

# User Experiences with Web-Based 3D Virtual Travel Destination Marketing Portals – The Need for Visual Indication of Interactive 3D Elements

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## ABSTRACT

The tourism sector has found virtual reality technology to be a good way to market travel destinations for consumers. In this paper, we describe two user studies with three web-based 3D virtual travel destination marketing portals. These three portals were developed to support and attract wintertime tourism into the region by offering a possibility to experience in advance, a virtual snowy scenery with different activities, for example downhill skiing. In both user studies with 21 subjects the focus was on user experience with the 3D virtual travel destination marketing portals. In the second study also the visual design aspects within these portals were studied. Our studies indicate that 3D virtual travel destination marketing portals can enhance 2D web pages, if they offer the possibility to explore the location freely and through different kinds of virtual activities. Also our studies support prior findings of the efficiency of glow effect for indicating interactive 3D elements within a 3D virtual environment.

## Author Keywords

HCI; user experience; 3D; virtual environments; travel destination marketing; design; visual indication.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION

Most travel information on the web has been on 2D web pages that offer images and textual description of the travel destination. Today's online map services offer more possibilities to see the travel location ahead with a realistic 3D view, for example Google Earth ([www.google.com/earth/](http://www.google.com/earth/)) and explore the place through photographed street views, e.g. Google Street View ([www.google.com/streetview/](http://www.google.com/streetview/)). Although these services offer some elements of a 3D experience, they are not full 3D virtual environments (VEs). That is why, the tourism

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marketing sector has moved its focus on 3D VEs and virtual reality (VR) for marketing tourist sites before the actual travelling happens (Guttentag, 2010), (Hobson & Williams, 1995), and (Huang et al. 2010 & 2013). Huang et al. (2010) even claim that virtual worlds (VWs), such as Second Life (SL) ([www.secondlife.com](http://www.secondlife.com)) can become an optimal marketing platform for the tourism sector. The benefit of using VEs for destination marketing is that they can simulate real visits and the virtual experience can provide almost real-life experiences (Buhalis & Law, 2008). According to Hobson and Williams (1995), the use of virtual reality systems can also help the user to make better-informed decisions and gain more realistic expectations, which leads to a more satisfactory vacation.

In this paper we study how users experience web-based 3D virtual travel destination marketing portals. As the portals are 3D user interfaces (UIs), there are different kinds of 3D objects presented within the portals, of which some are interactive. To make the user interaction smoother, the user needs to understand which 3D items are interactable. Therefore, the sub-focus of this paper is to study how interactive 3D elements within a VE should be designed and presented for the user. The research questions are: how users experience 3D virtual travel destination marketing portals and how interactive 3D objects should be presented to the user of a virtual portal? The results indicate that 3D virtual portals bring value to destination marketing. Also 2D icons within 3D VEs are more easily interpreted as interactive than the 3D elements. This might be because the 2D icons are more familiar from 2D computer user interfaces. 3D icons and elements were instead more easily interpreted as part of the 3D scene. A solution for improving recognisability of 3D elements is to highlight their visual appearance. We also found that icon design for the 3D VEs is quite challenging because of the icons various interpretations.

First in this paper, we go through related research. Second, we describe the three 3D virtual travel destination marketing portals. Third, we explain the first user study with 21 subjects. Fourth, we describe how our study findings were used to iterate the portal designs. Fifth, we explain second user study with 21 subjects. Finally, we discuss the findings and conclude the paper.

## RELATED RESEARCH

Virtual environments and worlds are computer-generated 3D UIs. Bowman et al. (2005) define a 3D UI as: "a UI

that involves 3D interaction". 3D interaction can be done also through 2D input devices, such as mouse and keyboard. Thus, if a user clicks the target object with a mouse in a 3D VE to navigate to it, it means 3D interaction. (Bowman, 2005.)

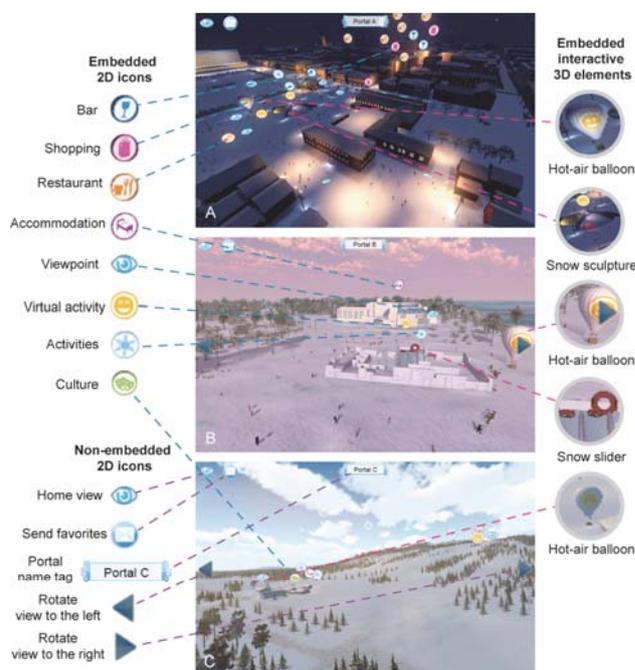
To be able to utilize VR technology and VEs in the tourism sector, we need to understand users and their expectations with VEs. Huang et al. (2010) suggest that virtual world design has to provide enough challenge to attract consumers. But as Buhalis and Law (2008) remind, every tourist is different and has unique motivations, desires and experiences. As Cotte et al. (2006) point out, consumers with utilitarian behaviour are more task focused and therefore more interested in information search than the experience itself. On the other hand, pleasure-orientated consumers typically enjoy using the Internet to play games or chat (Buhalis and Law, 2008). Also, as the role of children as decision makers in travel destination selection has grown within last decade (Wang et al., 2004), the playability aspects of the service should not be overlooked. As children are interested on games and fun, therefore, it is suggested that tourism web sites targeted for children should provide games to attract them to spend time on the webpage and finally visit the tourist site (Andersen et al., 2007; Buhalis and Law, 2008). Therefore, to attract children and pleasure-oriented consumers, travel destination marketing VR applications need to have playful aspects. This can be challenging, as Guttentag (2010) reports; it is easier to re-create the site or its objects than to re-create an activity, such as, a camel ride. Thus, there is a need for new knowledge of the playfulness aspects and virtual 3D activities in the VEs meant for destination marketing.

