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An Application of Desktop Virtual Reality to the Hospitality Industry

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Abstract

This paper discusses research being carried out to produce real-time interactive Virtual Reality (VR) models of some areas of Tourism interest in Ireland. In particular, issues concerning the development of prototype VR models of an ancient Irish monastic village are described.

Introduction

The purpose of the work described in this paper is to develop Virtual Reality (VR) walkthroughs of areas of Tourism interest in Ireland and to examine issues involved in the development of such models. In other words, a user can interact in real-time with computer-generated Tourism related models. Currently, a variety of prototype models have been constructed including a reconstruction of the monastic enclosure at Glendalough, County Wicklow. Ireland. Each of these models created has been linked together by way of a multi-media based environment which supplies the participant with additional information through text video imagery, photographic stills and voice-overs.

What is Virtual Reality.

The concept of Virtual Reality is perceived by many to be in its infancy but the origins of VR can be traced as far back as 'The Ultimate Display', a paper written by Ivan Sutherland in 1965. In this paper Sutherland issued the following challenge: "The screen is a window through which one sees a virtual world. The challenge is to make that world look real, act real, sound real, feel real" (Sutherland. 1965). Over the past decade this challenge has become the research agenda for a rapidly growing community of researchers and industries. Although VR technology has been slowly developing over this period the possibilities inherent in the new medium have only recently crossed a cultural threshold (Biocca 1992): that VR has begun to shift away from the purely theoretical and towards the practical. It is the implications of this orientation towards the practical applications of VR that are important for the Tourism Industry.

Traditionally the Tourism Industry is a highly information intensive industry. The unique features of the Travel and Tourism Product lend themselves readily to VR (Cheong, 1995). It is, therefore, conceivable that VR could have an overwhelming effect on the Tourism Industry in the future.

From a marketing perspective. VR has the potential to revolutionise the promotion and selling of the Tourism product (Hobson, 1995). Travel information is currently being dispersed by the use of travel agents, videos, travel brochures and Tourism multimedia software. These current distribution media provide prospective tourists with only short and rather limited glimpses of a destination's attractions. At times, the accompanying destination information may be inadequate for clients to make travel decisions. VR, in comparison, provides clients with the opportunity to explore each destination in great depth prior to making their travel arrangements. The client would be provided with ample information and would hence be able to form realistic expectations of the travel destination prior to his visit. In all. VR strives to dispel elements of uncertainty and ensures that the visitor's expectations of his impending visit are equitable to the subsequent actual experience (Cheong, 1995).

Defining Virtual Reality.
In an attempt to provide a complete understanding of VR. its applications and concepts, one must first give a comprehensive definition of VR. There is no standard definition of VR but in an attempt to choose the most appropriate definition one must first of all introduce the three main approaches to the VR definition.

Definition in Terms of Technology:
This type of definition pays particular attention to the component parts of an Immersive technological VR system. The following definition is an examples of such a technical definition.

> *Virtual Reality technology can be defined as the sum of the hardware and software systems that seek to perfect an all-inclusive, immersive, sensory illusion of being present in another environment, another reality, a Virtual Reality. (Biocca, 1992)*

This definition includes the concept of an artificially created environment and immersive input devices as the means to access these environments. The application of this type of definition is limited to the technologies that it describes: its unit of analysis and its potential for variance are left unspecified (Steuer. 1992). Therefore if one were to employ this type of definition, one would be clearly limiting the scope of VR and its applications.

Definition in Terms of Presence:
This type of definition describes the participant's personal response to VR Typically such an approach is based on the experiences or the feelings of the participant. Many perceptual factors help to generate these feelings, including input from some or all sensory channels, as well as more mindful, attentional. perceptual and other mental processes that assimilate incoming sensory data with current concerns and past experiences. (Gibson. 1966)

> *Virtual Reality is a remote and artificially constructed environment in which one feels a sense of presence, as a result of using a communication medium. (Steuer, 1992)*

The advantage of defining VR in terms of presence is that by employing the concept of presence. VR can now be defined without reference to particular hardware systems but problems arise because this can be a difficult type of definition to handle as it is relative to each individual. (Latta. 1991)

Definition inTerms of Virtual Environments:
This type of definition is based on the creation of a Virtual Environment. There are many ways that this can be accomplished. This definition covers all aspects of VR without discussing the participants' response or the technologies used.

