IMPLEMENTATION OF COMPUTER VISUALISATION IN UK PLANNING

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ABSTRACT

Within the processes of public consultation and development management, planners are required to consider spatial information, appreciate spatial transformations and future scenarios. In the past, conventional media such as maps, plans, illustrations, sections, and physical models have been used. Those traditional visualisations are at a high degree of abstraction, sometimes difficult to understand for lay people and inflexible in terms of the range of scenarios which can be considered. Yet due to technical advances and falling costs, the potential for computer based visualisation has much improved and has been increasingly adopted within the planning process.

Despite the growth in this field, insufficient consideration has been given to the possible weakness of computerised visualisations. Reflecting this lack of research, this study critically evaluates the use and potential of computerised visualisation within this process.

The research is divided into two components: case study analysis and reflections of the author following his involvement within the design and use of visualisations in a series of planning applications; and in-depth interviews with experienced practitioners in the field. Based on a critical review of existing literature, this research explores in particular the issues of credibility, realism and costs of production.

The research findings illustrate the importance of the credibility of visualisations, a topic given insufficient consideration within the academic literature. Whereas the realism of visualisations has been the focus of much previous research, the results of the case studies and interviews with practitioners undertaken in this research suggest a 'photo' realistic level of details may not be required as long as the observer considers the visualisations to be a credible reflection of the underlying reality. Although visualisations will always be a simplification of reality and their level of realism is subjective, there is still potential for developing guidelines or protocols for image production based on commonly agreed standards. In the absence of such guidelines there is a danger that scepticism in the credibility of computer visualisations will prevent the approach being used to its full potential.

These findings suggest there needs to be a balance between scientific protocols and artistic licence in the production of computer visualisation. In order to be sufficiently credible for use in decision making within the planning processes, the production of computer visualisation needs to follow a clear methodology and scientific protocols set out in good practice guidance published by professional bodies and governmental organisations.

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LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
API	Application Programming Interface
CAD	Computer Aided Design
CPS	Collaborative Planning System
CPU	Central Processing Unit
DEM	Digital Elevation Model
DSLR	Digital Single Lens Reflect
DSS	Decision Support System
DTM	Digital Terrain Model
EBD	Emotional and Behavioural Difficulties
EIA	Environmental Impact Assessment
ES	Environmental Statement
GIF	Graphics Interface Format
GIS	Geographic Information System
GNF	Great North Forest
GPU	Graphical Processing Unit
HCL	Human Computer Interface
HTML	Hypertext Transfer Mark-up Language
JPEG	Joint Photographics Expert Group
LDP	Local Development Plan
LOD	Level of Detail
LV	Landscape Visualisation
LVIA	Landscape and Visual Impact Assessment
NID	Notice of Intention to Develop
ODPM	Office for Deputy Prime Minister
OS	Ordnance Survey
PSS	Planning Support System
QTVR	QuickTime VR
RT3D	Real Time 3D
SLR	Single Lens Reflect

TIN	Triangulated Irregular Network
UDP	Unitary Development Plan
VDU	Visual Display Units
VE	Virtual Environment
VR	Virtual Reality
VRML	Virtual Reality Modelling Language
VRUI	Virtual Reality User Interface
WWW	World Wide Web
XML	Extensible Mark-up Language
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence

CHAPTER 1 COMPUTER VISUALISATION AND DEVELOPMENT MANAGEMENT

1.1 Introduction

According to Cullingworth and Nadin (2006), planning is essentially a means for reconciling conflicting interests in land use. In particular, the development management process involves something which has not been built or altered; hence, carrying out planning decision making without seeing what is going to happen.

Thus, it is important in planning to have capabilities of representing environments as well as any changes humans make in order to communicate ideas. Subsequently planning predominantly requires these changes to be visualised in some way within the processes of both project design and development management.

Within the UK, planning processes of development management, consultation and assessments are often required which feed into Environmental Impact Assessments (EIA) and Landscape Visual Impact Assessments (Wilson, 2009). These processes often involve computerised visualisations such as photomontage. During this process, it is also necessary for the planning actors involved to consider spatial information, appreciate spatial transformations and various future scenarios (Tahvanainen et al., 2001).

In the past, conventional media such as maps, plans, illustrations, sections, elevations and physical models have been used. Those traditional visualisations are at a high degree of abstraction, sometimes difficult to understand and inflexible in terms of the range of scenarios which can be considered. Yet due to technical advances and falling costs, the potential for computer based visualisation has much improved and has been increasingly adopted within the planning process.

For instance, photomontages are widely implemented in Landscape Visual Impact Assessment (LVIA) processes in the UK. They provide vital comparisons of a development with *before and after* scenarios and the effects of mitigation measures and screening options.

However, photomontages, though inexpensive, suffer the limitation of requiring early selection of fixed viewpoints and offer no ability to change the nature of the proposal without starting again. Whereas, animation sequences follow predetermined paths and take considerable time to amend and re-render if changes to the chosen route are required.

Modern planning process such as consultation and assessment require a degree of interaction among planning actors such as professionals, stakeholders, and the general public. There is more demand therefore for interaction and communication tools to be used in planning.

Since these approaches have enhanced visualisation there have been many calls for greater interactivity. Although more photomontages can be produced, this is not possible for every viewpoint. Within public consultation unforeseen questions may arise, for example, ‘how will the view from my house change as a result of this proposal?’ The demand for interactivity also comes from consultants, planners, urban designers and landscape architects (Porter, 1997). This has led to interactive media being tested in many planning processes (Schroth et al., 2011).

In addition, Virtual Reality (VR) technology provides us with the scope for enhanced exploration because, by general definition, it includes motion and interaction within the visualisation rather than just static scenes. A VR User Interface (VRUI) therefore provides the potential to ‘zoom-in’ from a large area to smaller areas of interest which have higher-resolution data, as well as being able to ‘fly’ over the landscape at a chosen resolution searching for anomalies or other features of interest (Brown et al., 2002).

On the contrary, visualising the real world is far from perfect and brings with its own challenges such as technology scepticism (credibility), levels of realism, and the costs associated with production.

Moreover, the drawbacks of virtual technology were first recognised in the early 1990s. For example, it was illustrated (Sherman and Judkins, 1992) that virtual reality could have gender repercussions as it works in a way more likely to appeal to women than men. It can distort existing power and influence channels. It can affect the way families and friends interact. It might well attract organised crime and almost certainly be exploited by the ruthless. In short, like electricity, antibiotics, flight, television and computing itself, it has the capacity to transform society.

Another disadvantage of acclimatising this technology in planning has been identified; Lange (2001) claimed that three-dimensional visualisation was not properly implemented within the planning process, but they are just used as an expensive supplement to sell the final project.

Sheppard (2001) also points out that there is a risk of manipulation within three-dimensional visualisation, which could mislead the observers.

The need for comprehensive tools has escalated alongside both the capacity for the data availability on the environment and the requirements of the end-user, potentially placing computerised visualisation in a key position to assist development management including consultation and various planning assessments. In principle, accessibility to the technology, available data, and a level of competence to utilise them in combination, provides a powerful facility for advocacy in relation to environmental practices and pressures driving environmental change. It also has the potential to enhance public education and participatory decision-making across the stakeholder community, especially when coupled with a World Wide Web infrastructure. However, computer visualisation has so far been a relatively unexplored subject within planning research, and it has often been viewed merely as a planning tool. The research into the use of visualisation in planning in the UK will further reveal a number of other interesting aspects of changes in communication within the planning process.

1.2 Framework for Evaluation and Research Questions

This study critically evaluates the use and potential of computerised visualisation within the UK planning process. More specifically, focus is given to the development management process by which planning applications are granted permission to build. This approach reflects the view that visualisation media cannot be separated from the planning process.

Before being able to critically evaluate the use of visualisation it is first important to *understand how computer visualisation has been utilised within the development management process*. In order to explore this, the following questions need to be answered:

- *Which types of planning application have employed the technology?*
- *What types of media are currently utilised in the UK?*
- *What are the pros and cons of using each computer visualisation media?*

Given the focus of these questions on the media used and its implementation within planning practice, the research adopts the lens of the landscape consultant. Whilst providing only a partial perspective, it focuses on the process of visualisation design and implementation as part of the development application. This perspective, which focuses on the visualisation and its usage rather than the planning process itself, uncovers the practicalities of the actual usage of visualisation and the challenges emerging identified as the key questions within this thesis.

In addition, the major questions also raised are not only about advancing technological changes and their strengths and weaknesses, but also the underlying users' recognition and attitude to them. The second question is:

What are the challenges computer visualisation is facing when implemented within planning practice?

Based on a review of the existing literature, this research explores in particular the issues of credibility, realism, and production costs. Computer visualisation can play a key part in envisaging the completed scheme. Therefore, used as a communication media, computer visualisation can be a major part in the process and could affect planning decisions. During the planning process, it is important that computer visualisations are credible, which refers to the accuracy of location, size and geometry of the elements chosen to be presented within visualisations, but also the extent to which stakeholders view the visualisations to be an unbiased representation of the present and future outcomes.

The realism of the presentation may also be important, which is defined here in terms of how close the visualisation is to the level of detail provided in the real world outcomes. Despite advances in technology, the real world cannot be perfectively visualised or duplicated by technology. Audiences still need to use their imagination to go from the visualisation to understanding how future scenarios will look. Hence, the level of realism used within visualisation needs to be decided for the purpose of planning use.

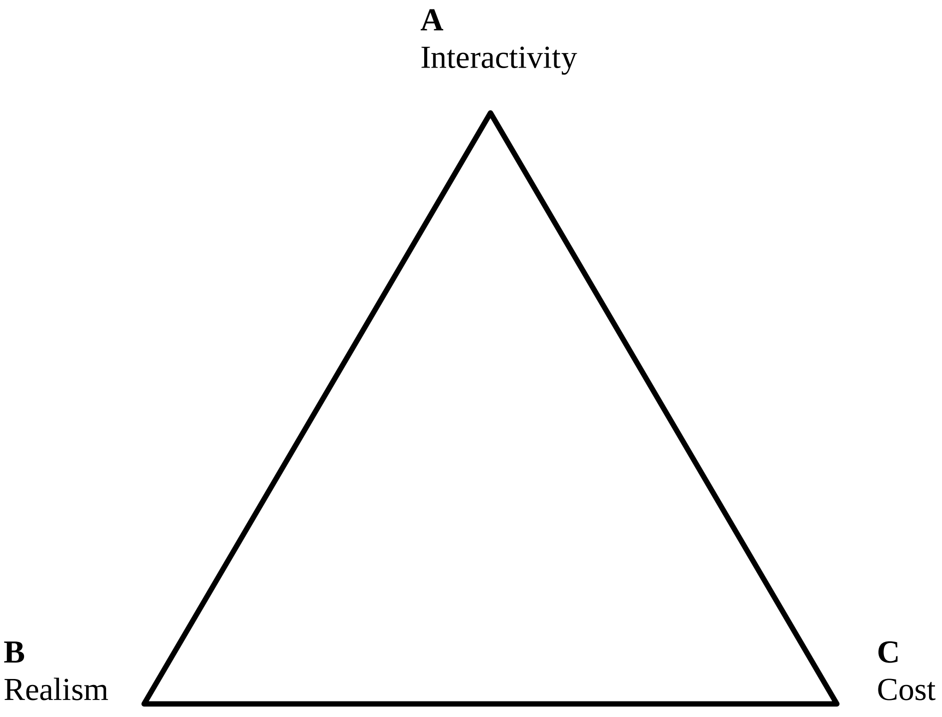
Therefore, stakeholders including modellers (preparers), planning practitioners, and planners play a key role in achieving a consensual agreement on the level of detail within computer visualisations for planning purposes.

In the research, realism refers both photographic realism and immersive 3D experience, where often multiple perspectives are required for stakeholders to consider a visualisation to be credible. Although credibility and realism are closely linked, they do not necessarily act together. The extent of realism is just one aspect within the development of a credible visualisation and may not be the most important.

Furthermore, interactivity is an important element within modern planning processes in order to achieve social sustainability and can also contribute to the overall credibility of the visualisations undertaken. In the UK planning context, interactivity implies inclusiveness and transparency in decision making, public involvement and participation during the planning process. However, interactivity within planning media interacts with realism, credibility and production cost. Under current technology, it is often traded off with realism and cost.

In summary, all significant elements reviewed in the research - interactivity, realism and cost - are closely related, interact and can be a triangular relationship (Figure 1.1 Triangular Dilemma of Computer Visualisation[1]) as below.

Figure 1.1 Triangular Dilemma of Computer Visualisation



A and B but not C: most of state of art computer visualisations

B and C but not A: pre-set path simulation and photomontages

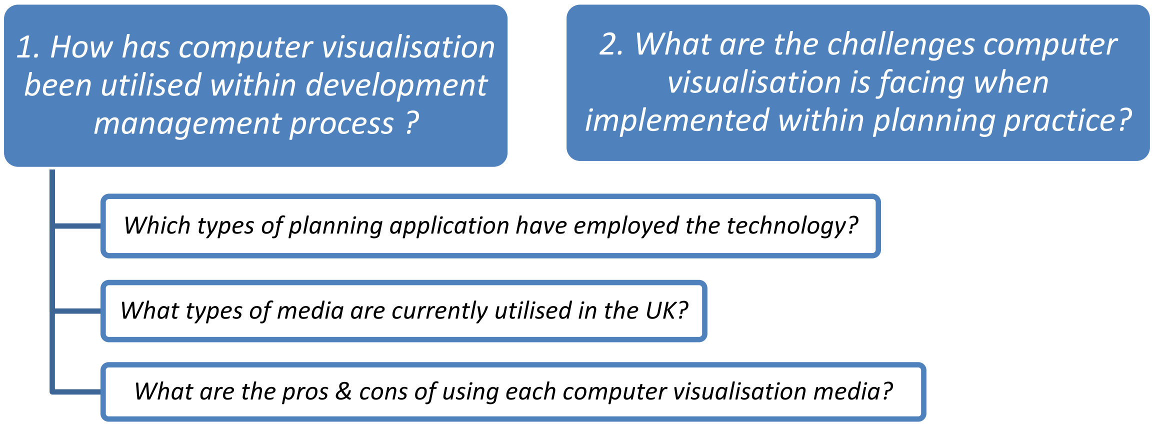
A and C but not B: real time rendering and panoramic VR

Finally, deciding the level of realism and extent of interactivity is closely related to production costs. Each visualisation media has its own advantages and disadvantages in terms

[1] It is adapted from Moseley (2003).

of production cost. In planning practice, cost may be a significant factor in employing computer visualisation. Therefore, the research questions could be summarised as in Figure 1.2 below:

Figure 1.2 Research Questions



1.3 Methodology Adopted

So far, few studies have attempted to integrate computer visualisation within the planning process (Appleton et al., 2001, Orland, 1992, Sheppard, 2001, Salter et al., 2009). Due to a lack of research into this area many of the major determinants underlying the implementation of technology remain unexplored and must be examined in order for us to more fully understand planning decisions. One of the best ways to understand the roles of computer visualisation within planning is to examine the most common scenarios and planning applications in order to uncover the mechanisms and structures behind the phenomena.

Reflecting this need the research is divided into two components: (1) *case study* analysis and reflections of the author following his involvement in the design and use of visualisations in a series of planning applications; (2) and *in-depth interviews* with experienced practitioners in the field.

Firstly, the individual planning application cases were selected based on typical planning applications and utilisation of computer visualisation in order to investigate empirical implementation of the technology within development management. With the case studies, the research will be able to scrutinise the empirical utilisation of computer visualisation used in planning processes in the UK as well as investigating the individual media employed in planning.

The author has worked on a large number of projects implementing computer visualisation in planning for environmental practices in the UK and internationally. This unique stance of being a practitioner as well as having produced visualisation gives valuable hands on experience in order to understand the realities of its implementation.

The majority of the projects studied were located in the North East of England. Consequently, most case studies in this research are based in this region. In terms of planning applications, these case studies were for Landscape Visual Impact Assessments, detailed and outline planning applications, public and stakeholder consultation, and discharge of planning conditions. Within the case studies personal experiences were supplemented by the analysis of stakeholder group meetings.

Secondly, the other element of the methodology is the employment of semi-structured interviews with experienced landscape practitioners. Through these interviews the research is able to explore their reflections on issues and challenges of implementing technology in planning. Therefore, this element of the methodology will contribute to investigate the current challenges that practitioners are faced with, with regards implementing technology in planning processes.

Using example visualisations from the case studies as tools for discussion, practitioner interviews were also conducted. These included planners, environmental consultants and developers who participate directly or indirectly in the process, with a focus on those involved in the consultation process within development applications.

Unlike various academic, social and technical commentators who have argued about the implementation of computer visualisation in the planning process, this research does not attempt to promote or deter professionals – environmental consultants - or local planning authorities from using technology and computer visualisation media in planning. Instead, this research has attempted to take a step back from the often heated controversy over the implementation of technology to investigate the appropriate implications of practice within making environmental assessments, planning decisions, and consultation. It is hoped that such a stance will begin to help fill a void in positive social and scientific research by presenting the concept of the valid use of the technology, which has rarely been monitored in the analysis of both technology and its implementation.

1.4 Significance of the Research

In recent years, it is not only the planning field that has adapted computer visualisation as communication media, but also a number of other areas including medical, environmental and mechanical engineering. So far, only a small amount of research has paid attention to the possible weakness of computerised visualisations (Sheppard and Cizek, 2009, Pettit et al., 2011) – photomontages and three dimensional media – and this negligence could raise issues of credibility within planning practice. Furthermore, even though the adaptation of the visualisation technology has been a phenomenon in various fields, standards and protocols have not been fully developed. Without appropriate guidelines, the results would more likely be distorted or manipulated to benefit certain parties.

This is the first research into the detailed subject in the UK planning from the visualisation preparers' point of view; therefore, empirical conclusions are derived from this research. This study can contribute to the development of strategies for constructing a better technological implementation system within planning. The major issues emerging relate to scepticism over implementation of technology, the levels of realism required within planning applications, and the production costs of computer visualisation. Considering these issues, the research is in a good position to investigate in a practical sense real motivations, technological progression, and obstacles of implication within the phenomena.

1.5 Outline of the Thesis

This thesis is divided into seven chapters. Chapter 1 introduces the background, research questions, and overall organisation of the research. The rest of the thesis is organised in the light of the research questions outlined in the research framework (pages 3 & 4).

Chapter 2 attempts to conceptualise computer visualisation in planning. It also reviews historical backgrounds and definitions to reach the most appropriate concept of the research. Thereafter, it presents the main points of computer visualisation together with emerging issues of current use of visualisations in planning through literature review. Furthermore, since the UK planning system differs from other countries and is closely related to the implementation of technology in the research, it is a prerequisite to make clear the general context of the planning system.

Chapter 3 is divided into three sections with each addressing qualitative research methods, methodology perspective 1 – case studies, and methodology perspective 2 – interviews with

North East practitioners. The first section, Understanding qualitative methods addresses generic research methodology – both qualitative and quantitative, research questions and units of analysis, case studies and interviews in order to understand principles of research techniques/ methodologies and why qualitative methodology has been chosen. Secondly, Perspective 1 - Case Studies – explains technical aspects of the case studies including pilot case, selection and design. In particular, the section provides feedback from stakeholders – mainly affected communities – with regards to computer visualisations for individual case studies. The third section – Perspective 2 Interviews with North East Practitioners – illustrates the design of semi-structured interviews that were employed and the selection of subjects within the North East of England. This section contributes to the research by investigating how practitioners perceive and reflect on the current phenomenon of computer visualisation used in the planning process.

Chapter 4 deals with case studies and individual planning scenarios that employ computer visualisation. It contains five case studies involving a variety of planning application and computer visualisation media. Hence, the division of case studies is based on two different types of category; diverse computer visualisation media and typical planning applications. Each case study is described in terms of location, contact, project overview, visualisation production and implication, and study results.

Chapter 5 analyses the case studies. These chapters attempt to answer the research questions set out in Chapter 1. Chapter 5 also examines technical aspects of the implementation of computer visualisation in planning based on the author’s hands on experiences in the field. In this part therefore, a technical review and analysis is based on the modelling and representational processes used within the case studies. The research therefore aims to demonstrate the potential roles of visualisation technologies in planning practice and cover the emerging issues of its implication in planning.