Prior research on VR technology within the context of travel and tourism has focused on usability and acceptance (Huang et al., 2010 & 2013). Lately research has started to focus more on substantive understanding of user behaviour and experience with VR technology. For example, Huang et al. (2013) have studied 3D VR tourism destinations by utilizing a technology acceptance model with hedonic theory. We claim that to be able to truly understand users' experiences and needs for the 3D virtual reality based travel destination marketing services, a more qualitative approach needs to be taken. User experience is defined in the ISO 9241-110:2010 standard (2010) as: "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service". As UX is dynamic, context-dependent and subjective (Law et al., 2009), it needs to be studied in real-time, otherwise the experience can change or be forgotten. The best way of collecting users experiences is suggested to be by interviewing the subject (Arhipainen, 2009). Also user experience is worth of studying as it is an important factor for products' success (Jordan, 2000; Pine & Gilmore, 1998).

### 3D VIRTUAL TRAVEL DESTINATION PORTALS

The study was done with a web-based 3D virtual travel destination marketing portal (www.mericityunturi.fi). Where three travel destinations (Portal A, B, and C in

Figure 1.) can be virtually visited. These portals were developed to support and attract wintertime travel and tourism into the region and to market the destinations. The idea was to offer a possibility to in advance, virtually experience the snow and wintertime lighting conditions with different 3D activities, such as, downhill skiing. As the portals are based on a webpage, user needs only to download the Unity Web Player to be able to start the virtual tours. On the webpage there is also a photo gallery, travel information, and other information links.



**Figure 1. 3D virtual travel destination marketing portals: A, B, and C. All portals have embedded 2D icons, overlaid non-embedded 2D icons and embedded interactive 3D elements.**

### Atmosphere in the Portals

These three winter-themed virtual portals have different visual appearance. The portal A (Figure 1, A) presents an evening lighted market place in the city context with light snowing. Portal B (Figure 1, B) presents winter activities on the beach by a frozen sea in the afternoon winter light conditions. Portal C (Figure 1, C) presents a ski resort in the middle of a snowy forest in midday light.

In addition, each portal has different sounds. Portal A has city noise e.g. people talking. In portal B and C, the sound is a windy breeze. Also in a few viewpoints mystical music or reindeer sounds are played.

The portals are not typical virtual worlds, as there are no users' avatars in the portals. Therefore, there are animated people moving in the portals to make them look more alive. People are ice-skating, reindeer or husky sledge riding, downhill skiing or walking on pre-defined paths.

In the portals, a user can experience winter themed virtual 3D activities. In portal A, the user can interact with the snow sculpture in two ways: a) s/he can adjust lighting design reflected on it by clicking it or b) s/he can take an animated tour around it by clicking in front of it. In portal B, the user can experience virtual snow sliding by clicking a snow slider. In portal C, the user can

experience virtual downhill skiing by clicking the slope or the 'virtual activity' icon on it. When activities are on, the user can rotate the view to all directions.

### **Interactive Elements in the Portals**

Within each portal there are three kinds of interactive elements presented: non-embedded 2D icons, embedded 2D icons, and embedded 3D objects (Figure 1).

#### *2D Icons*

2D icons look exactly the same within all three virtual portals. 2D icons are either overlaid on top of the portal view (non-embedded) or into the 3D virtual environment (embedded). The non-embedded 2D icons are: 'home view' icon (for moving back to the home/ start view), 'send favourites' icon (for sending favourite links to users own email), name label of the portal (for changing to an other portal by pressing the label and selecting portal name from the opening list) and arrows to the left, right, up, and down (for rotating the view). These arrows are not showed if the view cannot be rotated to a certain direction. Embedded 2D icons are: 'viewpoint' icon (via these icons a user can navigate through the 3D scene), 'virtual activity' icon (presents 3D activities that user can experience in that location), 'shopping', 'restaurant', 'accommodation', 'bar', 'activities', and 'culture' icons provide travel information of the site (when user clicks the icon, a 2D pop-up window opens on the screen and provides pictures and textual information).

#### *Embedded Interactive 3D Elements*

There are also different interactable 3D objects and elements presented in every portal. In all three portals there is a 3D hot-air balloon, which is used for moving to other portals, such as a teleporting device. When a user clicks the hot-air balloon, a 2D pop-up list of possible locations opens. In addition, within each portal there are different virtual activities presented in the form of a 3D element, and also indicated with 'virtual activity' 2D icons. A 2D icon is floating in the air above the 3D activity spot in the 3D VE. But the actual 3D elements and objects do not look any different from non-interactive 3D items. In portal A, there is a snow sculpture and in portal B, a snow slider. In portal C there is a downhill skiing virtual activity, but there is no 3D object or element presenting it, just a 2D icon floating in the air on the slope where the activity starts.

### **Moving in the Virtual Portals**

Even though portals have a 3D virtual space where a user can experience the location prior to the trip, moving in the portal is limited to predefined spots (indicated with the 'viewpoint' icon) where a user can use arrows to look around (up-down and left-right). This makes moving in portals collision free and easy also for novice users who do not have any experience with 3D VEs.

### **THE FIRST USER STUDY**

The focus of the first user study was on overall user experiences with the travel destination portals. Also usability aspects were studied.

#### **Tasks**

Prior to the actual tasks, subjects filled a background questionnaire. Also after the test participants completed a

post questionnaire with 5-point Likert Scale questions. Order of the portals shown in the user test was counter balanced for each participant. Seven subjects started with portal A, B, and C. The tasks were the following.

- **Task 1. Interactive elements:** Go to the virtual portal: A, B, or C. Don't move in the portal yet, just look at the view. Mark down on the printed image (Figure 1, A, B, or C) all the elements that look interactive and explain why.
- **Task 2. Free and task focused use of portals:** explore the portal while thinking aloud about your experiences, how do you understand it, where to go, and things you like/ don't like in it. Moderator gave tasks, such as: how would you move to another portal.