> *Virtual Reality is a human-computer interface where the computer and its devices create a sensory environment that is dynamically controlled by the action of the individual so that the Virtual Environment appears real to the participant. (Latta. 1991)*

The devices discussed in previous definitions are all relatively recent developments and. with the rate of current developments in technology may even become obsolete. However, the definition of VR in terms of Virtual Environments can be applied to past, present and future media technologies. Thus, this definition of VR provides a framework hi which such newly developed technologies can be examined in relation to past, present and future technologies. Since this definition is not based on technology, it permits variation across technologies along a number of dimensions.

In this paper, we are not primarily concerned with the technology available to produce "all-inclusive, immersive" VR models, nor are we primarily concerned with generating some sense of "presence". We are concerned with building realistic, real-time, interactive models

of areas of tourist interest on personal computers (PCs). Consequently, it was decided that defining VR in terms of the Virtual Environment would be the most appropriate definition for the purposes of this research.

Developing a Virtual Reality Model.
The general definition of VR in terms of the Virtual Environment can be reduced to a general systems model. Figure 1. The model is divided into two parts - the Actual Environment, on the left, and the Virtual Environment on the right. The model is described from a users perspective. The individuals actions are recorded by the VR system by way of the sensors and effectors and the environment is manipulated accordingly.

The Virtual Environment is created using a set of tools or objects. They are shown as the Environment tool at the top of the model and include:

1. An Environment model, which outlines the basic Virtual Environment;
2. An Interaction model, which governs what objects interact and how they interact with the individual and with other objects:
3. A set of resources to support these tools.

The VR system then forms and modifies the Virtual Environment which is supplied to it. The tools can also take the form of hardware and software which supply any of the components which describe the environment. This model is intended to describe the basic framework in which the system can be implemented and. thus, not every system will contain every element of this model.

Figure 1. The Virtual Reality Model.
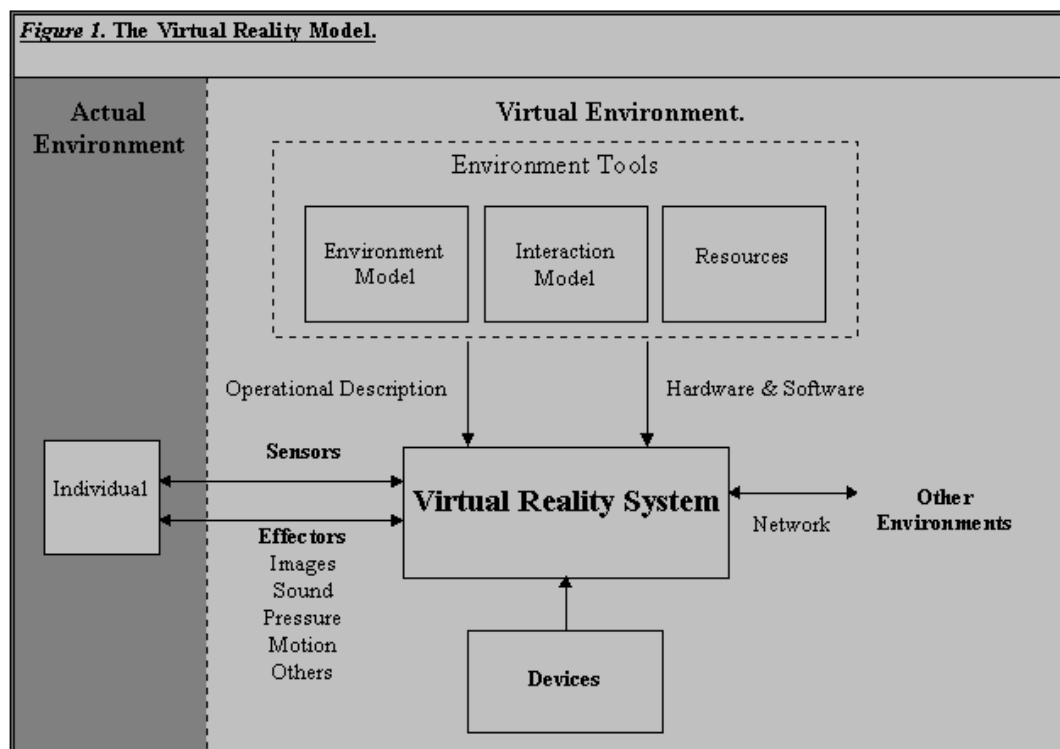
To illustrate, the environment model could be the design of Glendalough using some form of three-dimensional computer-aided visualisation package. The interaction model could be what would happen if the user attempts to open a door in the model or "walks" up steps in the Gateway in Glendalough. The set of resources to support these tools would be any hardware and software which combine to form the Virtual Environment.