On the other hand, Chapter 6 is focused on a semi-structured interview analysis of the emerging issues of computer visualisation set up in Chapter 2, which are technological scepticism (credibility), levels of realism, and production costs. Chapters 5 and 6 define the importance of the credibility of visualisations, a topic given insufficient consideration within academic literature. The results of the case studies and interviews with practitioners undertaken in this research suggest a ‘photo’ realistic level of detail may not be required as long as the observer considers the visualisation to be a credible reflection of the underlying reality.

Finally, Chapter 7 develops a discussion, reveals findings, and concludes the research. It also makes the suggestion that there needs to be a balance between scientific protocols and artistic licence in the production of computer visualisation. In order to be sufficiently credible for use in decision making within the planning process, the production of computer visualisation needs to follow a clear methodology and scientific protocols set out in good practice guidance published by professional bodies and governmental organisations.

The research besides predicts that technology would in the future be implemented more readily as part of development management processes. In particular, real time technology and interactive tools would be utilised more frequently for the transparent and inclusive elements of the planning process. Consequently, realism and interactivity will be increased within the media; at the same time, the cost of production would decrease significantly considering the technological development that has occurred in the past decade.

CHAPTER 2 EMERGING ISSUES ON COMPUTER VISUALISATION

2.1 Introduction

This chapter examines the implementation of computer visualisation in planning in terms of the relevant history and theory; critically reviews practice usage and investigates the necessity of the study into computer visualisation. In reviewing the literature on computer visualisation and planning, the chapter also argues that computer visualisation has been boosted by hardware and software development. In particular, a review of the literature on computer visualisation within planning reveals that very little academic attention has been paid credit to developing technologies and establishing visualisation guidelines. This chapter considers the limits of previous work on computer visualisation and argues for a more detailed and rigorous investigation of the phenomenon.

Recent decades have seen a consistent move towards the usage of technology in the planning process or its application. Some studies have investigated computer visualisation, planning, and the implications, focusing on a variety of issues. Some evaluate the pros and cons of the technology, planning advantages, or public involvement while others examine the social and economic aspects that may affect planning decisions. Technology, computer visualisation and planning tools are closely related to each other and therefore, it is difficult to divide the literature on them by subject area.

Nevertheless, there are a number of potential benefits of employing computer visualisation in the planning process. Notably, these can be summarised into two main themes: consultation (public participation and stakeholder groups) and various assessments including EIA and Landscape / Visual Impact Assessments. Firstly, the consultation and participation process has become an essential part of UK development management due to its discretionary system. Already there is some research that has suggested (Perkins and Barnhart, 2005) that the use of computer visualisation in public participation is beneficial to the planning process.

In the UK, the planning system is essentially a means for reconciling conflicting interests in land use (Cullingworth and Nadin, 2006). In particular, UK planning is unusual in the extent to which it embraces discretion. This allows for flexibility in interpreting the public interest. In terms of social sustainability, Roe (2000) claimed that without changes in social behaviour, values and equality in conjunction with economic and political change, opportunities to develop a more ecological sustainable lifestyle will be severely limited.

Critical issues on employing computer visualisation in planning were identified from the literature review and from the pilot case study. Three areas require to be addressed to determine the suitability of employing computer visualisation as a communication media in planning within the UK. These include *scepticism of the technology, levels of realism, and production cost.*

2.2 Introducing Computer Visualisation

Before undertaking the literature review, it is important to address terminology and definitions of the subject. For that reason, visualisation and landscape are defined, followed by a brief history of visualisation, which includes both digital and non-digital visualisation.

2.2.1 Visualisation and computerised visualisation

Landscape visualisation itself is an indefinite term and it also involves a number of visualisation communication methods ranging from still images to three dimensional illustrations. Defining landscape visualisation is not easy because 'landscape' and 'visualisation' need first to be considered separately. In particular, this research is focused on computer-generated visualisation as the medium within the more generic category of visualisation methods.

An English dictionary[2] defines visualisation as 'to form a picture of (something or someone) in the mind'. Moreover, Ervin and Hasbrouck (2001) defined landscape as natural world, in which we live, garden, work, and build, including both natural systems such as plants and weather, and also built systems, such as roads and cities. Though we may sometimes speak of "the landscape" there are many different landscapes in this world, and many different perceptions of them. Of course, in the real world that we live in, the landscape includes structures of all kinds, including buildings and bridges and cars, and a wide variety of animals whose activities are vital to the function and look of the landscape.

In the light of computerised visualisation, Slater et al. (2002) claimed that the origin of computer graphics is generally agreed as being marked by publication of the seminal paper

[2] Longman, Dictionary of English Language and Culture

by Ivan Sutherland, describing the Sketchpad System. Sutherland's system allowed users to interactively draw on a screen, using a pointing device called "light pen". Many of the concepts that we take for granted today were invented for this system: for instance, the idea of a "rubber band line"-that is, stretching out a line across the display as if it were a rubber band, with it staying in place in the position in which it was released. The idea behind two-dimensional viewing was also invented for this system. Most importantly-and this is the issue that separates computer graphics from just being a medium for the presentation of pictures-the concept of a graphical object was invented, that is, an entity with its own semantics and interactive behaviour-albeit in a primitive form, but nevertheless the starting point for a new science.

They continued to define 'Virtual Environments' as follows;

> In an application the program that brings the stuff of the world into being. In an application the illusion of a world is maintained by the interactions between this basic stuff of the world, which people perceive as things, the graphical objects, and the high-level internal cognitive models of the group of people interacting within it. Their behaviours are themselves embodied in that world through objects that represent them-typically each person is represented by a virtual character, or avatar, whose dynamics corresponds in some fashion to the activities, behaviour, and movements of their physical human counterparts. Computer graphics gives us the ability to visually depict this world with an infinite variety of possible representations (Slater et al, 2002, p21).

Initially, virtual environment is associated with video games, film, etc., involving many and varied but always very specialised computer technology using hardware such as headsets, VR theatres, caves, data-globes and other feedback devices (Fisher and Unwin, 2003).

There are three basic forms of virtual reality. The first, and best known, uses small TV screens and earphones in a Darth Vader[3] (or Gulf pilot) helmet, and a glove (or a joystick, wand, or six-dimensional mouse). The second form is where video cameras place and track the image of a user(s) in a virtual graphic world, in which they interact with virtual objects. A variant on this is to convert the video image into graphics and place this graphic image of the user in the virtual world. The third type is to take three-dimensional modelling, but either view it through 3D glasses, play it in a flat screen (like a CAD[4] package), or a large, curved or angled screen to get the inclusive, or what are known as 'immersion' effects.

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[3] Darth Vader is the central character in the Star Wars films appearing as one of the main antagonists in the original trilogy and as the main protagonist in the prequel trilogy.
[4] Computer Aided Design

Virtual reality was initially coined by Jaron Lanier (1987) ‘Artificial reality’ (Myron Kruegar, 1970s) ‘Cyberspace’ (William Gibson, 1984), ‘Virtual Worlds’, ‘Virtual Environment’ (1990s) in fact, the term was invented just a few decades ago. Compared to other media in landscape illustration, this is not a long history.

Moreover, based on their methodological development of the rendering process, visualisation was classified into three groups (Appleton et al., 2001). First, image draping, where a single image or combination of image layers is draped over a three dimensional representation of the terrain; second, ‘photo-realistic’ rendering where vegetation and other landscape features may be incorporated to give a more realistic representation of an area; and, third, virtual worlds, which allow the user to interactively explore an environment and may include links to auxiliary information.

Ellis et al. (1993) suggested a useful analytic framework for the discussion of such Virtual Environments. They classified a virtual environment as having three major components: content, geometry, and dynamics. The content consists of the “objects” that make up the environment, the geometry consists of dimension, metric and the extent or boundaries of the environment, and the dynamics consists of the rules of interaction between the objects (for example, how a button responds to a mouse event, or in physical simulations, how objects respond to collisions with other objects).

‘Virtual reality’ is a very trendy term; neither ‘virtual’ nor ‘reality’ is either well defined or strictly appropriate. For example, much more helpful would be the earlier notion of ‘alternative reality’ or the more recent of ‘virtual worlds’ (Fisher and Unwin, 2003). They continued,

> Virtual reality is the ability of the user of a constructed view of a limited digitally-encoded information domain to change their view in three dimensions causing update of the view presented to any viewer, especially the user (Fisher and Unwin, 2003, p1).

The definition above encapsulates the essence of all visualisations that can legitimately be called virtual reality. There are a number of definitions and terminologies of ‘virtual’ and ‘virtual reality’. Even though most of the research refers to the term as the ‘immersive three dimensional world’, the author’s personal experience suggests that some private landscape consultants use the term for general computer generated visualisations including photomontages. Therefore, this research attempts to define the term ‘virtual’ beforehand. Table 2.1 defines terminology of the virtual reality, virtual worlds, and etc.

Table 2.1 Research Definitions and Terminology of 'Virtual'

Term	Description
Virtual Reality (VR)	Most inclusive term for immersive three dimensional space and interactive movement
Virtual World/Virtual Environment	Immersive three dimensional space generated by 3D geometries/objects

The emerging virtual reality technology does operate in a three dimensional virtual world. It offers the viewer a set of stimuli of the real three dimensional world, and provides a high level of spatial cognition, when interactivity is provided to freely navigate the virtual world, and this world is visualised with sufficient sophistication and detail to be perceived as 'real' environments.

Moreover, a virtual reality model is a three dimensional computer model, which permits the viewer to 'fly', 'walk', or 'drive' through a representation of a development proposal. Within the bounds of the area modelled-often known as the virtual reality world the onlooker can select any route and stop at will to examine views in any direction. The virtual reality model can also be set up with options to turn various development proposals on or off. Typically, this will include adding or removing buildings, changing the number of storeys, altering a flat to a pitched roof, or altering the colour or texture of cladding materials until it satisfactorily respects the building line prescribed by neighbouring properties (Wilson, 2009).

In some respects, the virtual model can also offer interactivity in the fourth dimension. Illustrating changes over time is frequently important in predicting the degree to which planting may screen a development in the future. Based on growth tables for a known planting mix, benefits resulting from a tree belt may be shown at say five, ten, and fifteen years' growth, while still offering the facility to move freely around the site. This degree of flexibility is a powerful tool for objectively predicting and then mitigating impacts before major changes to site layout prove necessary.

Bodum (1990) claimed that the different types of model can, for each type, be described at a specific level of abstraction. It was suggested that four different kinds of models have specific characteristics; near reality, enhanced reality, enhanced virtuality, and virtuality.

In the same findings, Bodum also continued that near reality is the kind of 3D model in which video or stereoscopic pictures are used to give an illusion of 3D. These models are mainly image-based. Enhanced reality uses the video or photographs as a background for new physical objects in the plan. These new objects can mainly be placed in the foreground of the model. It is more difficult to integrate the objects in the model so that they can be moved behind real objects in the video or in the pictures. This kind of model is used, for instance, in feature films such as Jurassic Park and The Lost World. These models are image-based with vectorised features on top. Enhanced virtuality is, for example, the texture mapping of pictures on to objects in a CAD model. It can also take the form of pieces of digital film that are played on top of a CAD model. The idea is that the CAD model is the background and the small pieces of photograph or film can give the model a more realistic image. These models are vector-based CAD models, with images used as texture. Finally, virtuality is a full-scale model created without the use of realistic elements. All objects in a virtual model are created as vector-based features in a CAD environment. They can be combined with more abstract patterns stored as image.

VRML[5] is a graphic computer language to build 3D model in Internet (Ko, 1998) It provides not only 3D space beyond 2D but also hyperlinks such as HTML[6]. Initial VRML 1.0 file format was created by Silicon Graphics in the basis of a graphic language 'Open Inventor[7]'. The current version VRML 2.0 has become an international ISO/IEC standard under VRML 97.

However, in 2004, VRML was superseded by X3D. X3D is the ISO standard XML[8] based file format for representing 3D computer graphics, the ability to encode the scene using XML syntax as well as the Open Inventor-like syntax of VRML97, or binary programming interfaces.

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[5] VRML provides 3D worlds with integrated hyperlinks on the web. The viewing of VRML models via VRML plug-in for web browser is usually done on a graphics monitor under mouse control. VRML was mentioned in the first International WWW Conference in CERN, Swiss on May 1994 and a team was created for developing VRML. On October 1997, VRML 1.0 was announced in the second International WWW in Chicago, US.

[6] Hyper Text Markup Language

[7] Open Inventor is an object oriented 3D toolkit offering a comprehensive solution to interactive graphics programming problems. It presents a programming model based on a 3D scene database that dramatically simplifies graphics programming. It includes a rich set of objects such as cubes, polygons, text, material, cameras, lights, trackballs, handle boxes, 3D viewers, and editor that speed up programming time and extend 3D programming capabilities.

[8] Extensible Markup Language

2.2.2 Visualisation and human: emerging new technology

This review looks primarily at the history of human visualisation. As the long history of art shows how humans have attempted to illustrate and visualise the world for others. The history of actual visualisation could go back to a prehistoric age such as paintings found in Altamira Cave which is estimated to have been drawn between 16,000 and 9,000 BC (Johnson, 1996) and Lascaux's complex of caves in France where paintings have been estimated to be 17,300 years old. Since then, there have been numerous human attempts – as far as they remain and are recorded – to express the world environment: drawing, carving etc.

Traditional analogue visualisation techniques for the representation of concepts in planning and design are plans, sections, sketches, perspective drawings, photomontages, and physical models (Lange and Bishop, 2005). The most practical example of using visualisation in environmental planning is provided by Humphrey Repton's before and after representation (See Figure 2.1).

Figure 2.1 Repton's Illustration which shows 'before' and 'after' scenes, source (Loudon, 1839)

In the 18th century, Repton's before and after approach became a classic to reproduce proposals in planning and design process. It is composed with a simple picture to show the existing site conditions and another picture to illustrate proposals, both of which were presented to Repton's clients to convey ideas of transformation. This is a basic drawn form of photomontage and using computerised methods has become a popular media to convey proposals to clients. Figure 2.2 also illustrates 'flap' type of before/after overlay photomontage, which gives existing/proposed landscape almost real time.

Figure 2.2 Example of Repton's Red Book (Sheringham Park, Norwich)

In the past, visualisation methods have included scale models, artists' impressions and manipulated photographs and landscape visualisation. Previously, the word 'model' referred to a physical model in planning. However, in recent years, it could mean both physical and computerised models. Production costs for both are approximately the same; however, unlike computerised models, physical models are very difficult to change.

Nevertheless, Wilkinson (2008) claimed that physical models have unique advantages, which could be built by communities. For instance, Planning for Real[9] provides hands on tools and techniques for people to engage in planning. In planning for real exercises, the 3D model is usually made by local residents, often children, on a scale of about 1:500. The model is lightweight and portable so it can easily be taken to the places where people meet and gather. During the consultation exercise, the model is surrounded by suggestion cards or flags. Residents select cards, or write their own, and place these on the model to show what their needs are. Residents work in small groups, supported by the appropriate partner officer to review the suggestions and decide priorities and possible options.

Figure 2.3 illustrates differences between physical and computerised model. Despite the pros and cons, computerised models are more often employed in development management because of their flexibility.

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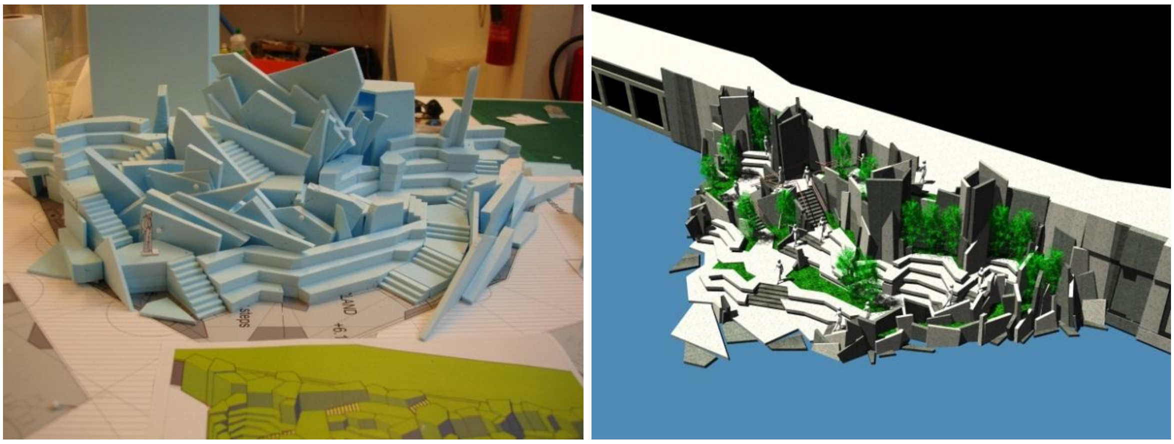
[9] Planning for Real is a community planning model which helps people shapes the places where they live. Planning for Real is part of the Accord Group, delivered nationally from the Neighbourhood Resource Centre for Central England, based in Walsall, West Midlands (www.planningforreal.org.uk).

Figure 2.3 Physical and Computerised Models (Courtesy of MSP Ltd.)



With advances in computer technology, the use of visualisations has increased sharply. Virtual[10] reality may have appeared in the headlines only in the past few years, but its roots reach back four decades (NCSA and EVL, 1995). A young electrical engineer and former naval radar technician named Douglas Engelbart envisioned computers as tools for digital display. In the early 1960s, the US military commissioned a new radar system that would process large amounts of information and immediately display it in a form that humans could readily understand. The resulting radar defence system was the first 'real time,' or instantaneous, simulation of data.

Meanwhile, aircraft designers began experimenting with ways for computers to graphically display, or model, air flow data. Computer experts began restructuring computers so they would display these models as well as compute them. The designers' work paved the way for scientific visualisation, which is an advanced form of computer modelling that expresses multiple sets of data as images and simulations.

The idea of using a computer to display data in a graphic format dates back to the earliest days of computing itself. The first implementations of this concept into practice evolved as quickly as the pace of hardware development permitted.

By the early 1960s, many of the basic concepts in the early computer graphics field were outlined in a 1962 PhD thesis by Ivan Sutherland, describing a system entitled Sketchpad. Beyond its technical specifics, this publication is widely regarded as the first to establish computer graphics as a technical discipline. Although the Philco Corporation developed a

[10] The common meaning of 'virtual' in the computer is just 'simulated'. And so 'Virtual Reality' is just simulated reality, and a 'virtual garden' is nothing more than a simulated garden; simulated in a computer, using CAD, GIS, image processing or animation.

remote stereo camera and head-mounted display as far back as 1958, the genesis of virtual reality is commonly accepted to be a paper, 'The Ultimate Display', written by Ivan Sutherland in 1965 (Ellis et al., 1995). Following the early work of Sutherland and many others, the 1960s witnessed the development of such major advancements as colour raster display, hidden surface removal, and light source shading (Gallagher, 1995).

One of the most influential antecedents of virtual reality was the flight simulator (NCSA and EVL, 1995). Between World War II and the 1990s both military and commercial firms developed the technology to simulate flying airplanes as well as driving tanks and steering ships.

By the 1970s, computer-generated graphics had replaced videos and models. These flight simulations were operating in real time, although the graphics were primitive. In 1979, the military experimented with head-mounted displays. These innovations were driven by the greater dangers associated with training on and flying jet fighters that were being built in the 1970s. By the early 1980s, better software, hardware, and motion-control platforms enabled pilots to navigate through a highly detailed virtual world. Notably, some of Hollywood's special effects were computer-generated, such as the science fiction movie Star Wars released in 1976, Terminator (1984) and Jurassic Park (1993).

Originally, computer graphics was a largely unified discipline revolving around the display of geometry. As time passed and the field gained rapid commercial acceptance, a number of subspecialties developed including rendering techniques, simulation of natural phenomena, and radiosity.

The terms 'visualisation' as eventually coined to describe this subspecialty, was perhaps first made popular in a 1987 National Science Foundation initiative on scientific visualisation. Thereafter, early visualisation applications generally involved large-scale interpretation of visual data, such as medical tomography, satellite imagery, and scientific data reduction.

