe it would be dirty" (Participant 11).
- "still the clothes hanging on the rack in front of the radiator seems to be a girls ... like a girls room" (Participant 12).
- "I think it's a girls room, um I think I can see female clothing lying around but then when I think the colours I immediately felt female" (Participant 13).
- "I would say a girl ... seems a girl to me, am sure it's a girls room" (Participant 14).

This contrasts to the participant's experience of Environment A where four participants experienced a female narrative and more interestingly, 13 participants read a more couple/male and female narrative. These comments from the think-aloud data gathered in Environment A show a leaning towards the couple/male and female narrative:

- "well still a girl ya but could be ... there's definitely a man living here" (Participant 1).
- "it's probably a couple, probably not a very old couple" (Participant 2).
- "It's obviously a couple: Welsh and Irish" (Participant 4).
- "I would say a single female with a boyfriend possibly a partner that would stay quite often" (Participant 5).

- "It seems a bit more couply than just one person" (Participant 6).
- "I still think it's a couple because there seems to be a mixture of male and female things around so I reckon a couple" (Participant 13).
- "I think there are two males" (Participant 14).
- "a couple because I saw the picture here" (Participant 15).
- "I don't know because there's a boys suit and a girls suit but I think just one person but he or she has a boyfriend/girlfriend" (Participant 16).
- "there is still the couple" (Participant 17).
- "I would say both male and female am simply because of the golf clubs but there is a pair of high heeled shoes on the floor" (Participant 18).
- "maybe it's two guys and a girlfriend or whatever" (Participant 19).
- "it looks like a couple" (Participant 20).

The above results suggest a strong difference in the participants' experiences of the two environments. Going on to consider the ordering that participants experienced the environments (see Table 2), an interesting observation is also revealed. When shown Environment B followed by A, the results suggest that the viewers will be heavily inclined to see the first as a female environment and the second as couply. Reversing the ordering, however, seems to reduce this effect since having seen Environment A first, participants seem to be less confident about whether Environment B is a female, couple or other experience. In a real life scenario, however, viewers would tend to experience only one environment at any time. Therefore, the results for those that experienced Environment A first and those that experienced Environment B first are important in that they suggest quite confident leanings towards the female narrative (i.e. Environment B) and also towards the couple narrative (i.e. Environment A).

From an overview of all the data analysed, it is clear that the saturated colours in Environment B have attracted participants' attention to objects that they did not necessarily notice in Environment A. The strategic patterns of colours have not only put an emphasis on certain areas in the room but in doing so, they have subtly persuaded participants to participate and to become involved with each object. It would appear that the participants in Environment B are tapping into their intuition, sensation and sentiment to create new meanings and to build up impressions (different to Environment A) about the person that lives in the flat. We can see more "engaged interactions" emerging where participants are forming happy and peaceful feelings while others are being more specific when they claim that the colours are giving them more female-orientated feelings and impressions:

- "The first one (Environment B) because of the colours, it is much more colourful and I think it gives you as well as the feeling of happiness that you have more colour, more brighter colours, brightness actually thinks it makes you feel much more happy. Much more you know, peaceful feeling, I don't know if that makes sense . . . a peaceful and colourful environment . . . if it's not colourful you feel much more sad . . ." (Participant 1).

Table 2. Overview of results and their ordering of experience.

Ordering of experiences	Female	Couple/male and female	Other
Environment A (first)	3	6	1
Environment B (second)	4	3	3
Environment B (first)	7	2	1
Environment A (second)	1	7	2

- "The feeling of the room gives off a girl's feeling ..." (Participant 7, Environment B).
- "The first thing that occurs to me as I think it's a girl room, um I think I can see female clothing lying around but then when I think the colours I immediately felt female" (Participant 13, Environment B).

These "engaged interactions" with the colours are feeding into participants' impressions of the room (i.e. the colours are making them feel more uplifted and happy which in turn are giving them lively and warm impressions of the room):

- "it seems a little bit livelier, the room" (Participant 4, Environment B).
- "But the first one (Environment A) felt like a dull day so the bright colours would automatically make me feel more cheered up" (Participant 5).
- "the feeling from the colours impressed me more" (Participant 20, Environment B).

When one probes closer, it is interesting to see how these feelings strongly differ from those felt in Environment A. The following comparisons show a distinct contrast between how participants felt in each environment:

In the Environment B, Participant 1 felt:

- "I will say a lively place, there's life here ... it's a very relaxed atmosphere, ya it's like because it's ordered but not totally ordered it's like everything ... ya it's a nice one" (Participant 1, Environment B).