### **Evaluation Setting and Hardware**

The study was conducted in a laboratory setting. The portals were shown from 12,1" HP EliteBook 2760p and an external mouse was used for interaction. The colour printed images for the first task were made from the screen shots taken from the portal home views. The images on the paper were similar in size as portals shown on the screen. A semi-structured interview method was used. Also observation notes and user comments were written down and sessions were video recorded. The sessions lasted about for one hour.

### **Participants**

We recruited 22 participants. One subject was later disqualified, as her markings in the first task were not clear, therefore results from 21 subjects are reported here. 53% of the participants were females. Subjects age varied from 20 to 72 with mean of 35. 24% of the subjects had experience with 3D games and 29% with virtual worlds.

### **FINDINGS**

Results were analysed by applying open coding principles. The analysis was done from observation notes aided by video. Results are presented in the following sub-sections.

#### **Interactive Elements in the Portals**

Participants' markings for interactive elements are presented in Table 1. In all three portals, from non-embedded 2D elements, the name banner was least marked as interactive, as from 0 to 2 of the subjects in each portal marked it. The other non-embedded 2D icons within all three portals were marked as interactive by 5 to 6 of the participants in each portal. Most of the embedded 2D icons were marked as interactive by 6 to 7 of the subjects in each portal. As the 'accommodation' icon in portal A was located behind the portal name banner, it was marked as interactive by only 4 of the subjects.

From the embedded 3D elements, the hot-air balloon was marked as interactive by 4 of the subjects in portal A, and by 2 in portal B and by 1 in portal C. The snow slider in portal B was marked by 4 of the subjects, but none of the participants marked the snow sculpture in portal A as interactive. Also non-interactive 3D elements, such as buildings, snow castle, sky, sea, and people, were marked as interactive. Hot-air balloon was not perceived to be distinctive enough to be noticed in the start view within portal C and B. The reason for why subjects noticed hot-

air balloon in portal A, was because of ‘virtual activity’ icon on it and the balloon was also well lit compared to the hot-air balloon in portal C where the light came from balloons back. In portal C, also the size of the balloon was small and the icon on it was not as distinctive as in portal A. In the portal B, the hot-air balloon was located behind the right arrow, which cluttered the view to it.

Even though people could not find all the interactive elements within the scenes, their own impression afterwards was totally different. 57% of the subjects thought that interactive elements were sufficiently presented and 76% of the subjects thought that interactive elements were distinctive enough from the background space. As one participants stated: *“I did not find any problem with this matter”* (Female, ID21). She completed the markings task with portal A, and failed to mark the hot-air balloon, snow sculpture, and even 17 icons of the embedded 2D icons from 5 icon groups.

Elements marked as interactive		Portal (n/7)		
		A	B	C
Non-embedded 2D icons	Name banner	1	2	0
	Home view	6	6	5
	Send favourites	5	6	6
	Arrow left	-	5	5
	Arrow right	-	6	5
Embedded 2D icons	Accommodation	4	7	7
	Virtual activity	7	6	7
	Activities	6	7	7
	Viewpoint	7	6	7
	Culture	-	-	7
	Restaurant	6	-	-
	Bar	6	-	-
	Shopping	6	-	-
Embedded 3D elements	Hot-air balloon	4	2	1
	Snow sculpture	0	-	-
	Snow slider	-	4	-
Non-interactive 3D elements	Buildings	1	1	1
	Nature	0	1	1
	People	0	1	0
	Snow castle	-	2	-

**Table 1. User markings of interactive elements within all portals: A, B, and C. (-) Not visible in the scene.**

### User Experiences with the Portals

From a user experience point of view, portals are interesting and can offer a lot of potential to the tourism sector. The best thing with virtual portals was perceived to be the possibility to get an overview of the area that the portal is presenting, 45% of the participants would like to use the portal for checking the neighbourhood and getting to know the place prior to the trip. As one participant commented: *“You will get to know the place and scenery*

*from your home”* (ID12). 85% of the participants perceived that virtual portals would bring added value to travelling. Also subjects perceived to get more precise information of the area with the portal than in any other way. As one stated: *“Nicer and more informative than static webpages”*(ID14). After using the portal, 38% of the subjects were planning a trip to the portal destination.

To make portals more suitable for tourism and travel planning, 90% of the test participants thought that portals should offer more travel information of the destination. For example, 70% of subjects wanted to find more reservation and shopping opportunities within the portals. As one participant commented when using portal B: *“I would like to do booking of hotel or some events through the portal”* (ID4). Also 25% of the subjects were interested in checking prizes, opening hours, and book tables through a virtual portal to the restaurants in the area. Also historical information of the buildings and sculptures was wished for. 40% wanted to see also videos and pictures of the location.

20% of the subjects perceived the size of the portal A as too limited, because it was showing only the market place and not the actual city. As one commented: *“City is more than just a market place”* (ID11). Subjects also wished to be able to have a wider view of the sea and port area.

48% of users thought that animals and people fit in the virtual portal and they bring liveliness to it. But 29% gave negative feedback of the character design: *“strange figures”, “moving looks odd”, and “gang is roaming”*.

Also subjects were glad that they did not have to sign in to the portal. They just opened the portal, as the Unity Web Player was installed to the computer in advance.

### Atmospheres in the Portals

The visual appearance of the all portals was perceived as pleasant by most of the participants: A 95%, B 81% and C 81%. The atmosphere of the portal A was commented as: *“Atmospheric winter night”, “nice colours”, and “realistic”*. Portal B was commented as: *“wintertime sunset”, “pleasurable”, and “nice”*. Atmosphere in portal C was perceived as: *“Cloudy winter landscape”, “calm” and “realistic”*. The sounds were liked, but it was wished that all sounds could be muted if needed.

### Virtual Activities

Virtual activities were perceived as a nice addition to the travel portals. Especially the downhill skiing in portal C was liked. Virtual activities also made participants to wish for more, as they wished that they could skate, drink hot chocolate, and fly with a hot-air balloon. Also 52% wanted virtual portals to offer more playability aspects. 50% of the participants also wished that they could exit from the virtual activity animation.