In the 21st century, computer visualisation has been used in many aspects of your life. Arthur (2007) claimed that computers are more powerful than ever before and used to make better sense of the human world. He continued that visualisation did not have to mean fancy eye candy, but it can be just simple, elegant and informative.

More recently, newer three-dimensional visualisation techniques allowing the display of volumetric, multivariate and time-dependent behaviour have joined earlier display techniques in numerical analysis applications. In addition to the visualisation algorithms themselves, this trend has been driven by increased computing capabilities, which allow for more complex analysis. Today, the move towards further real-time 3D graphics display capabilities is helping visualisation become part of a more interactive approach to analysis.

In addition, scientific visualisation uses computer graphics to transform columns of data into images. This imagery enables scientists to assimilate the enormous amount of data required in some scientific investigations including DNA sequences, molecular models, brain maps, fluid flows, or cosmic explosions from columns of numbers.

Computer visualisation can include various forms of alternative technologies and possibilities. The most commonly used visualisation option is digitised rendering. In particular, virtual reality creates a three-dimensional environment from the data and developments in it promises a much more involved way of using data.

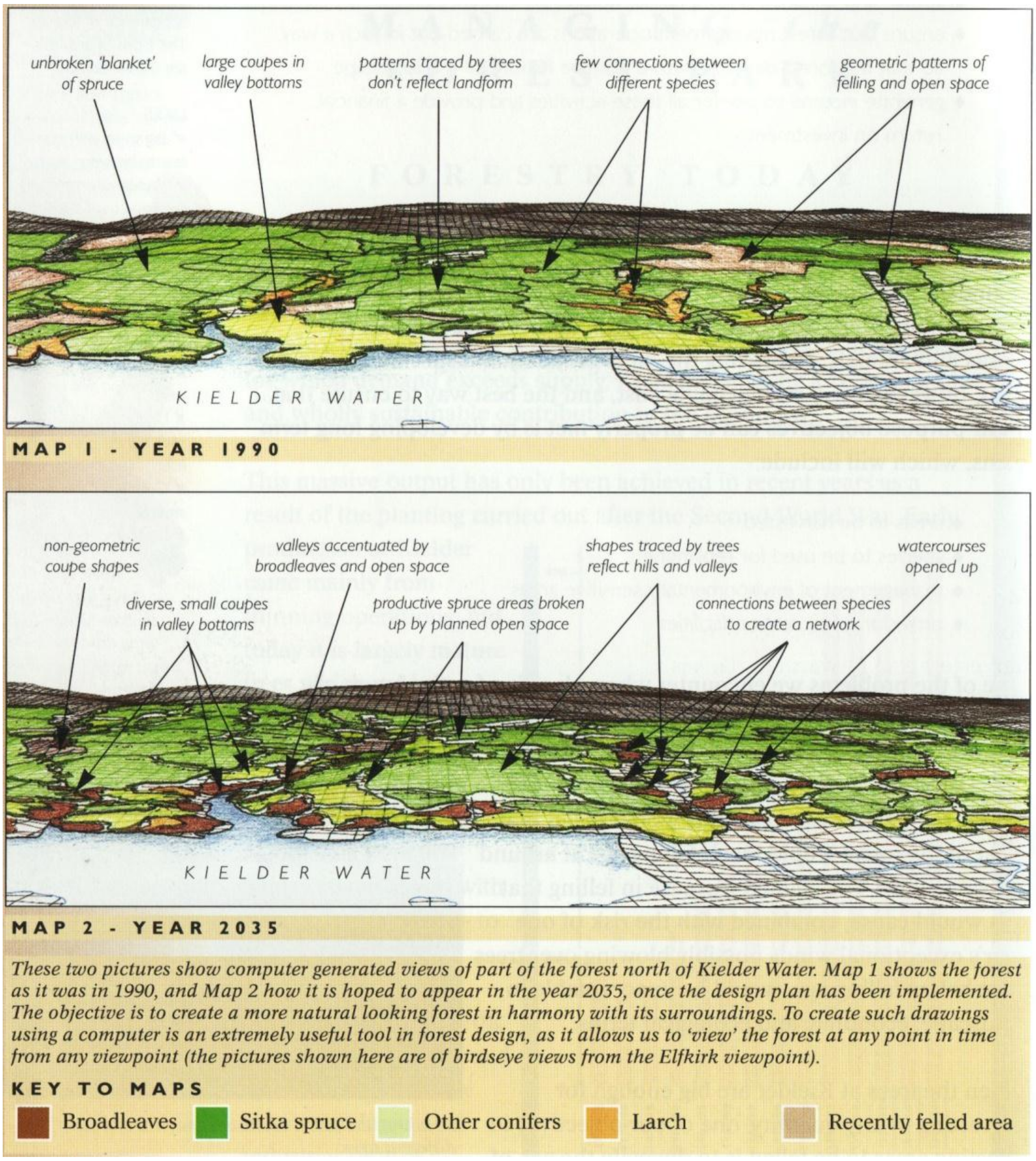
Critically in the virtual environment, users become part of the data set, part of a digital world where they can explore and interact with the data. The experience of being part of the data, called ‘immersion’, is enhanced by the use of stereoscopic three dimensional images, sound and real-time interaction (Brodlie et al., 2002)

Moreover, photo-manipulation technology, so called photomontage, is widely used in the planning process, notably within EIA[11] and LVIA[12]. It is based on the idea of Repton’s before/after presentation. Such approaches started with artists’ impression based on manual sketches and so on. However, these days computer technology enables the production of highly detailed photomontages.

Figure 2.4 provides an early form of a photomontage illustrating how computers were used in the early years of visualisation. In this case the image was employed to generate landform, upon which different types of forest were rendered by hand.

[11] Environmental Impact Assessment
[12] Landscape and Visual Impact Assessment

Figure 2.4 Early Photomontage Examples – Before/After in 1980s



Recent examples can be highly photo-realistic. Figure 2.5 shows an image produced for a planning public enquiry, the proposed fence on the left hand side of the image was considered within the enquiry. Details of the fence including height, types, and colour were carefully considered and taken into account within the modelling. In the rendering, time and condition of photography is reflected in the final production in order to minimise any possible human error.

This type of production often uses highly commercial software and hardware, although in general, more time and skilled labour is required which increases the cost of production.

Figure 2.5 High level of realism (photo-realistic) photomontage, Courtesy of WYG plc.

As well as photo manipulation tools, three dimensional technologies have also emerged. The environmental planning industry has been implementing 3D simulations and virtual reality for formal or informal planning processes such as assessments and consultation.

There is also the possibility of linking computer visualisation to web technology. In the UK, more than 77% of all households already have a connection to the Internet according to figures released by the independent Office of Telecommunications (Oftel) in 2011.

Moreover, dial up connections fell sharply by 2% in 2011. In 2007 broadband connection composed 84 % of UK household Internet, which increased to 93% in the year 2011.

Strictly speaking, literature on the implementation of Internet technology is outside the brief of this thesis; it is however worthy of review in the context of computer visualisation, so it is discussed later on in this chapter.

2.2.3 Reactions towards traditional visualisation

There have been many attempts to implement visualisation technology across various industries. This includes construction, education (Doyle, 2005), and numerous every day aspects of our life. Planning is no exception where Bishop and Lange (2005) claimed;

> In the past, maps, plans and sections have been predominately used. These representations are at a high level of abstraction. For the understanding of both the general public and the experts, it is important to communicate a proposal in perspective view, providing a more natural and direct approach to communication (Bishop and Lange, 2005, p4).

Turner and Watson (2000) discussed 7 ways in which digital technology will foster creative approaches to urban and landscape design: (1) 3D design must supplant 2D design (2) 4D simulations will facilitate the exploration of change through time (3) a wealth of digitally stored factual information can be brought into the creative design process (4) a full range of evaluative information can be brought into the creative design process (5) post-modern intellectual structures can guide creative design process (6) environmental assessment can guide and inform the creative design process. (7) the process of pattern-assisted design can be supported by computers.

Trumbo (1999) has claimed that visual representation can convey strong messages and make them easy to remember; pictures can condense complex information and communicate content which is new and hard to understand; images can provide the basis for narratives, personal thought processes and conversations, which also contribute to people's memory and issue-awareness; visualisation offers opportunities to communicate ideas in an instant using many different media in a variety of contexts such as awareness raising campaigns, participatory planning exercises, education etc.

Interestingly, Muhar (2001) compared graphical representations with actual on-site experience. It concluded that despite the limitations of computer visualisation, it is superior to on-site experience in communicating design and therefore, visualisations can be successfully employed in design communication.

2.3 UK Planning and Computer Visualisation: Overview

Within development management processes, from a planning applicant's point of view, the utilisation of computer visualisation is dependent on planning applications and stages of implementation. The use of computer visualisation as part of a planning application is typically associated with Landscape and Visual Impact Assessments (usually as part of an Environmental Impact Assessment), and is also involved in public participation, public enquiry, stakeholder consultation, appealing decisions, and final submissions. Computer visualisations can be utilised during the initial design and conceptual development stages, including in the development of sketches, study models, interactive drawings etc. However, most visualisation media is implemented formally to carry out assessments such as LVIA and consultations.

For example, landscape consultants prepare photomontages for a LVIA as part of an EIA. The photomontages can then be used for public consultation and other stakeholder events; however, they are usually produced for assessing landscape visual mitigation measures rather than reviewing initial proposals.

During the consultation stages, private consultants are often asked to prepare computer visualisations in order to obtain stakeholders' opinions or the publics' outlook on certain projects. For this reason, levels of realism and credibility need to be appropriated to the purpose for which it is required in order not to mislead consultees or the general public.

In summary, computer visualisation within the development management process is utilised as a communication tool between stakeholders and the general public – for both planning professionals and not-planning professionals – and the media used contains certain levels of realism, interactivity, and credibility, which are determined during the stages of the planning process.

2.3.1 Development management

Current legislation is consolidated in the Town and Country Planning Act 1990, the Planning and Compensation Act 1991, the Planning and Compulsory Purchase Act 2004 and the Town and Country Planning (Scotland) Act 1997. Detailed explanation and interpretation of development is given in the General Permitted Development Order (GDPO) 1995, revised in 2003.

However, planning permission is not always necessary. Most developments that took place before the Town and Country Planning Act 1947 and certain activities 'not considered to be development' are exempt from permission. Other activities are deemed to be 'permitted development' and no formal application is usually necessary. Some developments always require planning permission, i.e. certain changes of use, designed/bad neighbour developments and developments covered by Annex 1 of the Environmental Assessment Regulations.

To summarise, there are five kinds of planning application and consent. These are: full, outline, approval of reserved matters, variation to planning consent, and notice of intention to develop. During those planning applications, media (i.e. plans and sections) are usually submitted with applications.

Local planning authorities design their own application forms and the detail required in an application may vary between planning authorities. However, in 2004 the ODPM[13] issued best practice guidelines for compulsory and additional information submitted by an applicant.

In the guidelines the compulsory requirements in applications for full planning permission consists of the completed application form, the correct fee (where one is necessary), ownership certificates, agricultural holdings certificates, part 1 notice, location plan, site plan, drawings (including floor plans if relevant), elevations, section drawings, and environmental statement.

Whereas, additional information is dependent on the nature and type of the application and the character of the proposed location, the local planning authority may require further details about any of the following: supporting planning statement, design statement (for all application where design is an issue), access statement and so on. However, importantly, the additional information also includes *photographs and photomontages* and this has become a ground for the official employment of photomontage.

2.3.2 Environmental Impact Assessment (EIA)

Environmental Impact Assessment has been used internationally since 1970 as an environmental management tool. Its main process involves identification, prediction and evaluation of key environmental effects of a development. EIA is a technique and process by which information about the anticipated environmental effects of a project are collected, both by a developer and from other sources, and taken into account by a planning authority in forming their judgement on whether or not a development should proceed.

[13] Office for Deputy Prime Minister

EIA is based on The EC Directive 'The Assessment of the Effects of Certain Public and Private Projects on the Environment' adopted 27 June 1985. In England, the EC Directive was brought into force in the UK through the implementation of: Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 amended 1999.

The regulations require that certain types of projects, which are likely to have significant environmental effects, should not proceed until these effects have been systematically assessed. The regulations apply to two separate lists of projects:

- Annex/Schedule 1 Projects: EIA is required in every case.
- Annex/Schedule 2 Projects: EIA is required only if the particular project in question is judged likely to give rise to significant environmental effects.

During the appeals procedures of a planning decision – i.e. a public enquiry or technical and expert evidence, planning professions such as landscape architects may have to prepare a written precognition stating the landscape case on behalf of their clients, and/or illustrative material about visual or landscape matters and an environmental impact assessment. After the appeal decision, landscape architects may advise on reasons for refusal or implementation of landscape conditions.

As a member of the planning profession in appearing on behalf of either the local authority or the appellant, a professional witness is not meant to be an advocate but required to give evidence in 'good faith', that is, be able to present, declare and distinguish between generally accepted ideas and individual theories. If testimony is not given in good faith, then there may be a 'failure of candour' – true reasons may be being withheld because it is thought they may not gain wider agreement or further the client's case (Garmory et al., 2007).

2.3.3 Landscape and Visual Impact Assessment (LVIA)

LVIA is usually part of an Environmental Assessment of a development when there are likely to be negative effects on landscape. The technique of Landscape and Visual Impact Assessment is used to assess the effects of change on the landscape. For example, a new road or windfarm proposal, or a plan for forest felling and restocking. It is used to help locate and design the proposed change, so that negative landscape effects are avoided, reduced or offset. The two aspects of the assessment – landscape and visual effects – are independent but related.

Landscape and Visual Impact Assessment is also an evolving practice that continues developing to take account of new issues and assessment techniques. These include, among others, the continued importance of landscape character assessment and the greater emphasis on process and public participation, the development of systems for assessing environmental and 'quality of life' capital, and the increased use of Strategic Environmental Assessment (The Landscape Institute and Institute of Environmental Management & Assessment, 2003).

However, Landscape and Visual Impacts are related but separate, different concepts. Landscape Impacts are on the fabric, character and quality of the landscape. They are concerned with landscape components, character and special interests such as designations, conservation sites and cultural associations. Whereas, visual impacts are the effects on people of the changes in available views through intrusion or obstruction and whether important opportunities to enjoy views may be improved or reduced.

Landscape and visual impacts do not necessarily coincide. Landscape impacts can occur in the absence of visual impacts, for instance where a development is wholly screened from available views, but nonetheless results in a loss of landscape elements, and landscape character within the site boundary. Similarly, some developments, such as a new communications mast in an industrial area, may have significant visual impacts, but insignificant landscape impacts. However, such cases are very much the exception, and for most developments both landscape and visual impacts will need to be assessed.

2.3.4 Computer visualisation

Urban planning has adopted a variety of modelling and data manipulation technologies over the last 30 years (Bishop, 1998). There has been much research reviewing current trends in spatial hardware and software development in conjunction with development management.

Computer visualisation research provided to date has affected many different aspects of environmental planning. However, a particularly disappointing feature of the literature has been its reticence in dealing with the variation in communication tools of the planning process in the UK and the lack of guidelines of production in the planning process.

While many papers have considered the subject of computer visualisation in planning, they have been confined to chapters or sections of chapters in books, articles in journals, and small booklets produced by private consultants' for marketing purpose. Sheppard's research (2001) *Guidance for Crystal Ball Glazers: Developing a Code of Ethics for Landscape Visualisation* provides a degree of visualisation credibility and validity study. Salter et al. (2009) provides a substantial study of visualisation media used for community consultation processes in planning. Blasco et al. (2008) and Karjalainen et al. (2001) also researched the human preference on landscape.

In terms of community participation, Stock et al. (2006) developed an envisioning system that was able to assist communities contemplate alternative land use configurations. Whereas, Van Berkel et al. (2011) explored some development scenarios and discussed how computer generated visualisations - in particular, photomontages – could be implemented for stakeholder consultations.

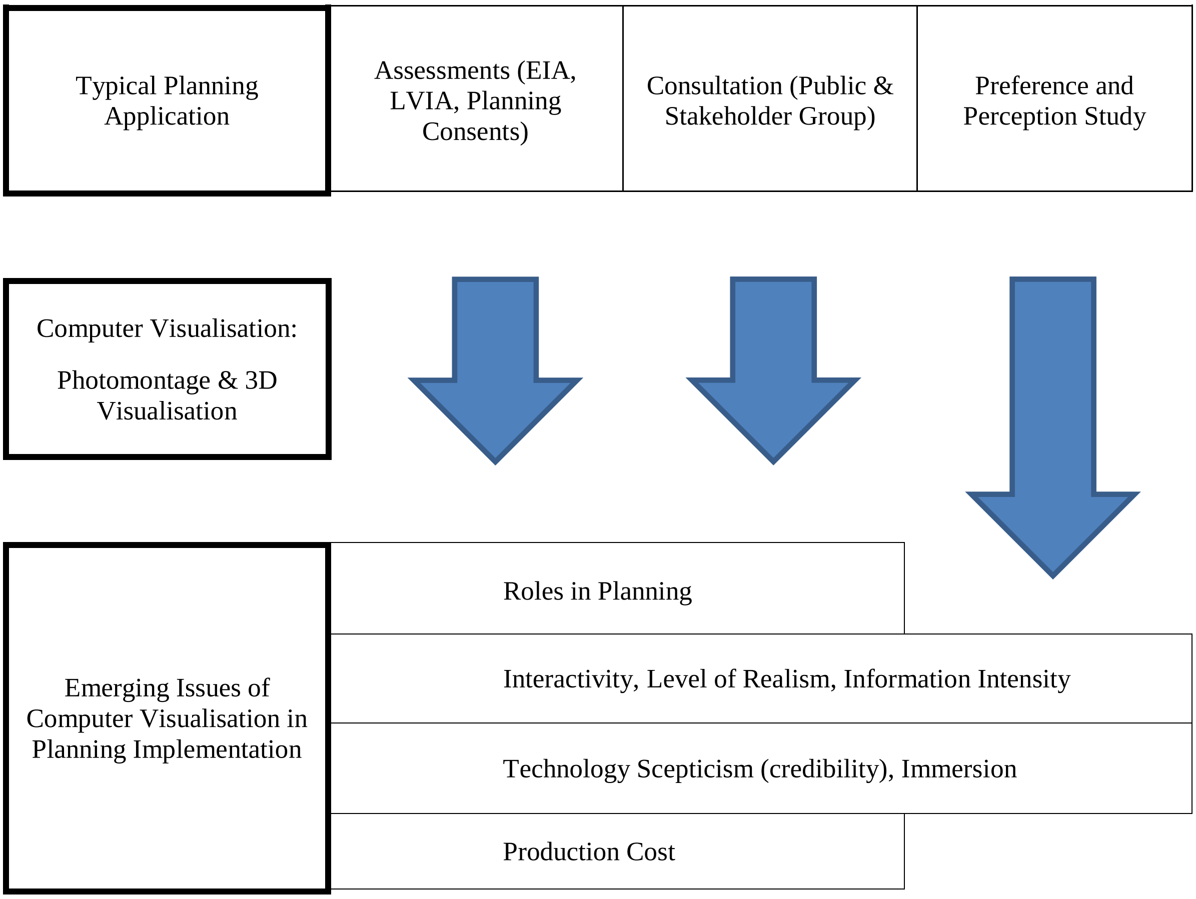
In fact, Schroth et al. (2011) carried out a very interesting discussion about computer visualisation (focused on Virtual Globes) and whether it was perceived as a tool or as a toy. In particular, they found that Virtual Globes could facilitate access to geospatial information, raise awareness, and provided a more representative virtual landscape than static visualisations.

One of the reasons for the lack of computer visualisation studies in relation to planning applications in the UK is that technology is both a very contemporary issue and a fast moving field, with the result that considerable effort has been made both to look for the development of technology and to adapt it into the UK planning process. Consequently, visualisation in planning has been used without appropriate research and approval. Moreover, variations in the use of visualisation media in development management processes has been neglected. The lack of visualisation media is clear from the following typology of the literature.

Earlier studies of computer visualisation and planning implementation can be broadly classified into the categories shown in Figure 2.6 in relation to the issues identified in this research. The aim of classifying the literature is not to instance every research on these topics, but to understand the general trends of such research.