While in Environment A, Participant 1 felt:

- "It's exactly the same but it looks sad ... I still feel comfortable but in the other one I would still have a smile on my face while looking at the bedroom but in this one I will just look at it I don't know how to express it, it's a global feeling ... its much more sad ..." (Participant 1, Environment A).

In Environment B, Participant 11 felt:

- "I think I feel warm about this room (Environment B) ah why ... the colours of the room, there are many warm colours in the room ... the room is small, not many things in the room and warm in my mind, it

feels comfortable maybe there is a beautiful girl'' (Participant 11, Environment B).

In Environment A, they felt:

- ''It's very similar but I feel some lonely ... um, um it's a simple and lonely room'' (Participant 11, Environment A).

When further investigated, some participants pondered over the contrasting feelings they were receiving from both environments (i.e. why they were feeling these):

- ''got slightly different feelings. it feels, um ... the first one (Environment B), I keep going back to colours but they were things that stood out first and foremost for me, um they would give me a different impression to the person who lived there, the second one (Environment A) I almost felt the person who lived there was in a, you know, longer relationship, don't really know why, could be to do with things like flamboyance for example the shoes ... ya that's it'' (Participant 5).
- ''I don't know because I thought story for the first environment ... if I think the second one (Environment A) is an old story and sad one in the first (Environment B) there is more activity, in the second one I don't know if the place was deserted just a little more deserted not a lot cos there are woman's shoes so in the second one'' (Participant 17).

It is interesting to see how the feelings, thoughts, intuitions, etc. triggered by the patterns of colours are encouraging participants to fully explore the room and in doing so to piece together a very specific story. As Participant (1) demonstrates, the saturated colours and the consequent feelings aroused are being framed into the creation of a narrative very different from that of Environment A (i.e. the happy routine of the person living in Environment B versus the more ''mundane'' routine of the person living in Environment A). Furthermore, the feelings and thoughts generated from the saturated colours are also influencing the participant's judgement on some of the finer details concerning this female character (i.e. the colours have made participants feel that the character is quite young):

- ''younger people probably 20's to 30's this time ok'' (Participant 4, Environment B).
- ''I would say the person is probably mid 20's early 30's'' (Participant 5, Environment B).
- ''certainly younger ah ... don't know if I would still say that it is rented certainly younger probably 20's, um ... ya'' (Participant 18, Environment B).
- ''I would say that she is in her late to mid twenties that, um ...'' (Participant 7, Environment B).

However, in Environment A participants are building different impressions, they feel that the character living in the flat is that bit older:

- "it kind of an old ladies flat ... oh no perhaps not middle aged slightly younger, kinda 30's to 40's maybe" (Participant 4, Environment A).
- "I would probably say they were a little bit more reserved ... in terms of what they were, maybe reserved is not the right word maybe a little bit ... they are not as flamboyant" (Participant 5, Environment A).

Overall, it seems that the strategic patterns of colour are drawing participants into the environment, engaging and then guiding their intuition, thoughts, feelings towards an "intended" female-orientated narrative. When asked in the semi-structured interview, which VR environment they found more engaging (i.e. which environment they were involved with and more drawn into), 15 out of 19 participants (one participant was unsure) found Environment B more "engaging" (see Table 3). This result is statistically significant (according to a binomial hypothesis test) at the 5% level.

In summary, this study demonstrates how the strategic patterning of colours in photorealistic VR environments can be used to engage and direct participants' intuition, sentiment and sensation into the creation of "intended" VR experiences. As the data show, participants in Environment B were "engaged" in teasing out female-orientated narratives; the colours triggered a narrative about a young and even "beautiful" female, a lively person, who is in a happy routine and living in a comfortable, relaxed flat. In the Environment A, participants read the opposite; they felt it is about an older and less flamboyant couple who are in a long-term relationship and in a routine, who perhaps live simple, lonely and sad lives.

4. Discussion

Can we design for experiences? Or more to the point of this paper, can we design for "intended" photorealistic VR experiences? The most significant outcome of this study suggests that aesthetics can be used in the design of VR environments to engage users' attention and direct them towards certain "intended" experiences. As we have seen, the strategic patterning of different colours in a photorealistic VR environment enticed the majority of participants into the creation of an "intended" narrative and in doing so an "intended" experience. The strategic patterns encouraged "engaged interactions", where participants (their feelings, past experiences, memories, knowledge, etc.) are seen to interact with the colours in Environment B and specific thoughts and feelings about the female character were created. Some might argue that "engaged interactions" might also have taken place in Environment A as participants also interacted with the content in the environment to come up with alternative narratives and experiences. In truth, to a certain degree, they probably did. However, the key contribution of this paper is demonstrating how we might design for these "engaged interactions", or to put it another way, how we as designers can induce these

Table 3. Comparison of Environments A and B.