This model describes only one Virtual Environment for one individual. The model can be extended to support multiple individuals in a given environment or multiple environments using an external interface, shown to the right of the illustration.

Types of Virtual Reality.
As a background to understanding VR it is important to understand the types of VR systems. There are three major types of VR system currently available. **Immersion VR, Desktop VR and Third Person VR.** and in order to produce an application for the Tourism Industry one must first decide which type is most appropriate for this Industry.

Immersion VR
Immersion VR describes a system which "immerses" or surrounds the participant in an environment. The participant can hear, see and. perhaps, feel nothing other than the artificially created environment hi order for an individual to participate in an immersive VR system certain equipment is deemed necessary. Some of the equipment which one would expect to find as part of such a system would be head mounted displays (HMDs). which track the participant's head movements while allowing nun to observe Virtual Environments, and bodysuits and data gloves which track and project a participants movements while also allowing him to manipulate objects within the Virtual Environment. As a result the user actually perceives that he is inside an environment. Immersion VR systems are the most demanding type of VR system in terms of the technology required to offer the appropriate system response and graphics display rates.

Desktop VR
Desktop VR. as the name suggests, is based on standard commercially available desktop computers. For instance a Pentium IBM compatible Personal Computer with a powerful graphics card can deliver the speed and reality to make Virtual Environments seem real. The user may interact with the Virtual Environments with a mouse, keyboard, or 3D controller, such as a "Spaceball".

Third Person VR
In Third Person VR the user views himself *in* a three-dimensional environment. The individual stands in front of a video camera which captures his image and body movements and sends the information to the computer which composites the image with computer and laser disc based imagery. The user then view the resulting images - his body as seen through the video camera, computer graphics and laser disc imagery - on a monitor in front of him. With this process users are able to "play" instruments, simple sports exercises, and education games by manipulating the computer generated objects they see in the monitor with their hands, feet and body.

Which Type of VR is Most Appropriate to the Tourism Industry?
As discussed earlier VR has an increasingly important role to play in the Tourism Industry, offering real time visualisation and interaction within virtual worlds. In this scenario, however. Immersion VR and Third Person VR systems currently have a number of drawbacks. It is generally agreed that the participant can suffer from what is commonly called "simulator sickness" while using headsets. Sensor lag, where the detection of head movement by magnetic sensors can cause notable delay to the view being updated, can cause disorientation and frequent recalibration of the equipment may also be necessary.

Desktop VR is not affected by any of these problems. The fact that interaction with Virtual Environments is controlled from the "desktop" immediately makes Desktop VR suitable for multiple viewing at presentations. The absence of a headset also overcomes the problem of the clarity of the screen, giving a greater level of resolution and detail. Using industrial-standard computer hardware also ensures higher reliability, lower maintenance costs and a larger diffusability through the industry. Though the resolution and accuracy of headsets are bound to improve, they do not reflect the needs of the serious user. These advantages of Desktop VR.,

both for Virtual Environment authoring and visualisation, make it the most suitable solution for the Hospitality Industry. Consequently, in this research we have chosen to concentrate on the two-dimensional screen variant known as Desktop VR.