As Figure 2.6 illustrates, that the literature on computer visualisation can be classified based on three typical planning application criteria used in this research. The literature on the assessment category denotes that the research addresses issues related to EIA or LVIA as a part of development management process. Secondly, technical literature on public (or stakeholders) consultations are explored since it has become an important part under UK's discretionary planning process. Thirdly, the preference studies deal with visualisation media themselves and adopt preference reviews on them. In brief, this research seeks to investigate the implication for visualisation technology.

Figure 2.6 Framework of the Literature Review on Computer Visualisation and Planning



In terms of visualisation media, this research reviews literature that deals with photomontage and alternative 3D visualisation, which includes pre-set path simulation (animation), real time rendering, panoramic VR and photomontage.

Later, as emerging issues of computer visualisation, the literature that also deals with issues on the use of technology in planning can be subdivided into three issues; *credibility, levels of realism, and production costs*.

In summary, the literature review is based on typical planning applications when computer visualisation is implemented and identifies emerging issues through the review. As a result, three issues of credibility, levels of realism, and production costs emerged and will be reviewed in the following sections.

2.3.5 Visualisation media

It is to be stressed that computer visualisation media in this research only deals with photomontages and three dimensional visualisation that are relevant to the planning process in the UK.

For instance, literature on using photo-manipulation (photomontage) technology investigated and analysed empirically the before and after comparison. This illustration method has been used since Humphrey Repton's *before and after* presentations of his landscape designs to his clients. The strength of the media lies in the combination of a real photograph and proposed rendered view of change.

Within three dimensional visualisation, pre-set path simulation (so called 'animation') deals with both how to implement animation in various consultation and assessment processes and how the medium is perceived. Moreover, the animation denotes that the research is based on experiments with pre-set path simulations, which normally provide a high level of realism. However, the media is expensive to produce and viewers cannot alter viewing angles and direction of movement as they are pre-set. Despite these disadvantages, animations are effective at visualising high levels of realism and for that reason it is often used for marketing and promotion.

Moreover, literature focusing on real-time rendering within planning practice was explored. Real-time rendering is employed in computer games, which benefits from full interactivity. However, it generally contains a lower level of realism compared to animation.

Finally, there are studies which employ technologies but these are not fully covered due to the limitations of this research. Such research, which adopts internet streaming technology have been tested in recent years for public engagement and survey procedures. There are only a handful of studies in this area at the time of writing; therefore, these issues are not common and are beyond the scope of this research.

Moreover, in the last decade, there are a number of studies on GIS and research using GIS technology. As the technology becomes part of our life-maps, post codes and digital navigation- the integration with database makes GIS an irreplaceable technology in the 21st century.

The realism of some visualisations produced with GIS is as good as pre-set path simulations and interactivity is as smooth as real time rendering in recent years. For instance, Bishop and Ghadirian (2008) explored a photo-realistic visualisation method which uses a combination of GIS with off-line augmented reality (AR) techniques. This approach had the potential to improve the communication between policy makers and non-experts and to improve the decision-making process.

However, this research is more focused on representational visualisation within development management processes rather than GIS method research and its heavy data dependency.

2.3.6 Participation

During the development management process in the UK, stakeholders can be the general public, residents, community groups and other organisations. The stakeholders usually interact with planning professionals during the process.

Within discretionary planning in the UK, public participation has had a strong role to play in development management processes. Participatory planning has provided social sustainability in the planning process in interacting the general public, communities, and residents with planning professionals (Baum, 2001).

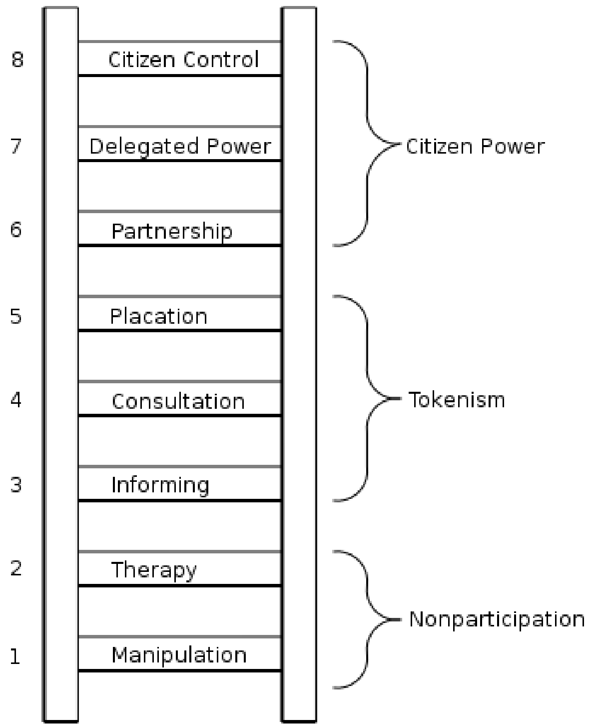
Healey (1997) also investigated collaborative process within UK planning and pointed out that continuing attention to the complexity and diversity of urban governance contexts and the importance for practical action of grasping the particularities of situated governance dynamics.

In 1969, Sherry Arnstein defines participation in terms of redistribution of power and classifies participation in eight categories. Within the eight categories - according to Arnstein (1969)'s model[14]- it ranges from manipulation to citizen control (Figure 2.7). Later, similar attempts have been made to define and classify citizen participation (Connor, 1988; Wiedmann & Fermer, 1993; Rocha, 1997; Fung, 2006).

[14] Ladder of citizen participation (Figure 2.7, page 33)

However, Connor (1988) raised a criticism on Arnstein's model for the lack of answers on any alternatives when the model is not working and Taylor (1998) claimed that the theory did not discuss what degree of democracy, and hence what degree of participation is feasible and desirable.

Figure 2.7 Arnstein's Ladder of Citizen Participation



In addition, some interesting research has been carried out by Astrom et al. (2011) regarding how public participation has moved on since Arnstein's establishment in 1969. They found that participation has not led to citizen control or citizens achieving dominant decision making authority over a particular plan or programme. Application of various forms of communicative planning have, however, come furthest in the sense that they have succeeded in getting people involved in solving problems with regard to services delivery and improvement of the local environment but have not got very far with regard to power devolution.

The research continued that e-participation had not had any significant impact on the question of power sharing – Arnstein's citizen power (Figure 2.7). This is not to claim that there is a status quo with respect to participatory planning. Since the new technology seems to lower the costs of public participation, the administrative benefits of e-participation for democratic governance may be substantial. Citizens may represent an important resource for the delivery of public goods. However, power sharing requires more than just innovation in computer visualisation technologies.

It is also claimed that public participation is formally encouraged since planners prepare the plans that are put on exhibition. However, citizens' views are very rarely taken into account. Plans are then endorsed by the local planning authorities (Khakee, 2007).

Within the case studies of participation that the author has been involved in (See Chapter 5) participations with stakeholders, communities, and the public fell into the category of 'Tokenism' in Arnstein's model, which includes placation, consultation, and informing (Figure 2.7, page 33). Those consultations were well supported to produce landscape mitigation proposals in LVIA/EIA, carry out communities and public reviews in the schools and community projects, and establish forest management strategies.

Even though the implementation of computer visualisation is dependent on the stage and purpose of the planning application, it is still questionable how stakeholder consultation can play a key role in controlling projects ('Citizen Power' in figure 2.7, page 33). In fact, most of case studies in the original research featured in Chapter 5 were at the consultation level and were utilised for determining mitigation measures.

Then, there is the question of how computer visualisation is implemented for participation in the planning process? Bishop (2005) claimed that the choice to utilise computer visualisation depends on the objective of the researcher. In particular, the use of complex decision simulation environments supported by computer visualisation provides the prospect for rational decision making (Carley, 1980) and of overcoming personally oriented decision processes of individuals (Simon, 1997). The example of immersing individuals in a virtual decision environment suggests a trade-off between rational and irrational factors, between individual and community good, between certainty and risk or between innovation and imitation can be explored and better understood.

2.4 Emerging Issues on Computer Visualisation in Planning

Three major issues must be addressed in order to determine the suitability of using computer visualisation as a communication medium in the planning process; credibility of media, levels of detail, and costs of production. These issues have been identified in the literature review and prior interviews with planners and visualisation preparers.

Therefore, it is natural to carry out literature reviews based on the emerging issues of computer visualisation in planning. The framework is founded as Figure 2.6 (page 30) for planning applications, issues, and media to be employed in this research.

2.4.1 Technology scepticism: credibility of computer visualisation

The issue of credibility is very critical but easy to overlook. Visualisation is often focused on how it looks and how realistic it is. In particular, using visualisation in the planning process, the validity of the media is as important as its appearance. Otherwise, it could be misleading and carrying information which is not a true reflection of what it will look like.

Sheppard's research (1989, 2001 and 2008) is one of the few studies which have raised the issue of credibility in implementing the technology. He discussed the risks of the growing but unstructured use of landscape visualisation as a popular decision-making and public communications tool in planning. His research concludes that a framework needs to be established for guidance and supporting resources for the use of landscape visualisation.

Moreover, Sheppard's other research (2001, 2005, and 2009) is concerned with the credibility of use including information possibly being misread in reproduction. This subset of the literature has concentrated on the advantages and disadvantages of the photomontage method, which used in many areas and widely in planning. In addition, Orland et al. (2001) claimed that in planning, misleading situations could arise and there must be processes and solutions for assessing the role of the visualisation technique.

Besides, a survey of local planning authority and officers by Appleton (2005) suggested that value judgement would always be present, and parts of the image would be selected and set up to show the scheme to best effect. While this could in part be attributed to artistic licence, there are further questions of intentional incorrectness in visualisations, for example to reduce the apparent impact of a proposal.

In the UK, visualisation guidelines for other similar techniques can be found for photomontages. For example, the use of 50mm focal lens is standard practice in picture presenting and photomontage illustrations. The Landscape Institute also published the 2nd edition of Visual Impact Assessment Guidelines in 2004, which includes recommendations and requirements on the usage of computer-based techniques such as visibility mapping, GIS, photomontages (Wilson, 2009). However, this provides only a basic level of recommendations and is insufficient as there is a need for a framework and guidelines to safeguard against technical and ethical misuse of the technology in its application in the field of planning.

However, development management process rapidly adopts computer visualisation for evaluating various scenarios and for visioning exercises. For example, Shaw et al. (2009) exercised computer visualisation in the field of climate change. Their research, *making local futures tangible – synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building* illustrated a participatory scenario study conducted in collaboration with a community in Canada. This study applies a participatory capacity building approach for climate change action at the local level where the sources of emissions and the mechanisms of adaptation reside and where climate change is meaningful to decision-makers and stakeholders alike. Hence, the multi-scale scenario approach consists of synthesizing global climate change scenarios, downscaling them to regional and local levels, and finally visualizing alternative climate scenarios up to 2100 in 3D views of local places.

2.4.2 Level of realism (detail)

Some time ago, Mandelbrot (1983) suggested that the fundamental problem is the digital representation of natural phenomena as 'clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line'. Seven years later, Hall (1990) introduced another definition of 'realistic'; 'creating an experience that is indistinguishable from the real experience; generating the same stimulus as the real environment; generating the same perceptual response as a real scene; creating the impression of a real scene'.

In 1999, Lange's research, Degree of Realism argued that the impression of realism did not necessarily require correct imagery in terms of geometric detail as long as the general behaviour was reasonable; that high image complexity is primary in creating the perception of realism; that subtle shading and surface detail were key in creating the perception of realism.

However, level of realism needs to be distinguished between photo-realism and immersive experience. Since this thesis is divided into two visualisation categories; photo manipulation and three dimensional media, the realism from rasterised image-based data is referred to as photo-realistic; whereas, in three dimensional media based on three dimensional geometries such as pre-set path simulation, real time rendering and virtual reality meant 3D immersive realism.

The definition of realism is generally regarded as ‘Creating an experience that is indistinguishable from the real experience; generating the same stimulus as the real environment; generating the same perceptual response as a real scene; creating the impression of a real space’ (Hall, 1990, page 191); realism is always an issue in computer visualisation.

Similarly, there is research raising technical issues on virtual reality (Doyle et al., 1998). In particular, they explored the subject in accordance with the Internet technology and the analysis of virtual reality as a flexible tool of information sharing in the context of planning. This research applies document and practical survey methodology to answer research questions; the review of capabilities of the technologies and how they can be applied in the field of planning and the design of urban environments.

On the other hand, Bishop and Rohmann (2003) focused on pre-set simulations. Simulations with high levels of detail were compared with real environments for subject responses. This research found that even detailed and time consuming computer simulation does not necessarily generate the same responses as the corresponding real environment. However, differences between day and night conditions are mostly the same in the simulated as in the real environment, and the realism ratings of the viewers were generally encouraging. The findings elucidate where further development and evaluation are warranted.

The actual limitation to resolution of the approach to visualisation can be determined by hardware (processing speed, memory or graphical capabilities), software or data (Brodlie et al., 2002). However, in the light of affordability, high levels of detail tending towards real world would not always be the prime target for computer visualisation in planning. Visualisation preparers and planners generally compromise and agree on an appropriate balance between levels of detail and production cost. This fact was supported by research (Appleton, 2001) pointing out that high degree of realism might actually prove distracting in some ways. In addition, the level of detail could be decided by the purpose and use of the model, which can be focused on certain elements in visualisation (Appleton and Lovett, 2003, Lange, 1999).

Even though visualisation technology has always aimed at approaching the real world, Vince (1998) and Whyte (2002) claimed that the virtual model might never match the real world because of substance beyond the technology. For instance, a real-time model would not reflect abundant atmospheric circumstances in the real world such as clear, cloudy, rainy and windy conditions. Moreover, causality in every action and reaction, and physics in the real world cannot be replaced with computer-generated models (Cavazza, 2004).

1. There is an issue relating to the precise relationship that is claimed between a given simulation and the source reality it purports to represent. In effect, this poses the questions: what is the virtual component of any given virtual reality and what is the real? Despite considerable rhetoric to the contrary, the answer to this basic question is often far from self-evident.

2. A number of navigational issues persist in multi-dimensional, complex spaces. Which users and which applications might benefit from limiting users in a virtual landscape to real-world navigation and movement?

Appleton and Lovett (2003) investigated the paradigm of the decision making support provided by visualisation in planning in order to seek a sufficient level of realism. But it sets up different landscape elements such as ground surface, shadows, buildings, sky and human elements of familiarity and experience. Then, it provides three different views with different composition of those elements and assesses each with a scoring system. It is found that the results indicate that not all elements of a visualized scene are of equal importance in helping viewers to image the landscape being portrayed and that effort may be best directed towards improving the realism of the ground, including vegetation, and especially in the foreground.

The sufficient level of realism has also been researched (Lange, 1999). With similar methods, Lange carried out an experiment on the region of Schwyz and Ingenbohl-Brunnen in Central Switzerland. Based on key elements, 90 images were prepared depicting the virtual landscape of the site. Three of the images were photographs from the three different viewpoints (a background, middle ground, and foreground scenes). Another 86 images were corresponding computer-generated images with different representation levels. The final image was a composite of photo foreground and virtual background. The different representation levels had been prepared on the basis of four elements: terrain, buildings, single trees, and forest.

The test set was evaluated by 75 test persons, consisting of experts, lay persons, local experts, and local lay persons. The results showed that the most important variable positively contributing to the degree of realism was the terrain with the draped high-resolution aerial ortho-photo. Second most important was the variable buildings. The evaluation was significantly influenced in a positive way if texture-mapped built-form was displayed.

Brodlie et al. (2002) raised the issue of accessibility in virtual reality. Virtual reality simulations could be prepared using an open standard, such as VRML or Java, rather than limited through the use of proprietary software. Therefore there are a number of commercial issues and technological considerations ranging from the restraints inherent in a current hardware and delivery strategies through to the thorny issue of technological determinism.

On the other hand, Dykes (2000) explored that 360 degree panoramic imagery is used as a means of representing geographic information in a visualisation context. He particularly pointed out that the software map presented contains a degree of realism, was inherently spatial and provided an excellent means of synthesising information from a whole range of traditional and novel spatial data types. It was also suggested that the architecture and computer map presented in the research offered a flexible, extendable and distributed spatial solution with high degree of realism and interactivity.

The meaning of realism in Dyke's research above is photo-realism. However, in computer visualisation research, realism refers to the immersive level of detail. It is also understandable that photo realism is less difficult to achieve compared to authorising three dimensional geometries. However, it is not actually three dimensional, but pseudo-three dimensional[15] which is composed with a series of still images.

However, this research does not suggest any hierarchy of computer visualisation media, but proposes a clear understanding of media and its pros and cons.

[15] This is a term for three-dimensional visualisation without physical geometries. For instance, it includes photographic 3D such as QuickTime VR and Panoramic VR.

Salter et al. (2009) investigated the role of digital tools in a collaborative planning process. In particular, the research was to evaluate the effectiveness of a ‘digital workshop’, combining the interactive community visualisation tool with the immersive lab facilities. They also suggested that there was a need to examine in greater depth how and when these tools might best be employed in collaborative settings.

Interestingly, the validity of images has been raised. Gower et al. (2000) explored an experiment of a GIS virtual tour which was designed for the interior of the Princess of Wales Conservatory, in the Royal Botanic Gardens, Kew. By recording a series of thirty one 360 degree; panoramas within the Conservatory, visual scenes were created to provide a virtual environment. Using photo stitching software, panoramas were created and programming language Visual Basic 5.0 enabled the panoramas to zoom, pan, and selection of panoramas and zones. By employing the photograph based medium, the research finds that the use of panoramas proved to be a very effective method of capturing details, botanical scenes and internal architecture, while the map of geo-referenced panorama locations provided a useful navigation tool. Therefore, Gower et al. concluded that they expected the use of this technology to grow rapidly.

Rather than authorising three dimensional geometries, the photo stitching technology is also recognised as an easy and effective way to create three dimensional models (Szeliski, 2006). For that reason, a number of software tools have been developed for this particular task of photo-editing easily and effectively at low costs.

There are a number of experts who already have indicated that 3D is real media which can change all our industries. In particular, real time virtual reality has been explored in the fields of design including architecture (Campbell and Wells, 1995). This research finds that both immersive and non-immersive virtual reality was useful in the design process. Immersive VR offered the designer a better perception of space and the opportunity to see the design from the inside. At the scale of a person within the building, the designer was able to examine details and connections more intuitively with an easy-to-control viewpoint. Non-immersive VR, with a monitor and spaceball, offered higher resolution and higher frame rates, both of which became necessary as the model increased in complexity. The non-immersion offered easier and quicker manipulation of the viewpoint.

Realism of virtual landscape study was carried out by Lange (2001). Lange’s research found that approximately 75% of the persons assigned the highest possible value (very high degree of realism) to one or more scenes of simulated landscapes. Moreover, the author suggests that in order to achieve an even higher degree of realism, more and very detailed three dimensional object data and accompanying texture information would be necessary.

On the other hand, the real-time simulations became more useful as a design tool as the level of detail of the model (colour, transparency, and geometric complexity) increased. However, the level of detail needed to be kept in check to keep the frame rate at an acceptable level. Although, more powerful geometry engines are continually being developed, it is unlikely that we will ever be satisfied with the level of detail that can be simulated in real time.

Nevertheless, two dimensional media offers a limited means of representing three dimensional spaces. Three dimensional media enhance the perception of three dimensional spaces. Designers need a digital design medium which allows them immediate, direct, and more intuitive control over their three dimensional design and virtual reality can help. An inclusive, three dimensional, world building toolkit that matches the sophistication of today would supplement CAD software, but not replace other design media. It is only when such software has been developed that virtual reality can significantly enhance the design process (Campbell and Wells, 1995).

This technology is best known as video gaming in particular first person shooting. It has been most developed in the past decade including gaming engines and graphics. On the other hand, there remains a number of issues in implementing this technology in planning. For instance, collision handling has been investigated in the research by (Jacobson and Lewis, 1997) as the users' point of view.

It is also debatable what sort of experience real time rendering technology can give to users. For example, users could navigate as walking through a virtual environment controlling both the speed and direction of walking. Furthermore, Jacobson and Lewis (1997) continued to explore three prototypical methods of collision handling in virtual reality: either the user goes through an object like a ghost, stops dead on contact, or slides around it. This research also concludes that by using mouse and screen, virtual environments become more affordable and accessible.