	Which did you find more "engaging"?
Participant 1	Environment B
Participant 2	Environment B
Participant 3	Environment B
Participant 4	Environment B
Participant 5	Environment B
Participant 6	Environment B
Participant 7	Environment A
Participant 8	Environment B
Participant 9	Environment A
Participant 10	Environment A
Participant 11	Environment B
Participant 12	Not sure
Participant 13	Environment B
Participant 14	Environment B
Participant 15	Environment A
Participant 16	Environment B
Participant 17	Environment B
Participant 18	Environment B
Participant 19	Environment B
Participant 20	Environment B

interactions to suggest, coax and guide users towards certain experiences. As HCI and VR technology moves into a new "design" era, the significance of this paper lies in the scope it opens for the design of experiences, and in particular, how it points the way towards empowering designers with the means and motivation to successfully design for these user experiences.

5. Future work

For this study, qualitative methods were administered to probe into participants' real time and reflected thoughts and feelings on both VR environments. Whilst these provided rich and interesting data, future investigations would aim to further probe the "engaged interaction" and its role in the design of the "intended" user experience. In particular, the focus would be on establishing a robust and effective way of articulating, measuring and evaluating the "engaged interaction" and its impact on the "intended" user experience across the whole HCI platform. For example, extending the experimental framework of the study (i.e. possibly getting the users/study participants more involved in the design and development processes) whilst also doing a detailed investigation into the physical, mental and emotional makeup of the users/study participants. The data that were recorded for this study shows a random sample of participants consisting of almost equal numbers of males and females, and a group mostly within an age bracket of 20–50 years of age. Although it was never the intention to look at such matters in detail for this study, it is possible that these issues may influence the level of "engaged interactions" that occurred. For related work in this

direction, see Simon (2000), Karsvall (2002), Khaled *et al*. (2006), Bosser *et al*. (2007), Da Cunha and Greathead (2007), Burnett *et al*. (2008) and Lottridge and Moore (2009). In the future, it would be interesting to give the users/study participants a more central role in the design and development processes whilst also to investigate the impact that gender, culture, age, emotions, personality and background has on how they might "engage" in the "intended" user experience.

6. Conclusion

As the findings show aesthetics (i.e. colour) can be strategically patterned in a photorealistic environment to suggest, coax and guide users towards "expected" and "intended" experiences. Indeed, aesthetics has huge potential in influencing how participants feel in a photorealistic VR environment and hence what type of experiences they might engage in. In terms of HCI, the power to permit and even direct users towards the experience that is "intended" for them, opens the door to endless possibilities of how we might control the design of experiences (i.e. how we might design for certain perceptions, cognition and behaviours amongst users). As this paper shows, by pursuing the "engaged interaction" instead of merely the "physical" interaction, this paper exposes a broader and richer HCI world. In this world, designers have more scope to consider and more deeply explore the way we use computers today (i.e. the relationships that are formed and how we design and build for those relationships). In summary, this paper has shown the potential of aesthetics to affect participants' interpretations and experiences of a photorealistic VR environment and in doing so, has given us the scaffolding to explore the design of experiences in other technologies. On one level, this paper has demonstrated that the aesthetic content of photorealistic VR environments holds many possibilities for the creation of new and exciting experiences. On another, it has introduced the concept of the "engaged interaction" and how we might start to think and design interactions beyond those solely associated with utility and usability.

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References

E. Anderson Feisner, *Colour,* London: Laurence King, 2000.

M. Blythe, P. Wright and J. Mccarthy, "Theory and method for experience centred design", in *CHI 2006 – Conference on Human Factors in Computing Systems, 22–27 April, Montréal, QC, Canada,* New York: ACM Press, pp. 1691–1694, 2006. Available online at: http://portal.acm.org/ft_gateway.cfm?Id=1125764&type=pdf (accessed 30 November 2006).