The Dimensions of Virtual Reality.
Before deciding upon what software to use when constructing our models, certain parameters had to be taken into consideration. When discussing the dimensions of VR one must discuss the two dimensions most commonly used to describe VR. vividness and interactivity, and then add a third dimension: Time.

Vividness
Vividness refers to the ability of a technology to produce a sensory rich Virtual Environment. In other words, how much detail is required? Do we wish to model every subtle aspect of the architecture, faithfully reproducing, for example, gargoyles on the churches? Higher detail leads to a more realistic VR model, hi our models of Glendalough. we have included texture (such as a stone texture) to make the buildings look more realistic. The term used for this concept is *vividness.*

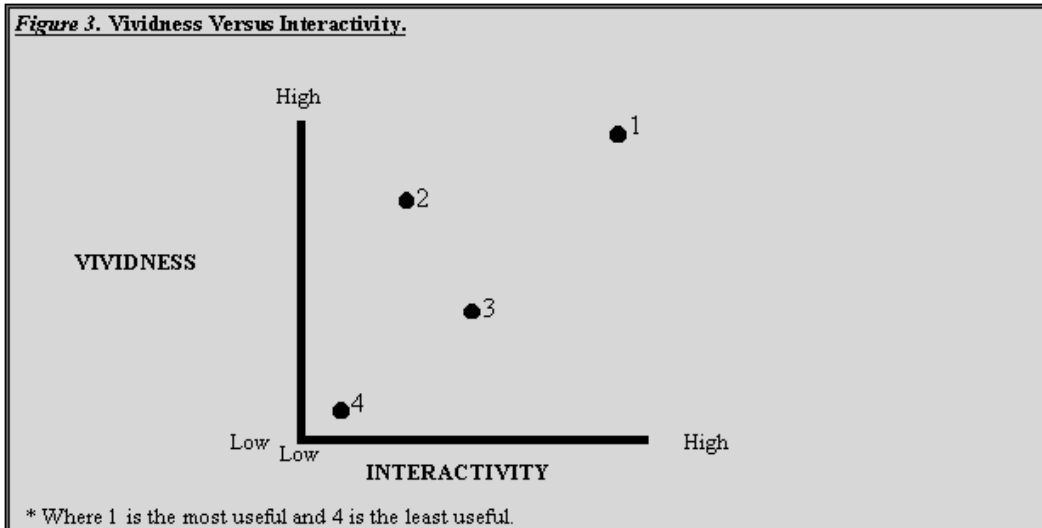Figure 2. Technological Variables Influencing Virtual Reality.
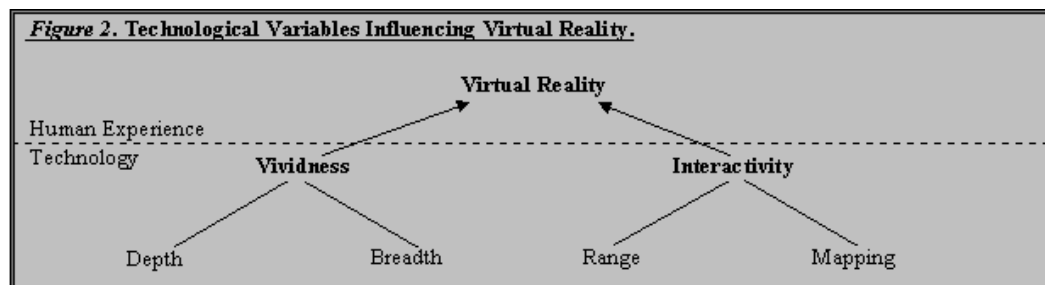
There are two important variables that constitute vividness and they are sensory breath and sensory depth (Figure 2.). Breadth is the ability of a communication medium to present information across the senses. The vividness of any environment is not generated by any single sensory input alone, but by a combination of all sensory inputs. Vividness also depends upon the depth of the sensory information. This concept can be described in terms of quality: an image with greater depth is generally perceived as being of higher quality than one of lesser depth.