This emerging new technology is also explored (Bishop et al. 2001) for the assessment of path choices on a country walk. The paper includes the process of model building for a section of the Dee valley in northeast Scotland, the development of software to support interactive exploration. In addition, an experiment which was designed to answer some primary questions about validity and some secondary ones about local landscape preferences.

The final issue that needs to be highlighted is the lack of people in our often highly-sophisticated virtual simulations. Navigating a virtual construct can often be a costly and unsettling experience, yet the introduction of avatars and virtual inhabitants poses considerable technical and representational challenges.

2.4.3 Production costs

So far, little research has been carried out on the cost of real-time visualisation. One of the reasons is that contemporary technology is constantly being developed; measuring figures would be very elusive. Software such as three-dimensional authorising and GIS could be key elements of measuring the cost as well as data availability and labour.

Case studies using real-time rendering technology were carried out (Martin et al., 2002). Within the category of housing, public participation and regeneration projects were aided by the technology. In the research, the authors were focused on the more empirical issues of the technology: production cost and its roles in consultation processes.

A virtual reality system is generally high cost and the complexity of moving it to the place of presentation has been up to now prohibitive. Even if the system was available, it would have been time consuming for each of them to walk through the design individually, and awkward to discuss the design with others not experiencing the simulation in three dimensions. Clearly, this problem could be addressed by the introduction of an inexpensive, multiple-participant VR system.

Some VR systems, however, were developed and tested for benefits of affordability and mobility such as Geowall Consortium[16] and Elumens VisionDome[17]. These VR systems

[16] The Geowall project combines researchers and educators from geological and computer sciences to develop hardware and software for low-cost stereo visualisation. A good understanding of spatial relationships is a fundamental requirement in the study of the Earth sciences. Traditional teaching methods have strongly relied on the 2D representations through maps and profiles that are occasionally augmented by physical models. Although most Earth Scientists have been trained to understand the 3D structure from such representations, the extrapolation requires spatial

are portable so that it can be used in various meetings and occasions as well as affordable compare to conventional VR system which fixed installed in a facility.

Moreover, the cost of creating a visualisation model is very dependent on types of model (mainly the degree of LOD[18]) and the services provided. In order to determine this within planning process, it is required to determine which planning stages does computer visualisation need to be employed. Therefore, it is difficult to determine a specific cost figure; however, it was suggested (Martin et al., 2002) that it generally ranges between £500 and £20,000, typically £5,000 in normal circumstances in planning in the UK.

Elements affecting the cost of computer visualisation are mainly planning stages to employ computer visualisation, which involves the credibility and realism of media. In short, the purpose of computer visualisation can lead into consensual decisions by stakeholders that what level of realism is required etc. Then, other elements such as hardware/software and skilled labour could affect the production cost.

GIS applications are normally used in academic institutions and large organisations, and the costs are generally higher than conventional 3D authorisation software such as Google SketchUp in terms of data acquisition and maintenance. Unlike such large organisations, most of computer visualisation in planning is prepared by private consultants.

2.4.4 Relationships – interactivity, levels of detail and credibility

The ability to interact with a visualisation is the key to its use for discovery, and may also be important in communication. There are numbers of example of visualisation which support both communication and discovery and are available to both the public and the professional. The degree of interactivity in visualisation depends in part on the nature of the controls provided by the user interface (Table 2.2, page 44). However, another element of interactivity is the ability of the computer systems to redraw images quickly enough that the user sees an 'instant' response to their input (Bishop and Lange, 2005).

Bishop and Lange's research (2005) also indicated that spatially abstract visualisation required a substantial degree of familiarity with both the subject matter and the display

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thinking skills that are difficult to learn and often form a stumbling block for students at the introductory level. (www.geowall.org)

[17] Elumens VisionDome is a broad and large spherical virtual reality cave-type display system, the VisionDome has been utilised to beneficial effect in several sectors, such as in marketing campaigns, trade shows, the entertainment industry as well as for research and teaching applications. This product can also be used as a large simulator, with room for up to 45 people simultaneously viewing inside. (http://www.inition.co.uk/3D-Technologies/elumens-visiondomev5)

[18]Level of Detail

technique. Therefore, except two dimensional maps, experts were required for understanding of abstract display. However, as technology advances, modern communication is offering different levels of detail, realism, and abstraction may be appropriate to permit ready public consumption.

Part of the role of visualisation for the public is to provide an opportunity for greater involvement in community decision making. In order to broaden the effective use of this information it needs to be in a format (or language) that can be widely consumed. Environmental management now covers a very wide range of issues and the public are concerned with a great many of these. At the same time as technology has advanced the opportunity for visualisation, public interest has increased the need for such visualisations.

In this research, the realism of the presentation was defined in terms of how close the visualisation is to the level of detail provided in the real world outcomes. Despite advances in technology, the real world cannot be perfectively visualised or duplicated by current technology. Planning audiences still need to use their imagination to go from the visualisations to understanding how future scenarios will look. Hence, the level of realism used within visualisation needs to be decided for the purpose of planning use. Therefore, deciding on the level of detail required would be generally determined by landscape consultants, technicians, and planners.

Credibility (validity) generally refers to whether an instrument or finding is sound, defensible and well-grounded or appropriate to the issue at hand (Table 2.2).

Table 2.2 Research Definitions: Level of Detail, Interactivity, and Credibility

	Definitions
Interactivity	The involvement of users in the exchange of information with computers and the degree to which this happens.
Level of Detail	Degree of familiarity with both the subject matter and the display technique.
Credibility	When someone can be believed or trusted. Whether an instrument or finding is sound, defensible and well-grounded or appropriate to the issue at hand.

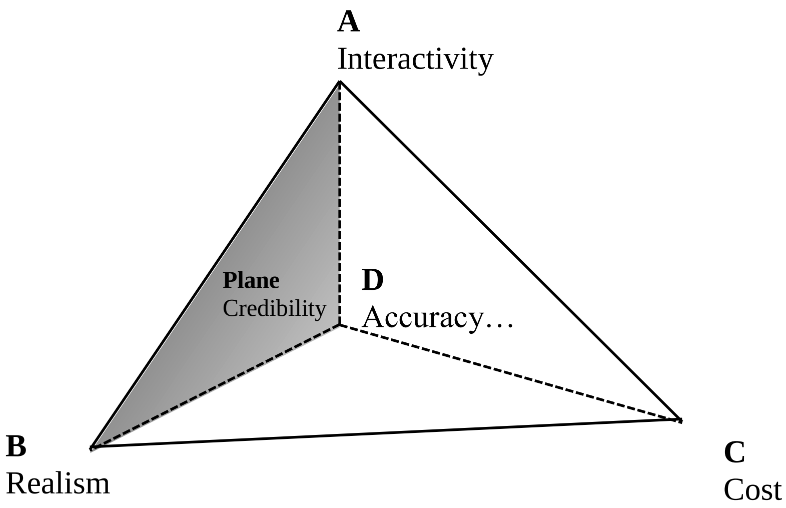
Moreover, Level of Detail (LOD) where often multiple perspectives are required for stakeholders to consider a visualisation to be credible. Although credibility and realism are closely linked, they do not necessarily act together. The extent of realism is just one aspect within the development of a credible visualisation and may not be the most important (Figure 2.8, page 45).

Within modern UK planning processes, interactivity is also an important element in the credibility of visualisations. In the planning context, interactivity is relevant within decision making and public involvement and participation. Interactivity within computer visualisation requires a lower level of realism – than provided by photomontages for example.

Finally, deciding the level of realism and extent of interactivity is closely related to production costs. Each visualisation media has its own advantages and disadvantages in terms of production cost. In planning practice, cost may be a significant factor in employing computer visualisation.

In summary, interactivity, realism and production costs are in a trade-off relationship. The closer the visualisation is to the level of detail provided in the real world outcomes, the more expensive it is to produce the visualisation. In that sense, level of detail, interactivity and other elements such as accuracy are placed in the plane of credibility which would cost more to produce a credible computer visualisation (Figure 2.8).

Figure 2.8 Tetrahedral Dilemma of Computer Visualisation (with Credibility), adapted from Moseley (2003)



2.4.5 Implementation in planning

The framework of literature shown (Table 2.6, page 30) is only indicative of the literature review structure. There are studies, which combine two or more issues in their subjects.

Ervin (1997 and 2001) raised general issues regarding the technical implications of computer visualisation, which could deal with issues of realism, cost, and planning usage.

Bishop et al. (2009) investigated landscape visualisation tools and methods within the decision making process. Using planning scenarios such as forest management, 3D models were created and levels of preference were tested for the different scenarios with the general public.

Similar to Ervin's research, there was also an interesting project called 'Greenspace' carried out by LRG[19] (Lange et al., 2003). The Greenspace project focused on the visualisation of different urban greenspace sites within the city of Zurich. The purpose of this visualisation was to provide a basis from which to analyse how people interpret and react to the visual experience of the landscape.

Their research employed both static and real time dynamic representations of urban green spaces as a basis for public surveys. Two forms of output were used in assessing the green space visualisations. Static simulations, images derived from the visualisations show a single green space scenario as seen by a static observer, at one point in time. Static images show the representation of the site in high detail, and are useful for comparative analysis and preference surveys; whereas, dynamic simulations allow for two types of visualisation. The first type is to show a demonstration of proposals as viewed by a moving observer. The second type of demonstration allows the viewer to see changes due to vegetation growth and evolution at a particular site. Dynamic presentations can be interactive and have the advantage that the observer is not limited to predetermined viewpoints. In general, dynamic visualisations are a more innovative and immersive approach to visualisation.

It is not difficult to find studies with a combination of the above types. For instance, the combination of photomontage and three dimensional media as planning tools, a study analysed the precision and accuracy of stand characteristic assessment by computer visualisation (Rautalin et al., 2000). A total of 20 forestry specialists assessed quantitative stand characteristics from the output of two software packages, Monsu and SmartForest, representing 40 stands of trees of varying age, density and species composition. The formal software uses line graphics and the latter uses scanned photographs of trees. Similarly, visualisation in forest landscape preference research was explored (Karjalainen and

[19] Landscape Research Group, Swiss Federal Institute of Technology, ETH Zurich

Tyrvainen, 2002). Both edited image and virtual landscape simulators were implemented for forest landscape preference research.

Besides this, there was an attempt to compare visual and verbal information for forest management and public perceptions (Tahvanainen et al., 2001). The study evaluated the impacts on scenic beauty and the recreational value of five different management practices: small clear cutting, thinning, and removal of undergrowth, natural state, and traditionally managed cultural landscape. Two evaluation methods, visual presentation (picture produced by image-capture technology) and verbal questions were used.

Wergles and Muhar (2009) also investigated the role of computer visualisation in the communication of urban design by comparing viewer responses to visualisations and on-site visits. Whereas, Salter et al. (2009) explored the use of interactive and immersive visualisation tools in participatory planning.

In the context of wind farms, MacFarlane produced (2005) useful a comparison of computer visualisation media. The potential contribution of landscape visualisation and virtual reality approaches in communicating development proposals and stimulating debate about change is widely accepted. The essential options are: virtual environments, GIS based landscape visualisation, QuickTime VR, and static photomontages.

This research identifies typical planning applications for implementing computer visualisation for assessments, consultation, and in determining preferences.

Firstly research of planning assessments is primarily concerned with identifying the pros and cons of computer visualisation in application and at the same time dealing with the issues of UK planning process as tools for assessments. This literature has developed alongside the introduction of ODPM's planning guidelines. Political and ideological support for photomontage production has primarily come from a variety of sources, such as governmental bodies and professional institutes.

Puller and Tidey (2001) investigated the implications of using three dimensional visualisation for visual impact assessments and as an evaluation tool to arbitrate the decision-making process. Three dimensional visualisation generated by GIS was found to be far from ideal for enabling communication and visualisation proposals presented to groups. The utility of 3D GIS for planning could be enhanced by research into appropriate decision making techniques and interfaces for communicating decisions and 3D data to planners. In similar research, mapping and virtual reality tools have been explored for modelling urban environments (Doyle et al., 1998).

Some research criticised the use of photographs in landscape quality assessments. Hull and McCarthy (1998) claimed that the expectations of seeing wildlife significantly increases landscape quality assessments. Another research (Sheppard and Picard, 2006) investigates the visual quality of forests using photographs. The research also found potential problems with the use of photographs as landscape surrogates in scenic quality assessment studies.

Secondly, the research into consultation in planning is more focused on the role of public or selected group participation. Within Al-Kodmany's research (1999) photomontages were used to assist residents in evaluating design changes by realistically depicting what design elements would look like when placed into the physical neighbourhood context. The media has been used in workshops to help the planning process. The research found that this enabled the planning team to visualise streetscape changes and make informed comments about the proposals. The realism of the images prompted a great deal of enthusiasm and lively discussion about the individual designs.

Recently, Berry and Higgs (2011) investigated levels of public acceptance of the use of visualisation in promoting public participation. In their research, online mapping tools were implemented to obtain feedback to questionnaires from stakeholders. The research found that the survey participants were generally optimistic regarding the potential for software and gave strong support for the development and the implementation of the technology.

In forest management, virtual environments have been explored (Uusitalo and Orland, 2001). The virtual environment is useful for helping to deal with the forest management issues of time dependence, irreversibility of decisions, spatial-quantitative variation of features and multiple objectives. However, it is also claimed that despite the acceleration of graphic performance capabilities of personal computers, there is no reason to suppose that virtual forest management will rapidly replace existing forest management procedures. This was explained in terms of two obstacles: the lack of appropriate information and the labour intensity of combining information from different sources and formats.

Schmid (2000) claimed 3D visualisation will support participation in the planning process and will become an important part of decisions to support systems in spatial planning. The use of virtual landscapes will help to study processes in the landscape such as fragmentation of landscape and/or urban sprawl.

In addition, this research found that the use of computer imaging technology in the community design workshops proved to be a successful technique for enhancing the group decision-making process. A relatively recent application to be used for planning purposes, computer-aided photo-manipulation offers an innovative way for planners to communicate visual relationships and patterns. It is found that by providing highly realistic images of potential design alternatives embedded into the actual neighbourhood context, research participants could more easily make communal decisions.

Van Lammeren et al. (2010) investigated effective appraisal of 3D land use visualisation. They discussed the response of users to three different visualisation types; coloured raster cells, 2D icons and 3D icons. Their research demonstrated that 2D icons and 3D icons, compared with coloured raster cells, did not improve the efficiency or accuracy of the participants in the experiment; moreover, the results provide evidence that the visualisation type may influence the effective appraisal of the environment represented.

In particular, some research has aimed to identify pre-set path simulation (animation) tool and assess the technology within the planning process. This literature has developed alongside other visualisation technology but gives a focus to high resolution and geometry levels of environment. Some studies on visualisation have used a theoretical approach. Ervin and Hasbrouck (2001) illustrated the landscape-modelling element in their research. They raised landscape elements of digital modelling, terrain, vegetation, water, atmosphere, structure and animals. In addition, it also represented various applications to create models. In respect of methodology, it is a document and survey oriented research.

Real time rendering technology is also explored within the planning context. Initial research (Orland et al., 2001) indicated that the development of computer tools for creating and representing virtual worlds had dramatically increased our abilities to capture salient aspects of the environment and communicate them to audiences remote from the landscape. It examined the suitability of Virtual Reality (VR) technology for supporting environmental decision-making.

Perrin et al. (2001) integrated virtual 3D with a GIS application called ‘IMAGIS’ that focuses more on the employment of GIS tools. However, the outcome of study is a virtual environment. Procedural development from the 2D world of plans to the 3D world of perspectives has been developed. The purpose of Perrin et al.'s study is a different community of users: planning and GIS organisations who need to visualise regional development plans for impact assessment, communication and decision-making purposes. Although, it may be applied in a wide variety of contexts, its built-in features makes it particularly suitable for suburban planning.

There are a number of studies focusing on usage of computer visualisation for preference research. In the early years of computer visualisation, photo manipulation technology was explored. Some researchers (Shafer et al., 1969) identified what quantitative variables in photographs of landscape were significantly related to public preference for landscapes. Using factor and multiple-regression analyses, an equation was developed that used six variables and accounted for 66 per cent of the variation in preference scores for photographs of landscapes.

Those literatures also analyse the practice of the real-time rendering technology. This literature can have a great deal of interaction and the main characteristics of the virtual world is its immersive environment (Boyd, 1997). Since the invention and development of the technology, virtual worlds have been a subject of adaptation for all industries including gaming (Bradbury, 2003).

While most of the studies are focused on applications with the virtual reality, George and Ramanathan (1999) explored issues of immersion. In their research, the authors describe an interface developed where users can have both the realistic experience and a world overview. With VRML technology, there is the distinction between egocentric and exocentric views, and George and Ramanathan argue that exocentric views are necessary for effective use of the virtual world. Moreover, Danahy (2001) investigated this technology for dynamic viewing in landscape visualisation. This real time technology demonstrates the advantages of interactivity. He outlines these issues and proposes that as electronic media and computational media become more developed and are applied to the realm of visual concerns, it will become more practical to include peripheral vision and dynamic viewing in deliberations about visual landscapes. Similarly, Bishop and Dave (2001) claimed that the immersive environment which people interact with planned changes in the urban environment settings.

Initial research about perception and response of real time rendering (virtual world) was developed by Bishop, Ye and Karadaglis (2001b). It is claimed that some aspects of behaviour in the landscape can now be effectively observed in a computer generated world at reasonable cost and with more complete control of variables.

The simulations of walk-throughs give design critics the opportunity to visualise the designs as they develop. They replaced the need for physical models and made clear what was not apparent in CAD drawings. However, more people would have benefited from the experience had they been able to walk or fly through design themselves rather that depend on views from a particular path flown for the presentation (Campbell and Wells, 1995).

In a similar way, Bishop et al. (2001a) also applied an experimental methodology on his research about assessment of path choices on a country walk using a virtual environment. Using the site of the Dee Valley in northeast Scotland, their research invited 42 interviewees who were presented with virtual model in computer cluster. Bergen et al. (1998) used survey and case study for his research into data intensive simulation, dimensional accuracy and realism of a landscape visualisation tool. He raised a forest modelling case using specific software, Vantage Point, comparing with real landscapes. He also presents his arguments on those technologies used within the survey method.

Integration with Internet technology was also explored. Wherrett (2000) employed a case study method to carry out research on creating landscape preference models using Internet survey techniques. In particular, she applied an experimental methodology to identify the general public’s preference on perceived scenic qualities of the landscape of rural Scotland.

Moreover, photo editing tools could be used in a preference study. Zacharias (1999) claimed that preserving a limited number of view corridors while restricting building height was preferred over planning policies that required uniformly low buildings or for taller buildings with multiple views. The research recognises that cities with characteristic natural settings are facing the question of how to promote development while preserving views of the natural amenity. The size, shape and number of view corridors have been regulated while the view amenity policy preferred by the general public was largely unknown.

Numbers of studies have employed photo manipulation technology for preference studies. In the paper *Enhancing visual preference of ecological rehabilitation sites*, Hands and

Brown (2002) claimed that an important criterion in evaluating industrial landscapes is whether they are being actively rehabilitated by human intervention, or allowed to naturally regenerate. Results indicate that the role of apparent human intent in visual preference for rehabilitating industrial landscapes is very complex and that there is a place for thoughtful design which considers aesthetic expectations, as well as perceived appropriate levels of human intervention.

Landscape preference research using digitally edited photographs are common. Gomez-Limon and Fernandez (1999) claimed that the livestock farmers tend to prefer open landscapes, in comparison to the recreationists and managers who show a preference for landscapes with denser vegetation. To find out the preferences, the authors implemented photorealistic simulations represented by digitally treated photographs.

Even though there is great potential for the technology in planning implementation, one criticism is that the employment of visualisation in the planning stage could become a supplementary part. It was claimed that without an integrated connection with the planning process, three-dimensional visualisation could just be an expensive supplement to sell the final planning project (Lange, 1999).

In the planning process the stage to employ computer visualisation also affects the decision over the model's level of detail. For example, in early and middle stages of the development management process, computer visualisation can be used in various degrees of realism; whereas, in final phases, much higher level of detail is required.