### Moving in the Portals

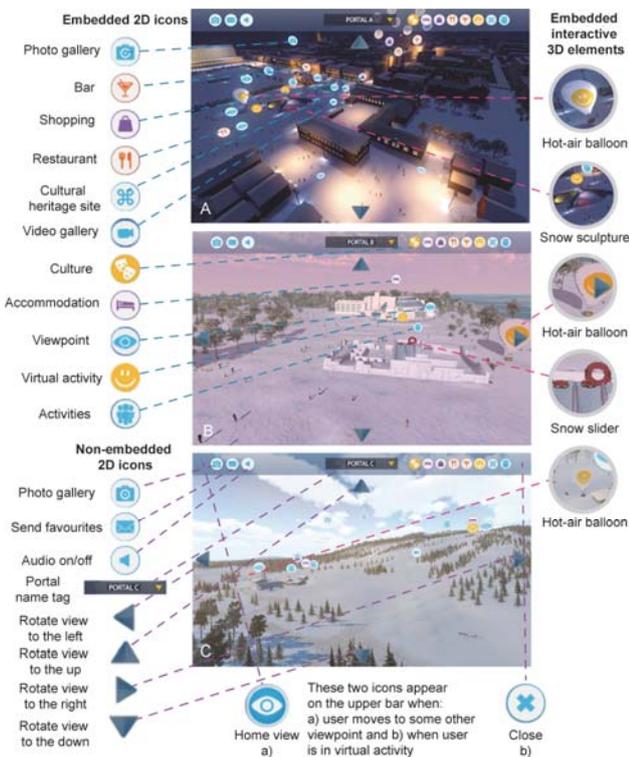
Arrows were perceived to be a natural way to move in the portal. But the viewpoint navigation in the portals was perceived not good, as 50% of the subjects would have wanted to move in the portals more freely by walking or flying. 25% of the subjects thought that it is possible to fly with the hot-air balloon and view area from the air.

## 2D Icons

The meanings of the 2D icons were not clear to 52% of the subjects. The 'activities' (snowflake symbol) icon was interpreted as snow or weather because of its symbol. The meaning of the 'viewpoint' (eye symbol) icon was also not clear for the users. Subjects had difficulties also in locating the actual location of the 2D icon in the 3D space, because the icons were floating in the air.

## CHANGES IMPLEMENTED TO THE PORTALS

Due to cost and time limitations, only the most critical changes were made. Visual changes for the portals are presented in Figure 2.



**Figure 2. Visual changes made after the first user study for interactive elements in three portals A, B, and C. All portals have embedded 2D icons, overlaid non-embedded 2D icons and embedded interactive 3D elements.**

## Icons

The overlaid non-embedded elements were located as before, but they received translucent dark grey rectangle area under them, to make them more distinctive from the background. The visual appearance of the portal nametag was made more modern and it was designed with a yellow arrow to indicate that it works as a drop-down menu. Also, to make the 3D view less cluttered, it was enabled to filter out icons showed in the view by de/selecting icons on the non-embedded translucent area.

Also some icons were redesigned. As the participants misinterpreted the 'activities' icons snowflake symbol, it was redesigned to a group of people to better represent activities or events. Also other icons; 'culture', 'bar', 'restaurant', 'shopping', 'send favourites', 'viewpoint', 'home view', 'accommodation' and 'virtual activities'; were redesigned to make them look more modern and simpler. Also, visual quality of icons was improved and they were made brighter. The 'home view' icon was

designed and implemented in the way that it appears on the upper left corner when user moves to some other viewing position. New services were also added based on our suggestions after the first study. Videos and images of the site were added and new 2D icons for them were designed. Also new icons were designed for a cultural heritage site and audio mute action.

## Moving in Portals

Even though subjects wished for a possibility to move more freely by walking, no changes were made, because it would have made navigation more difficult. As subjects wished to be able to move more freely in the portal by flying, and have at the same time a view of the area from air, the hot-air balloon function was changed to enable that. Steering was enabled by the arrows or holding down the left mouse button, while moving the cursor in the 3D VE area. Also rotation of the view was done similarly.

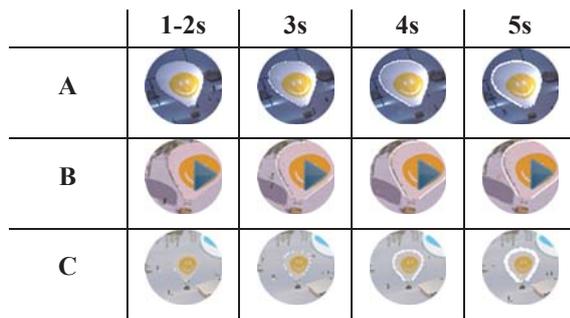
## Virtual Activities and Playability Aspects

Participants wished more playability aspect to the portals. Therefore, a possibility to toss snowballs with hitting the space key while flying in the hot-air balloon, was added. The snowball tossing was not advertised in the portal, but it was left to be found by the users, to offer excitement of discovering something hidden. As Arhipainen (2009) notifies, to be able to enhance the experience, the system should surprise the user by offering possibilities to experience something unexpected and unpredicted.

Also a possibility to stop virtual activity was implemented. When the virtual activity, for example, snow sliding is on, an 'x' icon appears on the right upper corner on the translucent area (Figure 2). When cursor is moved on the icon, a 2D pop-up window with text 'Close' appears next to it.

## Embedded Interactive 3D Elements and Objects

In the first user study, the biggest problem with embedded interactive 3D elements was that the subjects did not notice them well. Thus, we suggested that they should be made to look more interactive to draw user attention to them. Visual attention process has been studied extensively within cognitive science, neurology and psychology, but also within VEs especially on task-oriented VEs, such as interactive 3D games (Beeharee et al., 2003), (Bernhard et al., 2010), (El-Nasr & Yan, 2006). To enhance interactivity of 3D elements, Beeharee et al. (2003) suggest that highly contrasting colour and object orientation changes compared to their neighbours are most likely to gain visual attention from the user. Other user experience based studies with graphically rich looking VEs which are populated with colourful objects, suggest that a slight glow effect around the object is a better way to enhance interactivity (Pakanen, et al., 2013a and 2013b) than a total colour overlay on the object. Therefore, the hot-air balloons and snow sliders were designed with white pulsating glow effect around them. Figure 3 presents an example of the hot-air balloons pulsating glow effect animation within a 5-second timeframe. The size of the glow varies between zero and four pixels. Viewing distance affects the perceived size of the glow. Therefore, the effect looks slightly bigger if the object is located further from the viewer (Figure 3, C).