Interactivity
Interactivity refers to the degree to which users of a medium can influence the form or content of an environment. The models produced could have been interactive or non-interactive. Non-interactive models are pre-programmed. The participant views the model and is not provided with a choice at any stage throughout the walkthrough. He cannot decide to turn left here or right there or go straight ahead. In other words, the developer decides the only way in which the model can be viewed. Interactive models, on the other hand, provide the participant with the ability to navigate through the model and to interact with certain objects within the model.
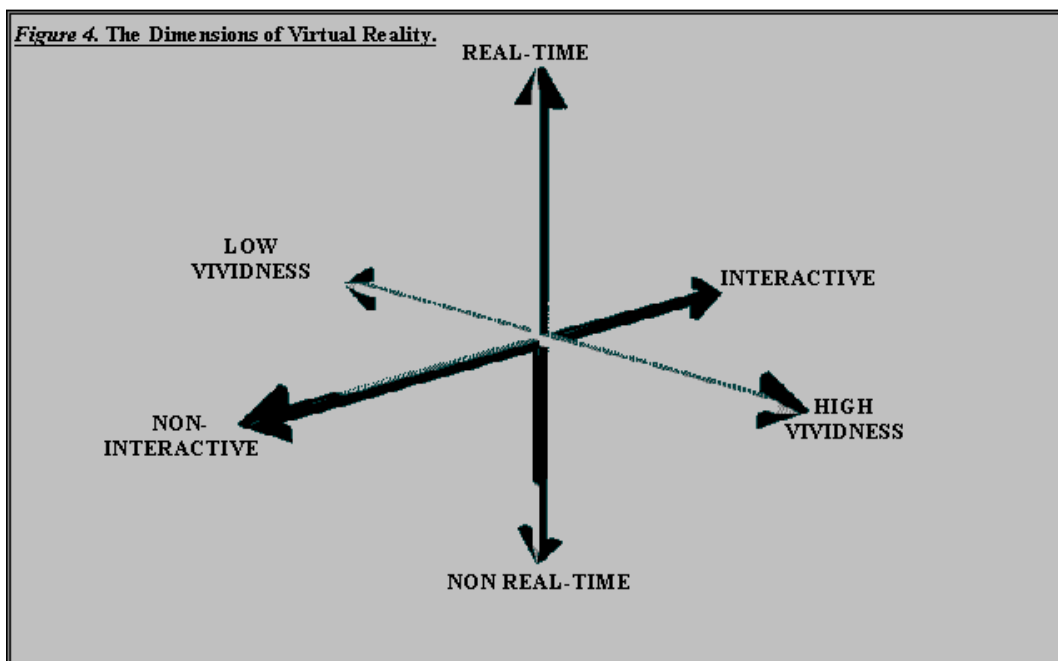
The two factors which contribute to interactivity are range and mapping (Figure 2.) The range of interactivity is determined by the number of attributes of an environment that can be manipulated, and the amount of variation available within each attribute. The greater the range of an environment the more interactive it will become.

Figure 3. Vividness Versus Interactivity.

VIVIDNESS

High

●1

●2

●3

●4

Low   Low   High
INTERACTIVITY

* Where 1 is the most useful and 4 is the least useful.

Mapping refers to the way in which human are connected to actions within a Virtual Environment (Norman, 1986. 1988). At one extreme, mapping can be completely arbitrary and unrelated to the action performed. For instance, an individual nodding might increase the brightness of a sensory output. At the other end of the spectrum, mapping may be completely natural: pointing at an object in a Virtual Environment might make the person in the environment point accordingly. It is usually advisable to have the mapping as close to the natural motion as possible.

Time

The two major dimensions across which communication technologies vary have already discussed (Figure 3) but in order to analyse the VR applications properly a third dimension, *Time,* must be included (Figure 4).

Figure 4. The Dimensions of Virtual Reality.

REAL-TIME

LOW VIVIDNESS

INTERACTIVE

NON-INTERACTIVE

HIGH VIVIDNESS

NON REAL-TIME

Time refers to the time lag between the instruction and the resulting action: when there is no time lag in the system it is said to be performing actions in 'real time'. To simplify a little, if the model reacts in the same time as would happen in the real world, then the model is said to be "real-time". If not, a time lag occurs in the application while the computer redraws the scene.