A. Bosser, G. Levieux, K. Sehaba, A. Buendia, V. Corruble and G. De Fondaumière, "Dialogs taking into account experience, emotions and personality", in *Proceedings of the 2nd International Conference on Digital Interactive Media in Entertainment and Arts, DIMEA'07, 19–21 September 2007, Perth, Australia*,

New York: ACM Press, vol. 274, pp. 9–12, 2007. Available online at: http://doi.acm.org/10.1145/1306813.1306823 (accessed 31 May 2008).
J. Brown, 2002. Michelangelo Antonioni. *Senses of Cinema*. Available online at: http://www.sensesofcinema.com/contents/directors/02/antonioni.html (accessed 16 December 2005).
M. Burnett, S. Wiedenbeck, V. Grigoreanu, N. Subrahmaniyan, L. Beckwith and C. Kissinger, "Gender in end-user software engineering", in *Proceedings of the 4th International Workshop on End-User Software Engineering, WEUSE'08, 12 May, Leipzig, Germany,* New York: ACM Press, pp. 21–24, 2008. Available online at: http://doi.acm.org/10.1145/1370847.1370852 (accessed 31 May 2008).
F. Carroll, "Developing a visual-narrative model to enhance engagement in a virtual reality environment", in *Proceedings: The 19th British HCI Group Annual Conference,* Edinburgh, UK: Napier University, 2005.
J.M. Carroll, *Human Computer Interaction in the Millennium*, New York: ACM Press, Addison-Wesley, 2001, p. 112.
D. Collinson, "Aesthetic experience", in *Philosophical Aesthetics, An Introduction*, O. Hanfling (Ed.), Oxford: Blackwell and the Open University, 1992.
G. Coulter-Smith, *The Visual-Narrative Matrix*, Southampton, UK: Southampton Institute, 2000.
M. Csikszentmihalyi and R.E. Robinson, *The Art of Seeing – An Interpretation of the Aesthetic Encounter*, New York: J. Paul Getty Museum, 1990.
A.D. Da Cunha and D. Greathead, "Does personality matter? An analysis of code-review ability", *Communications of the ACM,* 50(5), pp. 109–112, 2007. Available online at: http://doi.acm.org/10.1145/1230819.1241672 (accessed 31 May 2008).
A. Gazzard, "Playing without gaming", in *Digital Games: Design and Theory*, 14 September, London: Brunel University, 2007. Available online at: http://arts.brunel.ac.uk/gate/gamesconference/ (accessed 10 February 2008).
R. Harper, T. Rodden, Y. Rogers and A. Sellen, *Being Human: Human-Computer Interaction in the Year 2020*, Cambridge: Microsoft Research, 2008.
J. Karat and C.M. Karat, "The evolution of user-centred focus in the human-computer interaction field", *IBM Systems Journal*, 42(4), 2003. Available online at: http://www.research.ibm.com/journal/sj/424/karat.html (accessed 26 October 2006).
A. Karsvall, "Personality preferences in graphical interface design", in *Proceedings of the Second Nordic Conference on Human-Computer Interaction, 19–23 October 2002, Aarhus, Denmark,* New York: ACM Press, pp. 217–218, 2002. Available online at: http://doi.acm.org/10.1145/572020.572049 (accessed 31 May 2008).
R. Khaled, P. Barr, R. Fischer, J. Noble and R. Biddle, "Factoring culture into the design of a persuasive game", in *Proceedings of the 20th Conference of the Computer-Human Interaction Special Interest Group (Chisig) of Australia on Computer-Human Interaction: Design: Activities, Artefacts and Environments, 20–24 November, Sydney, Australia*, New York: ACM Press, pp. 213–220, 2006. Available online at: http://doi.acm.org/10.1145/1228175.1228213 (accessed 31 May 2008).
T. Lavie and N. Tractinsky, "Assessing dimensions of perceived visual aesthetics of web sites", *International Journal of Human-Computer Studies*, 60, pp. 269–298, 2004. Available online at: http://www.ise.bgu.ac.il/faculty/noam/papers/04_tl_nt_ijhcs.pdf#search=%22lavie%2C%20visual%20aesthetics%20of%20web%20sites%22 (accessed 3 October 2006).
M.A. Livingston, S.R. Ellis, D.W. Mizell, J.W. Ruffner and M.C. Whitton, "How do we solve human factors for AR and VR applications?" In *Proceedings of the IEEE Conference on Virtual Reality* (25–29 March, 2006), VR. IEEE Computer Society, Washington DC, 301–302.
D. Lottridge and G. Moore, "Designing for human emotion: Ways of knowing", *New Review of Hypermedia and Multimedia*, 15(2), pp. 147–172, 2009.
J. Löwgren and E. Stolterman, *Thoughtful Interaction Design – A Design Perspective on Information Technology*, Cambridge, MA: MIT Press, 2004.
S.J. Simon, "The impact of culture and gender on web sites: An empirical study", *SIGMIS,* 32(1), pp. 18–37, 2000. Available online at: http://doi.acm.org/10.1145/506740.506744 (accessed 31 May 2008).
A.G. Sutcliffe, *Human-Computer Interface Design*, 2nd ed, London: MacMillan, 1995.