Using photographic images, Ribe (2005) investigated aesthetic perceptions of options for green tree retention. This research was an attempt to evaluate scenes and human perception in a quantitative method using static images. Whereas, Pettit et al (2011) analysed landscape visualisations, identifying strengths and weaknesses for effective communication of future alternatives in planning.

2.5 Other Literature on Visualisation

This research cannot cover all literature related to computer visualisation and planning; however, it has made an attempt to deliver and review literature investigating computer visualisation, in particular photomontage and alternative three dimensional media which have been implemented in planning studies.

Modern technology is a fast growing field and since the invention and development of CPU[20], GPU[21], and memory processing, the software industry has become vast field to explore. Even though this research covers most of the computer visualisation media employed in UK planning, some of technologies which have recently emerged or have not often been exercised in daily planning have not been covered fully. In this section, literature on GIS and Internet streaming are briefly reviewed.

2.5.1 GIS Literature

Even though it is not a part of this research coverage, it is also essential to mention that literature using Internet is increasing in computer visualisation research. Therefore, it is worthwhile mentioning GIS and Internet related researches.

However, this thesis recognises GIS is a tool for representation, not a product of computer visualisation itself (Figure 2.9).

Figure 2.9 GIS as a formula in computer visualisation research

Therefore in this research, GIS is defined as a process which uses spatial data not a visualisation. It uses datasets that could provide spatial information in various forms of visualisation such as virtual environment, maps etc. that's why it is excluded from the main classification, but dealt with as an application to generate computer visualisation. Therefore, there is a number of research studies that employs GIS as an application. In particular, many studies have linked GIS into urban applications (Yates and Bishop, 1998).

Moreover, one of best literature to understand the use of GIS in landscape visualisation is carried out by Appleton et al. (2002). With GIS application, a number of computer visualisations were produced and tested for environmental decision making processes. The media; image draping, photorealistic rendering, and virtual worlds were explored and Appleton et al. concluded that the cost of a package was linked to its capability for high-quality output. However, with capability comes complexity, and the cost of training should also be considered if useful results are to be obtained in a reasonable amount of time.

[20] Central Processing Unit
[21] Graphics Processing Unit

Kingston (2000)'s research employed Internet in the planning process in order to explore it use as an aid to local environmental decision making. The author saw current research examining the potential of the Word Wide Web as a means of increasing public participation in local decision making in the UK. Interestingly, the research also compares traditional methods of public participation and argues that new Internet-based technologies have the potential to widen participation in the UK planning system.

Interestingly enough, Rantanen and Kahila (2008) brought in SoftGIS into planning investigating how planning decisions were made with a comprehensive understanding of local knowledge. A multidisciplinary approach was implemented with SoftGIS in order to gather and process local information for planning.

On the other hand, the impact of property prices in an urban area was explored with GIS (Lake et al., 1998). In addition, extending the applicability of viewsheds in landscape planning also studied with GIS (Fisher, 1996). Another example (Gourmelon, 2002) also demonstrated more possibilities of using GIS in ecological studies. Moreover, Selkirk and Bishop (2002) carried out research in an attempt to understand the parameters influencing each estimated animal's home range.

Bishop also continued (Bishop and Gimblett, 2000) GIS research on the management of recreational areas in conjunction with virtual reality. Through the GIS, impacts such as erosion can be modelled and the research finds that the combined models can become part of a decision support system for sustainable tourism in fragile environments.

In particular, Uusitalo and Orland (2001) illustrated the possibilities and challenges of virtual forest management through empirical modelling methods. They reviewed the virtual forest management technologies through creating empirical models and suggesting constraints on the models. Modelling was carried out with GIS applications.

Using visualisation technologies, Al-Kodomany (1999) employed a case study to answer the research question; reviewing the effectiveness and comparing visualisation tools including GIS and computer generated photomontage. Chicago's Pilsen neighbourhood was selected for the case study and in various planning stages, GIS based interactive visualisation of the neighbourhood through maps and images and computer-generated photomontages were provided in each separate planning stage. It was found that each media; sketches, GIS and computer photomontage were appropriate for different phases of the planning process.

Another reason for the popularity of GIS based research is its strength of data availability. Even though, a number of academic research indicates that GIS data collection is becoming a more commonplace task in planning (Appleton and Lovett, 2005), it is still an expensive option for ordinary professionals in real planning processes and in terms of scale of projects in landscape design, it isn't always appropriate either.

2.5.2 Research using the Internet

In the UK, more than 77% of all households already have a connection to the Internet according to figures released by the independent Office of Telecommunications (Oftel) in 2011. Moreover, dial up connections fell by 2% in 2011. In 2007 broadband connection composed 84 % of UK household Internet; it became the majority (93%) in the year 2011.

However, research from the Oxford Internet Institute claimed that cost is not a significant factor and that age and indifference are the key factors in who goes online and who does not. The survey found that the average person has access to the internet in at least two out of four places: home, work, school or at a public library, but 41% of people do not use it.

There was an on-line campaign (Johnson, 2004) to increase the turnout in European elections. It was an attempt to bring a distant institution closer to people's everyday lives. Recently, local councils across the UK launched online services (Cross, 2003). The aim was for citizens and local businesses to be able to connect directly with the council service they require, without needing to know which tier of government is responsible.

Since the invention of the Internet, academics started to recognise the potential of the technology. In 1995, Shafter (1995) claimed that the issue of connectivity with remotely accessible information has been addressed through the maturation of the Internet and the World Wide Web. This makes it possible for the globally networked community to access this information in an associative manner.

Kangas and Store (2002) even referred to the Internet as term of 'teledemocracy' in their research on landscape management. They believed that the widespread availability of Internet connections and the everyday aspect of the use of data networks provide many opportunities for exploiting in planning and affecting decision-making. They concluded that there were good changes for applying teledemocracy in participatory forest planning and rapid on-going development as interactive telecommunication technology continuously increases its future potential. However, taking the technical and social facts of today into account, teledemocracy cannot replace other forms and channels of public participation.

Similarly, Wherrett (1999) also used the Internet as a medium for landscape preference research. She went further on the Internet employment issues in survey techniques (Wherrett, 2000). Earlier, Bishop (1996) investigated landscape colour perception research using Internet. Therefore, it is reasonable to conclude that the Internet is well researched in the participation aspects of research.

2.6 The need for Computer Visualisation Studies in Empirical Planning

The literature review makes clear that while considerable attention has been paid to the many aspects of technology, informed analysis of the implications of computer visualisation developments for planning practice is distinctly lacking, and worthy of far more attention and consideration in the UK. Encouraged by the fast and efficient development of the technology, planning professionals have taken an interest in employing computer visualisations within their practices. Although scientists and visualisation preparers have addressed the question of how to implement visualisation within planning practice, the approach they have adopted is mostly too technical and superficial, implying that few, if any, credibility studies with special reference to the planning output have been conducted. As a result, effort has focused on the main factors influencing the usage and potential of computer visualisation within planning, and the dynamics behind implementing computer visualisation in relation to the UK planning process.

A number of planning studies have been conducted by academics from a technical and a media perspective, rather than the empirical planning adaptation point of view. These two viewpoints differ significantly in that the former focuses mainly on the technical capabilities of computer visualisation media and its potential while the latter is primarily concerned with identifying the dynamics of technology in the planning process, including roles, validity, and realism. That is, the social science point of view aims to examine empirically the actual determinants of the development management and to investigate how these are related to the dynamics of the implementation of computer visualisation and how they influence the planning decision. This thesis adopts a more social science point of view.

It is important to note why I feel that computer visualisation studies within the context of planning should be conducted from a social science point of view. Firstly, it is important to consider if computer visualisation can improve the process of development management and why the level of technology employed has varied in between planning applications and different stages thereof. Although the implementation of visualisation within planning is dependent on the specifics of the individual planning application and the interested parties involved, there may be common trends emerging across applications. This may help identify the potentialities and threats emerging from the application of visualisation, where it is also important to understand the roles of planners and other professionals within this process.

Secondly, through understanding the way in which modern technology attributes and affects planning decisions, we can identify the necessary conditions under which central-government-initiated policy guidelines or the policies of professional bodies may be implemented successfully.

Third, few professionals have been sensitive to the contested and dynamic process of employing computer visualisation for their planning applications and academic explanations fail to capture how the implementation process works at the local level and the way in which it influences planning decisions. The study of computer visualisation in planning presented here can provide us with some useful information as to what factors have affected the public consultation and assessment methods used. Such questionnaires are far from being of mere academic interest, but rather one of critical importance to scientists, technicians, professionals, local planning authorities, and private contractors.

In particular, the review of the literature finds that relatively few studies report on issues of credibility or validity coefficients. That gives a reason for some concern.

This review does not purport to provide a comprehensive list of all the research conducted up until now, nor to evaluate all studies in detail. Furthermore, the taxonomy of the literature on computer visualisation and environmental planning process offered here is undoubtedly incomplete. Its categories are inevitably partially overlapping, and the specific examples presented under each heading can only hint at the broad array of studies that each category subsumes. Nevertheless, the taxonomy may prove useful in so far as the categories demonstrate the characteristics of research on computer visualisation and environmental planning carried out in the fields of town and country planning, computing science, etc.

A more sophisticated explanation of the trends is required in order to answer the main questions that arise from an appreciation of the literature. First, how computer visualisation is implemented in the UK planning? Second, what are the current issues faced in the planning implementation?

In an attempt to rectify the shortcomings of the literature, it has suggested that study of a computer visualisation within planning is required to answer these questions. Such a study should consider the main determinants of planning decision in greater detail. It should also explore the ways in which the main factors in the process of employing computer visualisation interact, in order to provide an insight into the dynamics of the process. This will mean that the opinion and reflections of the key participants are considered when examining planning decisions. Accordingly, in the next chapter I begin to build the methodologies of the study in order to identify objectively the main factors involved in computer visualisation in planning.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

The aim of this thesis is to understand and reflect on computer visualisation in current planning practice. This will be explored by considering how computer visualisation in the UK has been implemented at different levels, examine the visualisation production processes, and suggest some of the implications of the experience of computer visualisation for the planning process. In addition to the use of the technology, the research is questioning the media on individual visualisation currently in use within planning practice. In order to achieve these aims, two main research questions were established in Chapter 1; *how computer visualisation has been utilised within development management process (in particular, focused on landscape consultant's' point of view)? and what are the challenges faced when implementing computer visualisation within planning practice?* To answer the questions, an appropriate methodology must be employed.

Accordingly, in order to answer those questions about implementation and current challenges in planning practice, this research is employing two perspectives of methodology. The first perspective of methodology is to examine the implementation of computer visualisation in planning through case studies. The case studies were selected based on planning applications and diversity of computer visualisations utilised. The second perspective of methodology is to investigate current challenges faced within planning through interviews with experienced planning practitioners.

The first method relied primarily on the author's professional experience and experimental research while the second method is based on semi-structured interviews with practitioners. The analysis structure of this research in later chapters is also organised by these methodology perspectives.

In order for a case study to provide an insight it is important to understand what it is a case study of. One approach to the selection of cases is through a typical case approach to case study selection (Gerring, 2007). The typical case exemplifies what is considered to be a typical set of values, given some general understanding of a phenomenon. In this thesis, in order to investigate the implementation of computer visualisation in planning, typical planning applications include assessments (i.e. EIA and LVIA) and various consultations with stakeholders. Moreover, diverse computer visualisations were also taken into account for the selection of the case studies.

Interviews generally depend on the quality of the questions asked as well as the awareness of the interactions involved. Interviews are more flexible than questionnaires and can probe deeper. In the case study, four main parties are interviewed; visualisation preparers, environmental consultants, forest managers and planners.

In addition, the practitioners within the interviews were based in North East of England. Generally, the interviews are focused on computer visualisation within planning applications and how it is implemented and perceived by experienced planning professionals rather than a specific application.

In summary, the research questions are divided into two main themes: to understand how computer visualisation has been implemented in UK planning and what are the challenges computer visualisation is facing when implemented within planning practice. In order to tackle the research questions, the methodology has been developed both but from two different perspectives: *1. In-depth study of individual applications* and 2*. Reflections of practitioners based on their experience through semi-structured interviews.*

Firstly, the individual planning application cases were selected based on typical planning applications and utilisation of computer visualisation in order to investigate empirical implementation of the technology within real development management. Moreover, the author was personally involved in the creation of models within these case studies. With the case studies, the research will be able to scrutinise empirical utilisation of computer visualisation in development management process in the UK as well as investigating individual media employed in planning.

Secondly, the other element of methodology is employment of semi-structured interviews with planning practitioners. Through interviews with experienced planning professionals, the research is able to explore their reflections on issues and challenges of technology implementation in planning. Therefore, this element of the methodology will contribute to exploring the current challenges planning practitioners are faced with regards implementing technology in planning processes.

Consequently, this chapter is divided into three main sections: (1) Understanding qualitative methods, (2) Perspective 1 – planning application case studies and (3) Perspective 2 – interviews with North East Practitioners.

The first section, Understanding qualitative methods addresses generic research methodology – qualitative and quantitative, research questions and units of analysis, case studies and interviews in order to understand principles of research techniques/ methodologies and why a qualitative methodology has been chosen. Secondly, Perspective 1 - Planning application case studies – explains technical aspects of the case studies including pilot case, selection and design. In particular, the section provides feedback from stakeholders – mainly communities affected – with regards to computer visualisations for individual case studies. The third section – Perspective 2 Interviews with North East Practitioners – illustrates the design of semi-structured interviews employed and selection of subjects in North East of England. This section contributes how this research to investigate how practitioners perceived and reflects current phenomenon of implementing computer visualisation in planning processes.

In addition, the rest of this chapter is composed with research hazards and conclusion. Three research hazards were indicated in the research: current computer visualisation choices, production method and generalisation.

3.2 Understanding Qualitative Methods

This section addresses the fundamental decisions made within methodological design. Firstly, the reason why qualitative methods are employed in the thesis is explained. Then, the differences between positivism and realism, and the basic principles of the empirical approach are spelled out. Finally, it shows how the principles can be applied to research into computer visualisation before presenting the conceptual framework of the research. The methodology adopted in the thesis is then summed up as the interface between case study method, theories of social learning and sustainable planning process and town planning.

The research methods used in social science are, in general, categorised into two kinds, one is a qualitative method and the other is quantitative. Although the division is not clear cut, qualitative research is characterised as being more interested in processes and how and why questions, while quantitative research is considered as more data-driven, and outcome-oriented social science (Yin, 2003).

This thesis adopts qualitative methods of case studies, semi-structured interviews, and structural analysis. Although there is some criticism of this approach as story-telling, as concrete explanations of events are required, this qualitative research design must be appreciated. While extensive studies, whose main aim is to describe the phenomenon concerned and to generalise findings, are weaker for the purpose of explanation then intensive research design is worth trying. However diverse and typical methods should be complementary rather than competitive since the understanding of ‘what’ is as significant as the understanding of ‘why’ (Sayer, 1992).

Yin (2003) defines the case study methods as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, addresses a situation in which the boundaries between phenomenon and context are not clearly evident, and uses multiple sources of evidence. Therefore case studies can include quantitative data (numerical measurement) where relevant as well as qualitative evidence. In other words, the case study is not limited to either qualitative or quantitative data and can incorporate both varieties of evidence.

As Yin continues, using case studies as a research strategy comprises an all - encompassing method – with the logic of design incorporating specific approaches to data collection and data analysis. In this sense, the case study is not merely a data collection tactic. That is, case studies can be based on quantitative or qualitative evidence or any mix of them according to the attributes of the types of data.

Qualitative data is data that cannot readily be converted to numerical values. Such data can be represented by categorical data, by perceptual and attitudinal dimensions not readily converted to numerical values. An answer to the research questions mainly requires a case study using intensive and qualitative research methods. In general, case studies are the preferred strategy when ‘how’ or ‘why’ questions are being posed, when the investigators have little control over events, and when the focus is on a contemporary phenomenon within some real-life context.

In this context, in order to evaluate visualisation and identify the value and role embedded within development management, it is necessary to employ qualitative research methods.

Given the nature of the research questions which the thesis asks, more qualitative and intensive forms of research are needed with a heavy reliance on case study, and semi-structured interviews with parties involved in the process.

Since the 1960s, a strong move towards a more qualitative (Blaxter et al., 2001), naturalistic and subjective approach has left social scientists divided between two competing methods: the scientific empirical tradition, and naturalistic phenomenological mode. In the scientific method, quantitative research methods are employed in principle. Such a scientific approach is often termed nomothetic and assumes social reality is objective and external to the individual. The naturalistic approach to research emphasises the importance of the subjective experience of individuals, with a focus on qualitative analysis.

The research on computer visualisation within a planning context tends to focus on exploring in as much detail as possible, a smaller number of instances or examples which are seen as being interesting, or illuminating, and aims to achieve ‘depth’ rather than ‘breadth’. Moreover, this research will deal with social reality which is regarded as a creation of individual consciousness with meaning and the evaluation of events seen as a personal and subjective construction, such as a focus on the individual cases rather than general law-making.

Therefore, this research into computer visualisation in environmental planning needs to be a qualitative investigation. Moreover, the research employs case study methodology in order to analyse emerging issues of the technology (Table 3.1).

Table 3.1 Research Classification

Research Hierarchy	**Computer Visualisation in Planning**	
Research Family	Qualitative	
Research Approach	Case Study (Diverse in computer visualisation and typical planning applications)	
Research Technique	Semi-Structured Interview and Analysis	Personal Experience

3.2.1 Research questions

Based on the empirical approach above (Table 3.1), the case study approach was deemed appropriate. However, before practical data collection is made, the research questions together with the unit of analysis and the number of cases must be clarified.

In terms of general orientation of questions, there are five levels (Yin 2003).

- Level 1: questions asked of specific interviewees
- Level 2: questions asked of the individual case
- Level 3: questions asked of the pattern of findings across multiple cases
- Level 4: questions asked of an entire study
- Level 5: normative questions about policy recommendations and conclusions, going beyond the narrow scope of this study.

While all these five levels of questions are important, at the data collection stage, the most relevant questions are levels one and two. In the research, there are two main questions asked in the research as well as the case study.

The first research question is *how computer visualisation has been implemented in UK planning*. In order to explore this aspect, the following questions needed to be answered.

- Which kinds of planning application have employed the technology?
- What types of media are utilised currently in the UK?
- What are the pros and cons of using each visualisation?

In recent years, the computer visualisation has been successfully applied within the UK planning process; therefore, those questions about analysis on the usages in consultation and assessment are already familiarised in practice.

The second question is *what are the challenges computer visualisation is facing when implemented within planning practice?* The virtual environment carries much more interactive information than traditional media. However it is highly technology dependent communication media; therefore, it might not be easy for the general public to benefit from such visualisation. This issue will be dealt with through interviews and questionnaires.

In addition, the credibility of computer visualisation is analysed. Recently, computer generated media have become commonly used within planning practice; however, the issue of the validity of computer visualisation is sometimes overshadowed by how computer visualisations appear. For computer visualisation to be used within the planning process, the images must be valid and credible. This issue will be dealt with within the semi-structured interviews and technology reviews as part of the modelling experiments.

3.2.2 Unit of analysis

The same case study may involve more than one unit of analysis. This occurs when attention is given to a subunit or in a series of subunits. Such a design can be called an embedded case study design in contrast to a holistic design which uses only one unit of analysis (Yin, 2003).

The unit of analysis of the research is related to the definition of the initial research questions. Computer visualisations are firstly examined with characteristics such as photomontage, real time rendering, and pre-set path simulation being reviewed. This demonstrates the principles in the accuracy, validity, level of detail and also provided current usage of the modern technology in case studies. Therefore computer modelling process and media in each subject area are the main units of analysis (Table 3.2).

Table 3.2 Units of Analysis

Topic	Computer Visualisation, Planning Implementation
1st Unit **Computer Visualisation Media**	Photomontage, Pre-set Path Simulation, Virtual Environment QuickTime VR
2nd Unit **Planning Applications**	Planning application, Public Consultation, Management, Landscape Visual Impact Assessment

Role in Planning, Level of Detail, Credibility, Production Cost

Analysis of the individual visualisation elements explains the kinds of media that have been employed in the planning. In this case, the visualisation media used is the unit of analysis. Although the unit of analysis for the implementation of computer visualisation is individual media, the level of analysis of each modelling elements is as important as that of each visualisation medium because visualisation media is to be understood as a technical aspect of the research. Another unit of analysis is planning applications.