This immediacy of response is one of the properties that make even low-resolution applications seem highly realistic.

In this project, we have decided upon producing real-time, interactive models with as much detail as it as is possible. Vividness, real-time and interactivity are not independent. Deciding on one dimension has major implications for the others.

An Application of Virtual Reality.

Once one has a clear understanding of the dimensions of VR. the next step is to decide which engine or piece of software to use in designing an application for the Tourism Industry. The first step that was taken hi this process was a comprehensive analysis of the computer-aided visualisation packages available. Three categories of packages were examined and each was used to produce a prototype model of a familiar structure, namely the Computer Section at D.I.T. Cathal Brugha Street. These categories included commercially available three-dimensional modelling and visualisation programs, engines from well-known three-dimensional games and high quality three-dimensional graphics and animation packages. After each package was analysed and the most appropriate packages chosen a further prototype model, this time of Glendalough, was constructed using each package.

Figure 5. The Gateway, Glendalough.
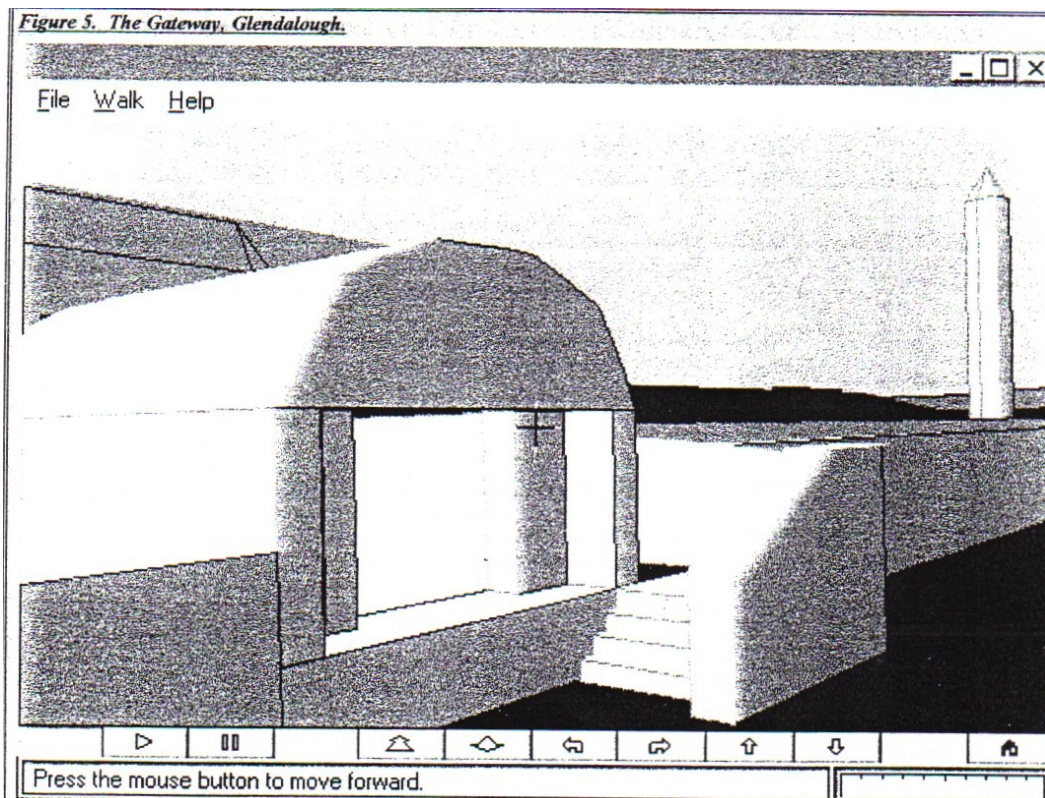
The first category of package analysed was the commercially available three-dimensional modelling and visualisation programs, an example of which is clearly illustrated in Figure 5. These packages were chosen because of their ability to design highly interactive walkthroughs. There are. however, certain limitations to these type of packages. The first limitation is that some of these packages do not facilitate texture mapping the application of photographic and synthesised images onto the surface of a simulated object. Texture-mapping is the key to enhancing the realism of any VR application. A photographic image can be imported and mapped onto a wall, for instance, and you instantly have an environment that the brain is more than willing to believe in. even without full "photorealism" effects. (Stoppi. 1992) The second major limitation is the fact that speed and detail are inversely proportional. The more complex the model you design the slower your model will "walk". The third major limitation