**Figure 3.** The pulsating glow effect size varies from 0 to 4 pixels on hot-air balloon within a 5-second timeframe.

### THE SECOND USER STUDY

The focus of the second study was also on user experiences with the portals, but it was more concentrated on visual changes implemented to the portal. Especially, we wanted to find out if the visual indication of interactive 3D elements helps participants to notice the embedded interactive 3D elements more easily.

#### Tasks

Prior to the actual tasks, participants filled a background questionnaire. Also after the test participants completed a post questionnaire with 5-point Likert Scale questions. Seven participants started with portal A, seven with portal B, and seven with portal C. The tasks were the following:

- **Task 1. Interactive elements:** Look at the view, don't move in the portal yet. Mark on the printed image of the portal (Figure 2. A, B or C) all the elements that look interactive and explain why.
- **Task 2:** Start moving in the portal while thinking aloud. Then move to the viewing position and turn the view to things that moderator is pointing to. Then the next questions were asked:

**Embedded 2D icons:** Where is this icon pointing to in the 3D VE and what embedded 3D element is it indicating? Is an additional visual cue needed from the 2D icon to the 3D element, such as a line?

**Glow effect:** What do you see in the hot-air balloon? Is a similar effect needed on the other embedded interactive 3D elements?

- **Task 3. Virtual activities:** What can you do with this 3D element? Comment also moving in the portal?

#### Evaluation Setting and Hardware

The evaluation was conducted in a laboratory setting. The portals were shown from a 13" Macbook Pro and subjects were asked to interact with portals through an external mouse or the computers track pad. The colour printed images for the first task were made from screenshots of the portal home views when the glow indication was not in sight. The images on the paper were similar in size as the portals on the screen. A semi-structured interview method was used. Also user comments and observation notes were written down and sessions were video recorded. Sessions lasted for about 20 minutes.

### Participants

We recruited 21 subjects of which one participated also in the first study. Participants' age varied from 19 to 56 with a mean of 35. 53% of the subjects were male. All participants had some experience with 3D technologies. 57% of them used virtual environments or worlds and 48% played 3D games. All of the subjects used online maps for planning travel trips and 90% of them used also Google Street View. To search for information about the travel destination, 86% had used 2D webpages, and only one had used a 3D virtual world.

### FINDINGS

Results were analysed by applying open coding principles. The analysis was done from observation notes aided by video. Findings are presented in the following sub-sections. Participants' markings of interactive elements are presented in Table 2.

Elements marked as interactive		Portal (n/7)		
		A	B	C
Non-embedded 2D icons	Name banner	4	6	5
	Mute	3	6	6
	Envelope	3	6	6
	Camera	3	6	6
	Arrow left	-	6	4
	Arrow right	-	6	4
	Arrow up	4	6	4
	Arrow down	4	6	4
	Filtering icons	2	6	6
Embedded 2D icons	Accommodation	1	7	6
	Virtual activities	6	7	6
	Activities	6	7	6
	Viewpoint	6	7	7
	Culture	-	-	-
	Restaurant	6	-	-
	Bar	7	-	-
	Shopping	6	-	-
	Cultural heritage site	6	-	-
	Video gallery	6	-	7
	Photo gallery	6	-	7
Embedded 3D elements	Hot-air balloon	6	3	5
	Snow sculpture	0	-	-
	Snow slider	-	6	-
Non-interactive 3D elements	Buildings	0	1	1
	Nature	0	0	0
	People and animals	1	1	1
	Snow castle	-	0	-

**Table 2.** User markings of interactive elements within all three portals A, B, and C. (-) Not visible in the scene.

### Interactive Elements

Of the non-embedded 2D icons, portal B received the most markings, as 6 of the subjects recognized all of the icons as interactive. In portal A, subjects' markings varied from 2 to 4 per icon, and in portal C, from 4 to 6 per icon. Some icons (the 'restaurant', 'bar', 'accommodation', and 'shopping') in portal A were problematic, because they were either completely or partly located under the translucent upper bar and therefore looked as non-interactive. Therefore, 6 subjects marked just those that were not behind the translucent area. The 'accommodation' icon was completely behind that area and was marked by only one subject.

Of the embedded 3D elements, the hot-air balloon was marked as interactive by 6 of the subjects in portal A, 3 in portal B and 5 in portal C. In portal B, the hot-air balloon is located behind the right arrow, thus the location of the item might have a bigger impact on its perceptibility than the effect, as in same scene the centrally located snow slider was marked as interactive by 6 participants. As one subject stated: "(I marked it) *Because of the glow effect*", and why he did not mark hot-air balloon as interactive: "...because it was behind that arrow so I did not notice it" (Male, ID11). Subjects who noticed the glow effect on the hot-air balloon in the first task, stated that it clearly indicated interactivity, as one stated: "*Immediately when I noticed it, I got an idea that says: press me...*" (Female, ID6). It was also marked as interactive for other reasons: 4 out of 21 marked it for the virtual activity icon on it and 2 out of 21 for the size of the balloon. Later when the users saw the hot-air balloon closer, 91% noticed the glow effect and interpreted it to mean interactive content.

No one marked the snow sculpture because it did not have any visual indication on it. As one subject stated: "*It looks nice with lights, but interactiveness of it is not distinctive as every house and sculpture is also lighted, so they look the same*" (Female, ID6).

#### **Pulsating Glow Effect**

95% of the subjects agreed that visual indication of interactive 3D elements is needed. The pulsating glow was agreed to be noticeable enough by 86% of the users. They commented it as: "*something is going to happen if you press here*" (Male, ID1 & Female, ID20), "*something special, because it is highlighted*" (Female, ID18), and "*it is available for you*" (Male, ID21). But those who did not notice the effect so well, stated: "*it is a little bit hasty*" (Male, ID11), "*effect could be larger*" (Male, ID12), "*not clear, too light*" (Male, ID3), and "*(pulsating) could be faster*" (Male, ID8).