In short, the unit of analysis for the implementation of computer visualisation is an individual visualisation medium in each case whilst the unit of analysis for examining the elements of implication in planning is an application.

However in the case of both units of analysis, individual visualisation media should be considered together with the planning application. Analysis of a visualisation medium without planning employment is meaningless for this research. Computer visualisation by definition presupposes a planning implementation. That is the reason why mere technology reviews or analysis are excluded from the research. With the same logic, it is not possible to find out the visualisation in a single planning application alone.

Social events cannot be explained by deducing them from the principles governing the behaviour of the participating individuals and descriptions of their situation because ‘societies are irreducible to people’ (Bhaskar, 1989).

3.3 Perspective 1: Planning Application Case Studies

In order to investigate the two different and related perspectives arising from the research questions, case studies and interviews were employed as methodologies. This section is about the first element, case studies.

The two main reasons suggested for the case study: the diversity of visualisation media used within planning, which will be dealt with in chapter five, and the need to reflect on typical planning applications in development management, which will be analysed in detail in the following chapter.

Case study methodology is commonly used in similar studies on computer visualisation. For instance, Lange (1999) employed case study methodology in his research on realism of GIS-based virtual landscape. In order to answer the research questions of comparison and analysis of landscape perspectives between reality and visualisation, computer models were created in association with the region of Schwyz and Ingenbohl-Brunnen in Switzerland. A semi-structured interview method was used for the 75 interviewees who were brought in to examine the differences to the real world.

In this research, four mini case studies will be carried out with one major case selected, Herrington Country Park, Sunderland. The case studies are chosen and categorised based on diverse and typical themes (Gerring, 2007)

In this research, the case study approach is mostly utilised to explore the methods of creating visualisation based on its individual strength and weaknesses. It will involve an experimental technique and the author’s experience in order to analyse the practical use of the visualisation media in environmental planning. In particular, semi-structured interview process will be carried out in the case study methodology to examine perceptive aspects of environmental modelling and the capabilities of those tools.

Then, what kind of case study design can be used in terms of the research questions? According to Yin (2003), there are four types of design for case study strategy; single-case (holistic) designs, single-case (embedded) design, multiple-case (holistic) designs, and multiple-case (embedded) designs. The embedded design is used when a case study examines more than two embedded units of analysis in a whole subject case while the holistic design is preferred if only a global nature of a case is researched. A multiple-case (embedded) design is adopted for the research.

Why is a multiple-case (embedded) design adopted? The first rationale is that one of the main aspects of this research is seeking answers to both technical and planning implementations of computer visualisation. A task of investigation of the two main aspects, in itself, requires more than two cases. Another rationale is that the evidence from multiple cases is often considered more compelling and the overall study is therefore regarded as being more robust. Each case in a multiple-case study should serve a specific purpose within the overall scope of the question.

Here, a major insight is to consider multiple cases as one would consider multiple experiments – that is, to follow a ‘replication logic’. The replication logic is said to be analogous to that used in multiple experiments. Each case must be carefully selected so that it either 1.predicts similar results (a literal replication) or 2.it produces contrasting results but for predictable reasons (a theoretical replication).

Therefore case studies would be designed from research questions and bring units of analysis on visualisation media in environmental planning; moreover, the multiple cases will be selected amongst six different types[22] and also pay explicit attention to sampling and selection issues, and use a range of data collection techniques, including interviews, observation and documents and experiment; therefore, the research will be identified as a multiple and exploratory case study.

In addition, this research adopts Gerring's classification for choosing case studies. While Gerring (2009) classifies case study reasons in terms of typical, diverse, extreme, deviant, influential, crucial, pathway, most-similar, and most-different, the research purpose summarised as *how visualisation is implemented in UK planning and how credible is visualisation techniques in the planning process,* in order to investigate those questions, the cases have been chosen on the basis of 'typical and diverse' reasons.

Table 3.3 illustrates the case studies of planning applications. Five cases are classified as diverse in visualisation types and typical planning applications categories based on Gerring's classification.

Table 3.3 Case Study of Planning Applications: Diverse and Typical Cases

Typical Planning Applications (Assessments, Consultation, Preference)	**Diverse Visualisation Media** (Photomontage, Pre-set Path Simulation, Real Time Rendering, Panoramic VR)
Herring Country Park, Sunderland	**Herrington Country Park, Sunderland**
Barnsley BSF	Saltburn Top Promenade, Redcar and Cleveland
Denham Hall Estate, Suffolk	Windlestone Hall School, Co. Durham

The typical planning application category includes Herrington Country Park, Barnsley BSF, Denham Estate Hall, since they provide examples of stakeholder consultation (Herrington Country Park), planning condition discharge (Barnsley BSF), and Landscape and Visual Impact Assessment (Denham Hall Estate).

These cases have been chosen out of a possible 20 that the author had been working on nationally in the UK. They provide good examples of typical planning applications.

[22] Yin (2003) identified six types of case study, defined along two dimensions; in terms of the number of cases-single or multiple, in terms of the purpose of the study-exploratory, descriptive or explanatory.

First of all, the main case study, Herrington Country Park was selected as a case, which is as representative as possible of a common planning application using a variety of computer visualisations as part of the planning application, including visualisations used for: (1) Assessment, (2) Consultation, and (3) Determination of Preferences. Herrington Country Park is more representative than, or at least as representative as other cases. Secondly, Herrington Country Park case study has a maximum variance of using (implementing) computer visualisation media. In the case study, various media such as photomontage, virtual reality, animation, and panoramic VR were tested under stakeholder consultation.

For the Barnsley BSF, a series of photomontages were produced in order to help the process of planning approval. The Local Planning Authority requested photomontages for the visual assessment of wind turbines. Similarly, photomontages were produced for a Landscape and Visual Impact Assessment for Denham Hall Estate.

Within the case study process, investigation methods determined from the author's experience will be employed for identifying the technical aspects of visualisation, and semi-structured interviews are carried out with practitioners and planners in local planning authorities.

Based on the criteria set out above, the author's personal reflections and practitioners' perceptions through interviews are selected as an appropriate research approach. However before practical data collection is made, the research questions together with the unit of analysis must be clarified.

3.3.1 Pilot case study

The final preparation for data collection is to conduct a pilot case study. The pilot study helps refine the data collection plan, assisting the research to develop the most relevant questions. The pilot study is, in a sense, more important than the actual data collection stage. Case study sites are selected based on the pilot study results.

Moreover, a pilot case study is essential to ensure that the answers given actually exhaust all the possibilities. Without any pilot study, the actual research is likely to address unsuitable questions that bewilder people (Shipman, 1988). In addition, the pilot case study represents the same site, Herrington Country Park, which is the main case study in the research. Therefore, nearly all the relevant data collection issues will be encountered in the pilot case.

The enquiry for the pilot case study can be much broader and less focused than the ultimate data collection plan. Moreover, the enquiry can cover both substantive and methodological issues (Yin, 2003). Some of the points to be considered during the pilot case study are the time to be taken for each interview; the degree of difficulty of the questions; the possibility of biased questions to induce certain answers and the method of analysing the answers.

Technical aspects of the research are answered in conjunction with the case studies through creating computer models. The most important issues in the experiments are data availability, methods of model creation, and software availability as well as the credibility of production.

In order to testify interview questions in the actual case study, a pilot case study interview was designed. It was based on four different media applications, which contains a flyover pre-set animation, two virtual environments, two photomontages and panoramic VR and interactive environment in computer screen and data projector. Moreover, participants were given an option of weather conditions and viewpoint changes.

Altogether three interviewees participated and all respondents were lecturers of University of Newcastle upon Tyne. In general, they had some previous experience of computer graphics and virtual environments.

The area used in the experiment was a subset of a larger suburban model of the area around Herrington in Sunderland, England. The area covered was about 4 ha and the full model includes approximately 1210 polygons and 11 different surface textures (approx. 10Mbytes). In the daytime simulation, there was a single light source positioned to correspond to a sunny day in the North East of England.

The model development and rendering were all carried out using 3D Studio Max software and the full software rendering size was 640 x 480 with Macromedia Director Shadow casting. The field of view was approximately 50 degree and the camera was free pointed. Sounds were recorded on-site in daytime conditions.

To measure responses to environmental features as well as the perceived simulation quality, a standardised questionnaire booklet was developed. This was based on the conceptual framework presented in Chapter 2 and the basic framework of the questionnaires consisted of four parts as follows;

- General questions about interviewees – age, profession, sex
- Computer visualisation recognition – previous experience, negative or positive
- Technical comparison to traditional media (or experience) – accuracy, helpful, comparison with other media
- Planning implementation – development management, assessment, and consultation

A key aspect of response measurement in either the real or virtual environment is to understand computer-modelling technology and the use of such in future visioning and development management.

In summary the findings from the pilot study results were:

1. The level of detail is not critical to those who know the site and the nature of project.
2. The validity of computer model is more significant than how it looks.
3. The outcome of the interview could be determined by interviewees' experience.

Most of the pilot interviewees commented that the case study results could be affected by the level of visualisation experience of each individual respondent. Moreover, it is suggested that interviewees with a greater level of experience in development management and the use of computerised visualisation would be able to produce in depth reflections of their experience in planning and technology in the UK.

3.3.2 Technical aspects of the case study design

The case study sites were chosen to match selected criteria. They needed to be UK planning applications, which were formal, but which, when combined, formed an integrated whole with development management processes. The case study site and models of visualisation also need to have various landscape features. One of the reasons for these criteria is that there needs to be interaction between the planning process and technology implementation within.

In order to be able to consider the local context, the second criterion for site selection is that the size of site should not be large. On a site larger than 4ha, for example, it would be difficult for viewers and programmers to create and use a digital model with full interactivity because of its dependency on individual computers even though it is subject to the level of detail of the models produced.

In most of cases, digital data was provided by local planning authorities and other governmental organisations. This data included DTM, base survey maps, tree survey information and raster OS plans. Following its data collection a survey was carried out to obtain detailed site information such as texture, colour, vegetation and etc.

There were three organisations who provided data for Herrington Country Park. The Great North Forest, Sunderland City Council, and the University of Newcastle upon Tyne. Newcastle University had access to Digimap, which provided the Land-Form panorama DTM[23] (1:50,000), Land-Line Plus (multi-scale), Land-Form Panorama Contour (1:50,000), Colour Raster (1:50,000) and Meridian (1:50,000). The Great North Forest provided aerial photographs of the area, which were in turn supplied by ukperspectives.com. Sunderland City Council provided digital data of Herring Colliery, which is one of the case study modelling sites (See Appendix B, page192).

In all the case studies, computer models of the sites will be created as a part of the process. The modelling process involved site survey, building ground terrain, inserting landscape elements, texturing and applying a timeline scale.

Ervin and Hasbrouck (2001) claimed that there are distinctive differences between architectural and landscape models in terms of nature and character. Particularly, applying atmosphere and time changing procedures were unique in landscape modelling.

Ervin and Hasbrouck's points were taken into account for the modelling process. Three basic weather conditions – clear, clouded, and dark sky – were provided as an option in Herrington Country Park case (Figure 4.13, page 106). As well as the basic weather conditions, vegetation grown were represented in four different options: current, 5-10 years, 10-20, and over 30 years.

However, the case study models did not include atmospheric options other than basic sky changes and vegetation growth (Figure 4.11, page 105).

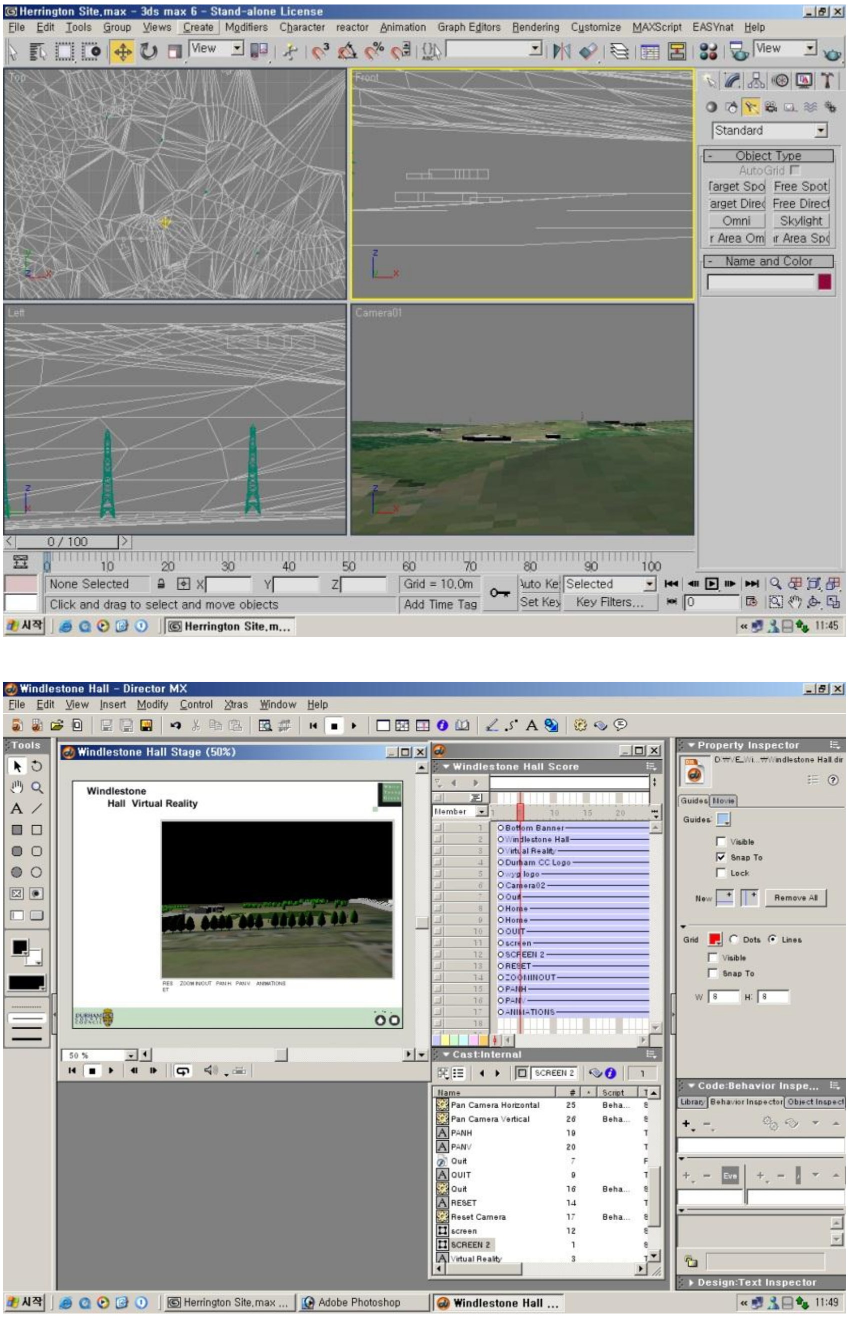
There are a number of software packages that are commercially available for the preparation of landscape visualisations. However, there is also freeware to create models

[23] Digital Terrain Model

built on the basis of a programming language (such as VRML[24]). With VRML, simplified shapes such as cubes and spheres can be created with basic text edit software (such as Notepad) and viewed by any Internet browser (in some occasions, with free plug-ins installed)[25].

However, commercial applications are needed to create complicated shapes, apply materials and illustrate time based changes.

Figure 3.1 3D Studio Max and Macromedia (Adobe) Director Interface



24 It has been superseded by X3D in 2004.
25 Such as Virtual Terrain Project (VTP)

Major commercial software was licenced by Newcastle University and White Young Green Environmental Limited including Autodesk's AutoCAD and 3D Studio Max. Table 3.4 indicates actual software employed throughout the research and case study.

Table 3.4 Software for Modelling

Software	Purpose
3D Studio Max	3D authorising, modelling, animation
Macromedia Director	Lingo Script, real-time rendering model, Creating Human Interface
Adobe Photoshop	Bitmap editing
AutoCAD	Vector drafting

3.3.3 Stakeholders feedback

In order to find out the planning applications of computer visualisation, the case study procedures involved not only technical modelling but also a review of different stages in planning including assessments (EIA, LVIA), planning condition discharge, and consultation (public and stakeholders). The processes are part of formal planning and development management in the UK.

The choice of the case studies was motivated by the typical planning application and diverse media selection. The visualisation was created showing proposals for each planning scenario and case study: Saltburn Top Promenade, Herrington Country Park, Windlestone Hall School, and various assessment processes. The visualisations were designed for public consultation and professional decision making on the overall concept of proposals, via presentation, interview and digital questionnaires, and to illustrate uses in planning.

Table 3.5 Case Study and Communities Affected

Projects	Herrington Country Park	Windlestone Hall Relocation	Saltburn Top Promenade
	Steering Group Meetings	Residents, School Staffs	Community Groups

In particular, engagement with community groups, residents, and steering groups was undertaken for the Windlestone Hall School Relocation and the Saltburn Top Promenade cases that provided valuable feedback for this research (Table 3.5).

3.3.3.1 Herrington Country Park – Semi structured interviews, Steering group meetings

Real-time media was used in various meetings in the Herrington Country Park case study. One of these meetings was with a steering group meeting where future landscape changes (5, 15 years of forest growth) were presented. In terms of the production of landscape proposals, real time rendering media adopts the same principles of photomontage with additional immersive reality, which can be operated (explored) by the keyboards and the computer mouse.

In the steering group meeting at South Tyneside Council, photomontages and real time renderings including phasing options (5, 15 years of forest growth) were presented. The steering group was composed of the local planning authority, forestry organisations, and representatives of the local communities. During the 1 hour presentation and interaction with participants, the most positive feedback was received in relation to the media visualising interaction and phasing forest growth. Participants claimed that the capacity to visualise 5 and 15 year forest growth and to walk through freely along the footpath were the most useful contributors to the design and maintenance of the community forest.

This unique feature offers viewers the ability to navigate at their own will and to explore in any direction they wish (It is similar to first person video games). Significantly in planning, it can be used where viewers are able to choose paths and experience a virtual world.

3.3.3.2 Windlestone Hall School Relocation – School Staff and Residents

A real time rendering visualisation was presented as part of a public exhibition held on May 2004. 20 participants who lived adjacent to the proposed site were interviewed. Since the participants were residents, they had detailed knowledge of the area and were also aware of the nature and context of the project. Other participants included a Planning Officer from Durham Country Council and members of the school staff.

Following a brief introduction of the proposal and the visualisation exercise, all the participants viewed the visualisations using a 4x3 screen ratio projector on one side of the room. All the participants were given the opportunity to control views themselves through a camera controlled by a keyboard and a mouse. An open discussion followed regarding the school relocation project as well as the real-time visualisation. After this free discussion, participants were questioned on the following topics:

1. Their understanding of the project
2. Their perceptions (benefits of computer models),
3. The level of realism (level of detail) of the visualisation, and
4. The value of using such technology within the planning process (specifically for planners)

The consultation process and participants' choices were recorded and all data collected was analysed.

3.3.3.3 Saltburn Top Promenade - Communities

As a community-led project, a number of consultations took place during the funding, conceptual development, and construction stages. Those consultations were made with Saltburn Forward, a community group, the police, and the local planning authority. In addition, a local artist was commissioned to design specific features such as ammonite wall patterns in conjunction with neighbouring schools.

Progress meetings were held every two weeks in order to inform on the progress and decisions about materials. The community hall was able to accommodate a maximum of 20 residents together with local police representatives, planners, Groundwork staff, and the local artist.

In the periodical meetings, the landscape proposals were visualised as photomontages and animations and were presented to the community and the stakeholders. Following discussion about the scheme, immediate feedback was collected regarding the computer visualisation.

3.4 Perspective 2: Interviews with North East Practitioners

As the second element of the methodology, the research employed interview technique. The research attempts to investigate the practitioners' reflections on computer visualisation by semi structured interviews.

Practitioners within the interviews were based in North East of England. Generally, the interviews are focused on computer visualisation within planning applications and how it is implemented and perceived by experienced planning professionals rather than a specific application.