of these type of packages is that some of them do not contain a collision detection facility. In other words some packages do not stop a participant from walking through walls and other solid objects. This proves a major drawback and makes it very difficult for a participant to maneuver around the Virtual Environment.

The second type of packages chosen to construct prototype models are not design programs at all: in fact they are engines from well known three-dimensional games. These engines were chosen because of their ability to allow the participant to interact within a Virtual Environment in real-time. An example of the use of such a package is illustrated in Figure 6. These packages, while overcoming all the major limitations of the visualisation packages discussed, have some limitations of their own. The first limitation of such packages is their inability to construct a model on more than one level, thus, not allowing more than one floor to be built above another. This reduces the applications of these packages as it does not allow spiral staircases, roofs or models on more than one floor.

Figure 6. St. Kevin's Church, Glendalough.

The third category of packages chosen was high quality three-dimensional graphics and animation packages. This type of package provides the user with a highly vivid, pre-programmed computer-generated walkthrough. The main drawback of such packages is that they do not allow the user to interact with the Virtual Environment in real-time. It is, therefore, a thoroughly pre-programmed experience.

The objective of this analysis was to compare and contrast these packages in an attempt to determine whether these packages were compatible with each other and. if they were not. to choose the package most suitable to the design of this application. As an aid in this analytical process a set of criteria was drawn up. These criteria were divided into two categories: Performance Criteria, which defines the dimensions of VR. and Social Criteria, which describes how easily the application can be distributed and accepted into the market. (Table 1)

Table 1. Basic Criteria for Evaluating VR Software.

Criterion	Description.
(a) Performance Criteria.	
Sensory Vividness	The capabilities of the base hardware and software, and not just the output devices, contribute to sensory vividness, a key component in creating a high quality Virtual Environment. Sensory vividness includes such considerations as (a) the number of sensory channels supported, and (b) the sensory resolution within each sensory channel.
Interactivity	Interactivity is also critical to create a high quality Virtual Environment. In VR the criteria can be defined as (a) the number and forms of input and output, (b) the level of responsiveness to conscious and unconscious user actions and states, and (c) the range of interactive experiences offered by the system.
Time	Time refers to the time lag between the instruction and the resulting action; when there is no time lag in the system the system is known as performing actions in 'real time'. Real-time interaction is where the action of the user is immediately simulated by the mediated environment.
(b) Social Criteria.	
Sociability	Sociability is defined as the number of users a system can support. The lowest level of sociability is the single user interacting with the contents of a virtual world. This is an important factor to consider when creating applications for the Tourism Industry as its sociability maybe directly proportional to its usefulness.
Diffusability	Diffusability is the likelihood that a system can be adopted and used by various business, educational, and personal users. Variables that can raise or lower diffusability include: (a) Hardware compatibility: Systems that run on computers that are commonly available in organisations as opposed to those that require highly specialised computers. (b) Software compatibility: Systems that can import existing two dimensional and three-dimensional models are more likely to be diffused (DXF format for CAD packages). (c) Tool integration: Integrated systems with hardware support, modular software, and catalogues of virtual objects and worlds are more likely to be diffusable. (d) User friendliness: Systems that allow world building with minimal to moderate computing skills.
Cost	Cost is influenced by all of the variables above. We can anticipate the some pattern of development we have seen elsewhere in the computer industry: cost dropping as low-end systems 'inherit' high-performance features previously available only on the most costly systems.

(Derived from Biocca, 1992)

Table 1 Basic Criteria for Evaluating VR Software

It was proposed that once prototype models were constructed using each of these packages they should be linked together by way of a multimedia package (Figure 7.) which provides the participant with ease of access to each environment.