Subjects were concerned with what would happen if all the interactive 3D elements would be indicated with the glow effect in the scene with a lot of interactive 3D elements. As one stated: "*It is a funny element, but it would start to be disturbing if there would be a lot of these elements...could it be designed in the way that it is shown only if the cursor is moved on the interactive element*" (Female, ID17). Also another suggested: "*yes, it would help the first use, as it guides quite well...could it close automatically after a while*" (Female, ID15).

Subjects suggested that there is no need to indicate all of the interactive 3D elements. As one stated: "*something should be left for the user to be discovered*" (Male, ID21). Another stated: "*If people are searching for information, then it would be good that it would be found immediately... but there could be also some kind of an 'Easter egg', and if you click it something exiting will come out of it*" (Male, ID7).

#### **Other Items Interpreted as Interactive**

Animations drew users attention efficiently within the portals. In each portal, people were marked as interactive by one of the subjects, but also a few other participants commented that animated people, husky and reindeer sledges looked as interactive, because they were constantly moving all the time, especially within portal B and C. But they did not mark them as interactive.

Also elements with highly contrasting colours from their neighbourhood drew user attention. For example, one subject did not notice the glow effect on the snow slider in the portal B, but he marked it as interactive, because: "*It looked like it did not belong to the 3D scene, as it was so colourful... it popped up from the white background*" (Male, ID9). Also red and yellow snowmobiles in portal C were interpreted as interactive, because: "*Their colour makes them to pop up to*" (Female, ID15) and "*The colours are brighter, so I assume that they can be clicked, they look like they are departing*" (Female, ID17).

#### **Embedded 2D Icons Location in 3D Space**

Subjects had no idea of the actual locations of the 2D icons in the 3D space, as one stated: "*You cannot tell where those (icons) are, but just direction where they might be*" (Male, ID1). Subjects were asked to comment where they think they end up if they press the icon. For example, in portal B, subjects ended up in a totally different place that they were anticipating, as one stated: "*Oh...I thought I went to the changing hut (on the beach), but ended up on the parking lot (which is located far behind the hut)*" (Female, ID10).

Icons have their exact location in a 3D space, but the viewing angle and the distance can change how large they appear in the scene. As one subject misleadingly perceived it: "*The size of them is probably referring to their distance, the smaller the size is the further icons is located*" (Male, ID1). Participants suggested depth information for the icons: "*Icons which are located further could be more opaque than icons located nearer*" (Male, ID8) and "*Icons in the front should be bigger than those which are located further away*" (Female, ID17). Even though it was difficult to perceive where the embedded 2D icons were located in the 3D space, 71% of the subjects thought that 2D icons belong to a 3D VE.

Subjects thought that there should be some kind of visual cue from the 2D icon to its actual location in the 3D space. A line was offered as an example solution when one subject stated: "*Yes it would probably help, icons would be then like balloons*" (Female, ID17). Subjects agreed that the indication does not have to be shown all the time, as one stated: "*When cursor is moved on the icons it could give some clue about its location, such as*

*dimmed spotlight*” (Male, ID8). One subject was wondering if the 2D icons are needed at all: *“I would probably catch it (snow slider) from that glow... it is a bit odd that there are two symbols for the same function... it makes it to look that there is more to do than there actually is”* (Female, ID19).

### Moving in the Portals

Most of the participants started to move in the portals by using arrows or rotating view by holding the left mouse button down. Then they started to explore the 2D icons in the scene and noticed that there appeared a 2D pop-up window with the text ‘Move’ on some of the icons. Most of the people then clicked these icons and moved to another viewpoint. But subjects who had first clicked information icons, such as the ‘activities’ icon, did not see any difference between those and the ‘viewpoint’ icons. As one user stated: *“Eyes (‘viewpoint’ icons) were not unique enough from other icons, therefore I did not notice them”* (Male, ID 11). Also eye symbol was not perceived to indicate viewpoints. As one subject stated: *“If you have to put this pop-up with text ‘Move’ here, it means weakness in the design, because it (the icon) does not show the possibility to move”* (Female, ID 19).

76% of the subjects agreed that using the portal was easy. They liked that they could fly with the hot-air balloon or move through viewpoints. As one subject stated: *“It is nice that with the hot-air balloon you can get an overview and see also what is in between of the viewpoints... with eyes (‘viewpoint’ icons) you can move faster to the location... I think these are meant for different purposes”* (Female, ID17). Still, 81% of the subjects would have liked to move by walking and 86% by flying. But as those subjects, who were familiar with 3D VEs and games, commented: *“I would not want to substitute existing (moving) ways, but these (flying and walking) could be good bonuses”* (Male, ID7). *“Yes, it would be nice (move freely)...(but) you need to remember the usual problem with VEs, the slow pace of walking”* (Female, ID19).

### Switching Between 3D and 2D UIs

It was quite difficult for the participants to switch between non-embedded and embedded interactive elements, because they were so immersed with the 3D virtual environment and rotated the view with a mouse holding the left button down. This was problematic especially when they wanted to leave from virtual activity or get back to the home view. As one participant stated: *“I did not even notice it (‘home view’ icon)...I was not anymore paying attention to the items in the upper part of the screen”*. (Female, ID10). Almost all subjects stated that they did not know how to stop the hot-air balloon ride and most of them did it just by clicking some ‘viewpoint’ icon in the 3D scene. But those who did not see any ‘viewpoint’ icons had no clue how to get out of the hot-air balloon, as one stated: *“Wait a minute, how I can get out of here... help! (laughing)”* (Male, ID9). First he tried embedded 2D icons, but as they did not stop it, he started to look at non-embedded 2D icons and noticed the ‘x’ icon on upper right corner and its pop-up text ‘Close’ and stated: *“That (‘x’ icon) closes the whole application, right?”* (Male, ID9). Also another participant had similar

problem and stated: *“No it cannot be this (x-icon), it will close the whole application”*, then she tried keys (Figure 4) and finally the moderator asked her to try to press the ‘x’ icon, when she stated: *“it felt that it will close the whole application because it was on this (translucent upper bar)”* (Female, ID15).