Figure 7. The Cathedral Menu.
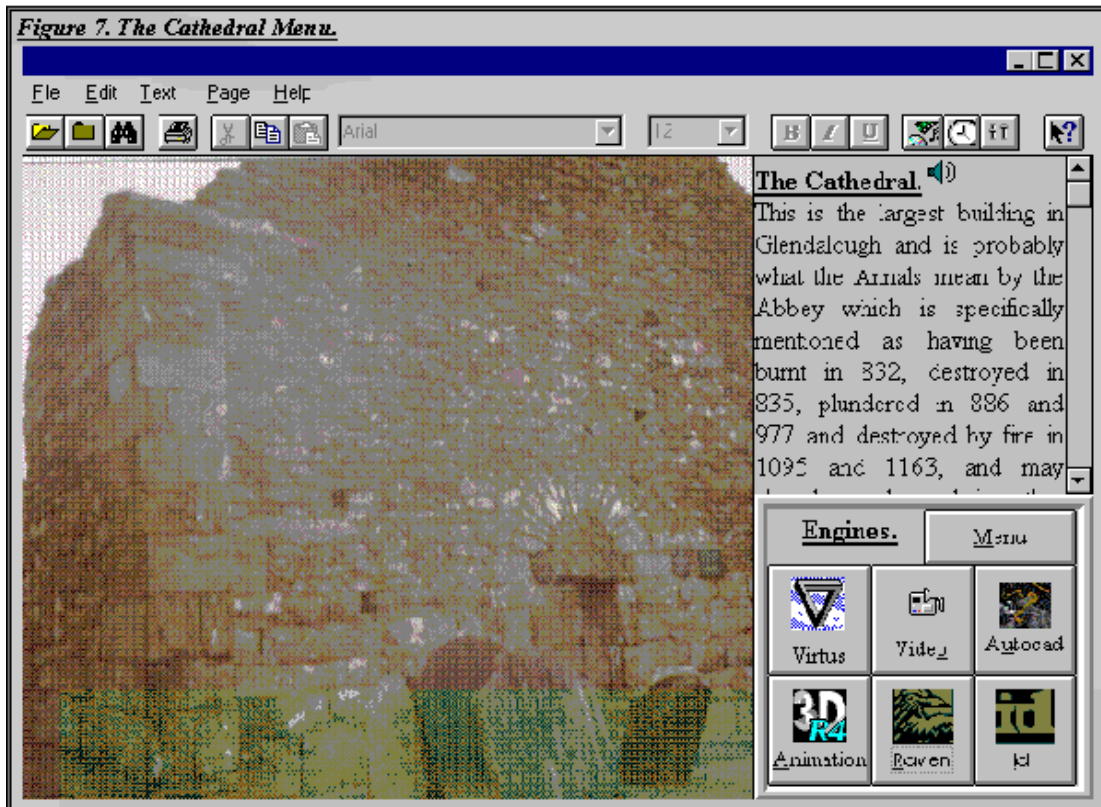
Conclusion

At this intermediate juncture in our project, it was found that real-time interactive and realistic walkthroughs of areas of tourist interest are possible on commercially available PCs. We have not yet reached a stage to state that a particular piece of software is best for all tourism sites. We hope to refine our work further and extend it to build the Boyne Valley monuments (older than the pyramids!) and other areas. When the models are complete, we intend to evaluate them in conjunction with local heritage and interpretive centres.

Authors:

Patrick Horan graduated with a B.Sc. (Mgmt) from the University of Dublin, Trinity College and a Higber Diploma in Hotel and Catering Management from D.I.T. Cathal Brugha St., in 1994. Later that year he returned to college to undertake his masters degree and lecture in Computer Applications.

Dr. Ciaran McDonnell is Head of Computing and Information Technology at Dublin Institute of Technology (Cathal Brugha St Campus). He has worked professionally with computers for almost 25 years in business education and research. Originally qualified as a scientist he has an M.Sc. and a Ph.D. in Computer Science from Trinity College Dublin. He is a member of the Irish Computer Society and is a qualified teacher.

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