Figure 4. A user is trying to stop flying with the hot-air balloon by pressing keys.

Participants suggested improvements for exiting the virtual activity. One participant stated: *“There (on the pop-up) could be a written ‘stop flying’,-text as a hot-air balloon cannot be closed”* (Female, ID 17). In shorter virtual activities, for instance snow sliding, the ‘x’ icon was not noticed at all, because the users’ focus was on the movement in the 3D space, as one participant stated: *“I did not notice it because my focus was on the activity. Could there be controls for the activity here (points on the centre of the 3D space area)”* (Female, ID19).

### User Experiences from the Travel Point of View

Also in this study subjects commented that they would like to use these kinds of portals to get an overview of the place prior to the trip. 81% thought that virtual portal was useful and 85% thought that they could use similar portals in the future when planning a trip. Also after the trip it could be used for memorizing and sharing experiences.

### Visual Appearance

Participants liked the visual style and appearance of the portals and 86% thought that the portals were pleasant and memorable looking. As one subject commented: *“These are very well done, they are very nice looking”* (Female, ID13). Another commented the sounds: *“Sounds make it a holistic experience”* (Female, ID16). Also 76% of the participants agreed that the 3D view and atmosphere offered by the virtual portals would not transmit through other services. As one subject stated: *“This is memorable, Street View is just for information”* (Female, ID10). One commented also that: *“I like the people in the portal, it would feel empty with out them, for example in Google Street View there are no moving people”* (Female, ID17). Another stated: *“This is more alive looking, therefore more interesting”* (Male, ID12).

Most of the subjects did not know that these portals exist. A few subjects who used Google Street View thought that it would be nice to be able to access through it to the portals. Also 71% agreed that virtual portal compliments the Google Maps and Street View.

### **Virtual Activities**

Especially the downhill skiing in portal C was liked and it was commented to be: *“funny stuff”* (Female, ID18). As one participant stated: *“Nice...if you really want to experience how it feels to be there, then the downhill skiing viewpoint is the only one. Other (activities) do not provide the actual view which you will get when you go there in real-life”* (Female, ID16). Least liked were the changing lights and rotating around a snow sculpture in portal A. As one participants stated: *“Interesting, but I don’t understand the purpose of it”* (Male, ID21). A few subjects would have also wanted to experience swimming in portal B, as there is an outdoor pool near the building and it is possible to get by it, but not in to the water. Also in portal C, people would have wanted to ride on snowmobiles, huskies, and reindeers and walk with people. As one subject stated: *“It would be nice to go with some of these people, then the view would change according to where this person is going”* (Female, ID16). Another suggested mini games for children: *“collect three reindeers, find a sea shell...”* (Female, ID19).

### **DISCUSSION**

Our study indicates that users liked the portals and thought they bring value to destination marketing, because they can offer a more holistic experience of the place. Meaningful virtual 3D activities and a possibility to explore freely the 3D portal area was liked most in the portals. Also easy access was appreciated. Our study indicated also that 2D icons within 3D VEs were more easily interpreted as interactive than the 3D elements. Thus, one good solution for improving recognisability of 3D elements is to highlight their visual appearance with a pulsating glow effect. Also, the icon design for 3D VEs is quite challenging because of the icons various interpretations and content they offer. The key findings are discussed in more detail in the next sub-sections.

#### **Access to the Portals**

In contrast to prior research which has focused on Second Life users (Sweeney & Adams, 2009) (Huang et al., 2010 & 2013), our findings help to develop sites for people who are not experienced with 3D VEs and VWs. Our study indicated that people were happy that they did not have to sign in to the VE, they just needed to open the portal view. Therefore, the access to the portals should be as easy and effortless as using ordinary 2D webpages and people should not be forced to register and create avatars to be able to experience 3D virtual tourist sites. Our second user study indicated that also access through map services, such as Google Maps or Street View would be a good way to promote virtual portals and supplement the online maps by offering a full view over the area and a possibility to virtually experience the activities.

#### **Virtual 3D Activities**

We found that the virtual experience of a travel destination portal gets better if virtual 3D activities are offered. Virtual activities, especially the downhill skiing, were liked in both studies. Also hot-air balloon ride was perceived to offer a more comprehensive view of the place. When designing virtual 3D activities, a real user experience should be the target, e.g. a user has to feel that s/he is experiencing a real activity. A point made also by

Buhalis and Law (2008). When designing the 3D activities, a user needs to be able to control and exit from the activity easily. Therefore, the controls should not be located on the upper part of the screen, which is reported also by Sweeney & Adams (2009) and Beeharee et al. (2003). The controls should be located near where the activity takes place within the 3D environment.

#### **Navigation in the Portals**

Both studies indicated that users want to explore the portal freely. The viewpoint navigation was disliked, but its importance for the novice users and as an optional fast way of moving should not be neglected. Moving by walking in a 3D space with an avatar is never easy and completely collision free, because there are 3D objects on the way. This is also reported by Irani et al. (2008) who found that navigation through cameras before teleporting the avatar to other location within the Second Life, was easier and more collision free than walking or flying. Therefore, we highlight the importance of giving alternative ways for moving: fast viewpoint navigation combined with free moving by flying and/or walking.

#### **2D and 3D Icon Design**

If viewpoint navigation is used in the portal, then the icon design should be carefully done. Subjects criticized that the almost similar looking embedded 2D icons (e.g. form and colours) were used for indicating different kinds of things, e.g. some for moving and some for just offering information. To be able to distinct 2D and 3D content within the portal, we suggest that 2D icons should only be used for offering 2D information (e.g. text and photos). Instead, the 3D activities and moving in the virtual portals should be presented with 3D objects. For example, the 3D symbol for move action should indicate movement, thus it could be an animated 3D arrow.

#### **Visual Indication of Interactive 3D Elements**

Our studies indicated that 2D icons within the 3D VEs were more easily interpreted as interactive than the 3D elements. This is because the 2D icons are more familiar from 2D computer user interfaces and therefore they pop-up more easily from the 3D scene. Instead, 3D icons and elements were more easily interpreted as part of the 3D scene. One good solution for improving recognisability of 3D elements is to highlight their visual appearance. Prior research has suggested using highly contrasting colour on the important element to make it to stand out from its neighbourhood (Beeharee et al., 2003). But we argue that in these kinds of VEs where a real-life place is marketed for the tourists, the colours of the interactable 3D elements cannot be changed to something else, for example, yellow building cannot be overlaid with green colour. Thus, other type of visual indication is needed.

We argue also that visual indication of interactive 3D elements within 3D VEs should not rely on 2D icons, because their actual location and relation to 3D elements in 3D space is difficult to see. To make interactive 3D elements noticeable, they need to be highlighted. Good way for doing this is a pulsating glow effect around the interactive 3D element. Our finding supports and complements the results by (Pakanen et al., 2013a & 2013b). The implemented pulsating glow effect doubled

the amount of noticed interactive 3D elements within the portals in the first task in the second user study. In the later phase of the study 91%, of the subjects noticed the effect and interpret it as interactiveness of an element.

But not all the interactive 3D elements need to be indicated with the effect, as there can be also hidden 3D objects and items to be discovered by the user. These things should not be important navigational objects, but entertaining or rewarding features, such as games, virtual activities, or coupons to the shops in the real world.

#### **Limitations and Future Work**

We recognize the limitations of our study, as we focused more on user experience with portals, we were not able to investigate the pulsating glow effect in depth. Thus, we suggest future studies to focus on investigating the size and visibility time of the glow effect and the pulsating speed. Also the amount of simultaneously highlighted objects within one scene needs more attention.

#### **CONCLUSION**

In this paper, we focused on studying user experiences with three 3D virtual travel destination marketing portals. We did two user studies, which both had 21 subjects. The studies brought important insights for the travel researchers and practitioners and as well to the developers and designers of these kinds of 3D portals. We found that 3D portals can enhance 2D web pages, if they can offer the possibility to explore that location freely and through meaningful virtual 3D activities. Also our study indicated that pulsating glow effect is a suitable way for indicating interactive 3D elements within a 3D VE.

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#### **REFERENCES**

Andersen, L., Tufte, B., Rasmussen, J., and Chan, K. Tweens and new media in Denmark and Hong Kong. *Journal of Consumer Marketing* 24, 6 (2007), 340-350.

Arhippainen, L. Studying user experience: issues and problems of mobile services – Case ADAMOS: User experience (im)possible to catch? Doctoral dissertation, University of Oulu, Oulu, Finland, 2009.

Beeharee, A.K., West, A.J., and Hubbold, R. Visual attention based information culling for distributed virtual environments. In *Proc. VRST'03*, ACM Press (2003), 213-222.

Bernhard, M., Stavrakis, E., and Wimmer, M. An empirical pipeline to derive gaze prediction heuristics for 3D action games. *ACM transactions on applied perception* 8, 1 (2010), article 4.

Bowman, D., Kruijff, E., LaViola, J. and Poupyrev. 3D user interfaces: theory and practice. Addison-Wesley Press, Boston, USA, 2005.

Buhalis, D. and Law, R. Progress in information technology and tourism management: 20 years and 10 years after the Internet –The state of eTourism research. *Tourism Management* 29 (2008), 609-623.

Cotte, J., Chowdhury, T.G., Ratneshwar, S., and Ricci, L.M. Pleasure or utility? Time planning style and web usage behaviour. *Journal of interactive marketing* 20, 1 (2006), 45-57.

El-Nasr, M.S., and Yan, S. Visual Attention in 3D Video Games. In *Proc. ACE'06*, ACM Press (2006), Article No. 22.

Guttentag, D.A. Virtual reality: Applications and implications for tourism. *Tourism Management* 31 (2010), 637-651.

Hobson, J.S.P. and Williams, A.P. Virtual reality: a new horizon for the tourism industry. *Journal of vacation marketing*, 1(2), Sage (1995), 125-136.

Huang, Y-C., Backman, S, and Backman, K.F. The Impacts of Virtual Experiences on People's Travel Intentions. In *Proc. Information and Communication Technologies in Tourism'10*, Springer (2010), 555-566.

Huang, Y-C., Backman, S, Backman, K.F., and Moore, D. Exploring user acceptance of 3D virtual worlds in travel and tourism marketing. *Tourism Management* 36 (2013), 490-501.

Irani, L., Hayes, G.R., and Dourish, P. Situated Practices of Looking: Visual Practice in an Online World. In *Proc. CWCS'08*, ACM Press (2008), 187-196.

ISO DIS 9241-210:2010. Ergonomics of human system interaction - Part 210: Human-centred design for interactive systems. International Standardization Organization (ISO). Switzerland.

Jordan, P.W. Designing pleasurable products. An introduction to the new human factors. New York, Taylor & Francis, 2000.

Law, E. L., Roto, V., Hassenzahl, M., Vermeeren, A. P., and Kort, J. Understanding, scoping and defining user experience: a survey approach. In *Proc. CHI '09*, ACM Press (2009), 719-728.

Pakanen, M., Arhippainen, L., Vajus-Anttila, J.H., and Pakanen, O-P. Visual Indication While Sharing Items from a Private 3D Portal Room UI to Public Virtual Environments. In *Proc. INTERACT'13*, LNCS 8120, IV (2013a), 737-744.

Pakanen, M., Arhippainen, L., Hickey, S., and Karhu, A. Visual Indication of Interactive 3D Elements in 3D Virtual Environments. In *Proc. MindTrek'13*. ACM Press (2013b), 1-4.

Pine, B.J. and Gilmore, J.H. Welcome to the Experience Economy. *Harvard Business Review* 7-8 (1998), 97-105.

Sweeney, B. and Adams, A. Virtual world users evaluated according to environment design, task based and affective attention measures. In *Proc. BCS-HCI'09*, ACM Press (2009), 381-387.

Wang, K-C., Hsieh, A-T., Yeh, Y-C., and Tsai, C-W. Who is the decision-maker: the parents or the child in group package tours? *Tourism Management* 25 (2004), 183-194.