Most of the interviewees were known to the author with most of them being former colleagues who worked with the author on producing visualisations or have professional relationships with the author. In terms of planning applications, development management cases in the North East are not much different to those in any other part of England; therefore, planning applications and utilisation of computer visualisation is valid and applicable. Moreover, through the author's professional experience and contacts in the region, interviewees were easily accessible and selected in the North East. In addition, having the subjects of the interviews in the region has brought down the overall cost of the research.

There could be a range of issues arising such as most of the planning applications were in the public sector and dealt with more regionally related issues of planning; however, the north east of England was still a good locality due to the accessibility (contacts) and costs benefits.

Interviews generally depend on the quality of the questions asked as well as the awareness of the interactions involved. Interviews are more flexible than questionnaires and can probe deeper. In the case study, five main parties are interviewed; visualisation preparers, environmental consultants, forest managers, planners, and the public.

Most of interviews carried out with practitioners, planners, and visualisation preparers were performed using visualisations produced for Herrington Country Park. Herrington Country Park - the case study was chosen due to the diverse visualisation media employed such as photomontages, animation, real time rendering, and panoramic VR. Therefore, collecting data about the technical aspects of visualisation as well as the planning application from interviews with such media diversity in the Herrington Country Park is most appropriate.

In fact a total number of 18 interviewees were chosen to be interviewed (Table 3.6, page 79). They are categorised into groups of landscape consultants, planners, forest managers, visualisation preparers, and the community. Those planning professionals were well experienced and had practiced in the region for number of years.

The design of the questionnaires was based on the pilot study. In the basic information section, there were four questions concerning area, use, management and vision of the projects. In the nature of stakeholder section, there were two questions concerning roles (position) and degree of experience. In the technical information section, questions were divided into the same categories as landscape elements: landform, vegetation, water, structure, animals and atmosphere (Ervin, 2001). In the empirical information section, the main question related to the application of virtual models and real cases in landscape practice.

It was an open ended interview and there was no time limit. However, individual interviews lasted over an hour on average. Interviews were carried out in a one to one conversation style and were recorded.

3.4.1 Selection of interviewees

First of all landscape consultants have a major role to play employing and commissioning computer visualisations to explain their schemes. In Environmental Impact Assessments, Landscape and Visual Assessments, and other design processes, computer visualisations tend to be utilised in various forms such as the presentation of photomontages and animation.

Secondly, local planning authorities tend to be the client for environmental design issues; therefore, planners were included as part of the main interviewee group.

Thirdly, computer visualisation preparers were included for analysis of the technical aspects of the research. And finally, the university lecturers were invited to take part in the pilot study and an on-line interview for initiate questionnaires and the examination of the relevance of the questions.

In the research, interviewees were grouped by their profession. Private consultants constitute the first group: **Private Landscape Consultants**. In order to assess the employment of computer visualisation in environmental planning, it is essential to have interviewees who have relevant experience in the field. Therefore, they have been selected on the basis of their experience in the industry. Most of them possessed more than 5 years professional experience, some at director and associate level.

Table 3.6 Composition of Interviewees

Group		Position	Organisation	Case Study
Private Landscape Consultants	A	Associate Landscape Architect	Robinson Landscape Design Ltd.	Herrington Country Park
	B	Senior Landscape Architect	Sunderland City Council	Herrington Country Park
	C	Landscape Architect	White Young Green Environmental	Herrington Country Park
	D	Associate Landscape Architect	Southern Green Ltd.	Herrington Country Park
	E	Associate Landscape Architect	White Young Green Environmental	Saltburn Top Prom
	F	Senior Landscape Architect	White Young Green Environmental	General
	G	Director	Anthony Walker and Partners	General
Community Forest Organisation	H	Executive Director	NorthEast Community Forest	Herrington Country Park
	I	Forest Officer	NorthEast Community Forest	Herrington Country Park
Local Planning Authority	J	Senior Planner	Durham County Council	Windlestone Hall School Relocation
Visualisation Technicians	K	Forest GIS Officer	NorthEast Community Forest	Herrington Country Park
	L	Teesside VR Centre	University of Teesside	General
Academics (Pilot Study)	O	Lecturer	University of Sheffield	General
	P	Lecturer	University of Newcastle upon Tyne	Pilot Interview
	Q	Lecturer	University of Newcastle upon Tyne	Pilot Interview
	R	Lecturer	University of Newcastle upon Tyne	Pilot Interview

Officers of the Great North Forest are the second group: **Community Forest Organisation**. Planners in local authorities are the third group: **Local Planning Authority** and the fourth group is **Visualisation Technicians**.

Other interviewees are in **Academics**. This includes interviewees in the pilot study and other academics who provide views on computer visualisation.

Questions were designed to answer the research questions initially set up in Chapter 1 Introduction. In order to obtain coherent results the questions for semi-structured interviews were established (Appendix A). The questions were divided into four main categories, including questions on: landscape visualisation, comparison to traditional media, additional questions, and questions about the interviewees themselves.

The questions were tested at the pilot case study and a minor amendment was made from original semi-structured questions. Mainly these were as follows:

- Visualisation media needs to be clearly distinctive in order for interviewees to make clear choices,
- There needs to be coverage on the level of experience with computer visualisation that the interviewees possessed.

During interviews, a video recorder was set up for recording interviews in order to monitor interviewees' gestures and their own expressions during the interview process. As awareness of video recording distracted the interviewees at the beginning of the interviewing process; however, once questions get started then, its influence became negligible.

Even though most of the professional interviewees operate at a senior level and possess on average 5 to 15 years' professional experience, this did not extend to computer visualisation. For instance, one of interviewees in **Private Landscape Consultants Group** claimed that;

> I don't really use any design software. Probably Microsoft Office is the only software I use. I started to learn AutoCAD but it has not been successful. I mean it is also a generation thing. Maybe I am not interested, some people are. Think about your generation, you don't see many drawing boards whereas; in your generation imagine how slow we were.

> For the last 10 years, changes in landscape have been amazing. 10 years ago, we didn't have any email system we didn't have any CAD drawing. It has all happened in the last 10 years.

3.5 Research Hazards

Given the importance of the technical aspects of visualisation within this research, it is necessary to consider some risks that inevitably exist with researching technology. First is the question of weights. In other words, why and how much computer visualisation media is implemented in the development management process? There are a number of visualisation methods currently used in the planning process. Amongst those media, the research found that photomontages, in particular, are mostly used in planning applications. Nevertheless, the popularity of photomontage or any media preference does not necessarily reflect the weight of analysis criterions such as scientific accuracy and validity. Those are, as is discussed in Chapter 6, inherent in any media although the preference and reservation may vary according to the details of each planning application.

The second is a question of software choice. There are a number of visualisation software programmes in the current market and every application produces different results, particularly in terms of the rendering process. This research tried to use commonly used software as much as possible. Thus, the selection of software is inevitably carried out carefully during the case study modelling process such as image-editing, rendering, and user interface creation. However, this research cannot generalise the process nor the selection of software. Instead, the modelling process and the creation of computer visualisations in this research is one of many methods currently available.

Finally, any comparison risks inappropriate generalisation and over-simplification (Kenman, 1999). In order to reduce these risks, this research included a comprehensive record of all visualisation technologies used for the entire production including software choice, site survey, production cost, role of participants etc. Preference of visualisations was also observed to discover fundamental principles rather than superfluous and temporary phenomena. Based on these examinations the most commonly used media in planning are studied.

3.6 Conclusion

In order to answer the research questions: how has computer visualisation been implemented in UK planning and what are the challenges computer visualisation is facing when implemented within planning practice, the research adopts two elements of methodology: *1. In-depth study of individual applications* and 2. *Reflections of practitioners based on their experience through semi-structured interviews.*

Firstly, the case studies were selected based on typical planning applications that utilised computer visualisation – the cases were carried out by the author - in order to investigate the empirical implementation of the technology within real development management.

During the case studies, why is a multiple-case (embedded) design adopted? The first rationale is that one of the main aspects of this research is seeking answers to both technical and planning implementations of computer visualisation. The task of investigating two main aspects in itself, requires more than two cases. Another rationale is that the evidence from multiple cases is often considered more compelling and the overall study is therefore regarded as being more robust. Each case in a multiple-case study should serve a specific purpose within the overall scope of the question.

In addition, the author's professional and hands on experience in being involved creating models for planning submissions also became a vital part of the methodology in order to investigate the technical aspects of computer visualisation and the employment within typical planning applications, which involves Landscape and Visual Impact Assessment, public consultation, planning application, and the discharge of planning conditions.

Case studies were also selected and categorised based on diverse and typical themes (Gerring, 2007). The research adopted Herrington Country Park as a major case study; moreover, Windlestone Hall School Relocation, Saltburn Top Promenade, Barnsley BSF, and Denham Estate are mini case studies employed based on Gerring's classification: diverse and typical cases.

Within case studies, meetings with stakeholders and communities affected produced a valuable feedback to the research. Herrington Country Park (steering group meetings), Windlestone Hall School Relocation (school staffs and residents) and Saltburn Top Promenade (community groups) provided responses on current computer visualisation technologies as well as their utilisation within individual planning applications.

The other element of the methodology is the employment of semi-structured interviews with planning practitioners. Through interviews with experienced planning professionals, the research would be able to scrutinise their reflections on issues and challenges of technology implementation in planning.

This semi structured interview adopted in the research complemented by open ended questions. Those semi-structured and open ended interviews were carried out with experienced planning professionals, planners, and technicians practicing in the north east of England. The research attempts to investigate practitioners’ reflections on computer visualisation and to examine challenges that computer visualisation faces when implemented within planning practice.

The practitioners within the interviews were based in the North East of England. Generally, the interviews are focused on computer visualisation within planning applications and how it is implemented and perceived by experienced planning professionals rather than a specific application.

In terms of planning application, cases of development management in North East are not much different to any other parts of UK; therefore, planning applications and the utilisation of computer visualisation is valid and applicable. Moreover, through the author’s professional experience and contacts in the region, interviewees were easily accessible and selected in North East. In addition, having subjects of interviews in the region has brought overall cost of the research down.

The next chapter deals with the case studies to establish an appropriate model on which examine the use of computer visualisation in planning.

CHAPTER 4 CASE STUDIES IN TYPICAL PLANNING APPLICATIONS & DIVERSE VISUALISATION

4.1 Introduction

The case studies in this chapter represent examples of computer visualisations used in environmental planning undertaken in the period between 2006 and 2010 along with an examination of its roles in planning, technology scepticism, levels of detail, and production costs. Typical planning scenarios and case studies illustrate various facets of computer visualisation within the UK planning system.

The author has been involved in a large number of environmental projects whilst working as a private consultant, contributing to a number of planning applications. Every visualisation provided within this chapter has been prepared by the author.

The case study areas were selected to test and illustrate the role of various computer visualisations in the UK and were mostly located in the north of England. The nature of the case studies varied to accommodate a wide range of technologies used. However, there were three modelling objectives.

1. To test the ease and means of creating computer visualisation for environmental planning.

2. To provide demonstrative examples for assessing the value of each media in the environment.

3. To explore methods for presenting datasets for the development area.

As stated in Chapter 3, case studies are classified by two categories: Diverse Computer Visualisation and Typical Planning Applications. In the category of Typical Planning Applications, case studies were selected based on the frequency and formality of the planning process such as assessments, consultation, and preferences.

For the category of Diverse Computer Visualisation, the cases were chosen based on the popularity of their usage and selection within the planning process and the extent to which some of them are formally recognised in development management in the UK. Mainly they consist of photomontage, pre-set path simulation (animation), real time rendering, and panoramic VR.

Even though, photomontages are often implemented, the use of three dimensional media is becoming more common. In the case studies, those visualisations are employed diversely in design, planning decision making, forest management, project promotion, and public consultations.

Two types of case studies were undertaken. (1) an in-depth case study of Herrington Country Park and (2) four mini case studies, Denham Hall Estate, Windlestone Hall School, Barnsley BSF, and Saltburn Top Promenade.

Herrington Country Park in Sunderland represents a diverse computer visualisation. A multi-media CD was created for demonstration purposes and used within the steering group meetings and stakeholder consultations. The media in the case study includes photomontage, pre-set path simulation, real time rendering, and panoramic VR, which gives options of 5, 10, and 30 years of forest growth. Each of these media has its own strengths and weaknesses and deserves more than a single research topic. However, this study, as mentioned before, focuses on the planning implementation of each media in terms of its validity and credibility.

Table 4.1 Case Study Categories

Categories	Employment Areas	Case Studies
Typical application of photomontages in planning	Planning application, Consultation, Public Meeting, Planning condition discharge	**Herrington Country Park**, Denham Hall Estate, Barnsley BSF
Diverse in visualisation (3D alternatives)	Photomontage, Pre-set simulation, Panoramic VR, Real time rendering	**Herrington Country Park**, Saltburn Top Promenade, Windlestone Hall School

The Denham Hall Estate Hall case study in Suffolk (2010) involves the production of 5 photomontages to assist in the planning process. Similarly, five photomontages for wind turbine proposals were produced as part of the discharge of planning conditions in 2010 for Barnsley Building Schools for the Future programme (BSF). In those cases, photomontage was the major media to support the assessment of visual and mitigation measures.

Saltburn Top Promenade in Saltburn by the Sea, Redcar & Cleveland, a public realm revitalisation project, was selected. The case study involved a number of activities and liaisons with communities and stakeholders including Saltburn Forward, Redcar & Cleveland Council, and Groundwork. In relation to diverse media photomontages and pre-set simulation technology has been used extensively throughout both community meetings and the design proposal/ development stages.

In addition, Windlestone Hall School in County Durham involved decision making processes regarding the relocation of the school. An interactive real-time rendering model was presented at a series of community meetings.

In this chapter, the scenarios and case studies with many facets of computer visualisation demonstrate well how the technology is used in planning; how planning decision are made; how flexible and accessible it is; how stakeholders participate in and influence the decision making process. The case studies are not fully representative of the use of computer visualisation in the North East or in the wider UK but are indicative enough in answering the key questions: how is computer visualisation implemented in the UK planning system and what are the challenges that face computer visualisation within planning practice.

4.2 Use of Photomontages in Planning (Typical Planning Applications)

A credible photomontage is a visual representation of a proposed development that is as accurate as it is possible to be within the limits of the technology used and available costs. Although it is never possible to be perfectly accurate because of minor errors in survey work and photographic distortion, the careful implementation of a standard method will result in a negligible degree of error.

Photomontages are commonly requested by local planning authorities as additional information to support formal planning applications. Therefore, in most cases, both the position and number of viewpoints has had to be agreed with the local planning authority prior to taking the photographs. The number of viewpoints is at the discretion of local planning authorities and is dependent on the nature of the developments.

Site visits generally preceded the selection of individual viewpoints. Often, a Zone of Theoretical Visibility (ZVI)[26] map is produced prior to selection of locations, which helps

[26] Zone of Visual Influence or Zone of Theoretical View

select viewpoints. In the selection of viewpoints, a ZVI map is not only used for estimating visibility and sensitivity of the development, but adjacent areas must also be considered when identifying photomontage locations. During ZVI process, woodland blocks, built up structures, and hedgerows are often taken into account as a visual barrier.

In the case studies, the numbers of viewpoints were agreed as set out below.

Table 4.2 Case Studies for Typical Application of Photomontages

Case Study	Year	Nature of Development	Role in Planning	No. of View	Software
Herrington Country Park	2006	Forest Management	Communication Medium in meetings	3	AutoCAD, Photoshop, 3D Studio Max 5
Barnsley BSF[27]	2010	BSF Academy	Planning Condition Supplement	5	AutoCAD Photoshop, 3D Studio Max
Denham Hall Estate, Suffolk	2010	Anaerobic Digester Facilities	Planning Application Supplement - Photomontage	5	AutoCAD Photoshop, 3D Studio Max, InDesign

The in-depth case study, Herrington Country Park, utilised 3 viewpoints to produce photomontages for the steering group meeting. Average vegetation growth rates were applied in order to generate views on day 1, year 5, and year 15. In the case of the Barnsley BSF study, 5 viewpoints were agreed with the planners which took into account visual impacts on the surrounding area such as visually sensitive areas like housing, main roads etc. Moreover, the local authority requested 5 viewpoints for the Denham Hall Estate Project. There are no guidelines on the numbers of photomontages required, but a wind energy development tends to require a greater number of images than other kinds of development.

This can be carried out quickly and quite accurately using a combination of Digital Ground Modelling (DGM) software and Computer Aided Design (CAD) software. It must be remembered that the output is as accurate as the data used. Zone of visual influence (ZVI) or Visual Envelopes of any development can be refined by inputting elements such as buildings in the terrain model of an area. In both cases, on-site checks are needed to ensure that the final ZVI or VEM is as accurate as possible. ZVIs can be developed from cross sections but this is considerably more laborious WILSON, S. (ed.) 2009. *Guidelines for Landscape and Visual Impact Assessment,* London: Taylor and Francis..

[27] Building Schools for Future

Wind energy development is currently considered in the UK to be visually sensitive. According to European Directives' Annex One and Two[28], together with other environmentally significant developments, the assessment of a proposed wind farm requires an EIA. The European regulations are also implemented in local planning[29].

The regulations (The EC Directive 1985) require that certain types of projects, which are likely to have significant environmental effects, should not proceed until these effects have been systematically assessed. The regulations apply to two separate lists of projects[30].

Landscape and Visual Impact Assessments on wind turbines require viewpoints taken from a wider area. Sometimes, a viewpoint range could include a 20-30 miles radius; however, as the wind turbines in the Barnsley BSF case are relatively small and it is a single turbine the local planning authority excluded the need for an extensive analysis.

Photographs for the case studies were taken using a Nikon D70 Digital SLR with a 35mm lens (with the magnification ratio of 1.5 the digital SLR gives a 52.5mm lens equivalent which is as close to a 50mm lens as possible using a digital SLR) mounted on a Manfrotto tripod which built in level for accuracy. Photos were then combined (stitched) – if required - using PhotoVista Panorama or Hugin software. Photograph locations were accurately recorded using a Garmin Etrex GPS system and verified against Ordnance Survey data. A minimum of three reference points within each view were recorded to ensure accuracy and assist in preparing the photomontage.

On digital cameras, where the image sensor is often smaller than the 35mm negative image on traditional film cameras, the focal length of the lens used must compensate for the effective magnification resulting from the smaller sensor. For example, in the case of a camera such as the Nikon D70, a 35mm prime lens must be used in order to achieve a standard field of view. The smaller sensor in the D70 results in a magnification factor of 1.5 and this, combined with a 35mm lens gives an equivalent of a 52.5mm (1.5 X 35) focal length, which is within the "standard" focal length range.

The use of a prime lens rather than a zoom lens is important for two main reasons:

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[28] The EC Directive 'The Assessment of the Effects of Certain Public and Private Projects on the Environment' adopted 27 June 1985.

[29] Brought the EC Directive into force in the UK through the implementation of:

- Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (England and Wales) amended 1999 to:
- The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.

[30] www.opsi.gov.uk Office of Public Sector Information (formally HMSO, under the legislation section)

1. In general, a prime lens will result in a better image quality, particularly with respect to distortion. It is most important to reduce distortion to an absolute minimum so that the constructed perspective can be matched to the photograph and so that adjacent images in a panorama can be spliced seamlessly.
2. The second reason is a practical one. It is not always easy to accurately set the focal length on a zoom lens and it is not, therefore possible to be absolutely consistent about the focal length setting from one photo location to the next or between different projects. The use of a prime lens removes this uncertainty, producing low distortion images with a consistent focal length,

A GPS device which was used in this research is capable of receiving WAAS[31] (Wide Area Augmentation System) satellite signals[32]. Initial reception of the WAAS signal may take up to 15-20 minutes, then 1-2 minutes afterward.

These digital raster images were introduced into Adobe Photoshop image-processing software for the landscape management manipulations. The final digital images were printed using a printer to produce before/after or before/day1/year5/year15 for the evaluation. Using tools for image manipulation within Adobe Photoshop, the following forest and landscape management alternatives were produced on top of each original photograph.

Photographs are produced on A3 landscape format sheets showing “Before and after” views along with the technical information relating to the photography e.g. grid reference and elevation.

Many developments require a formal environmental impact assessment (EIA) to be undertaken and the incorporation of the results into an environmental statement (ES). One of the findings in the best practice for visual assessment of wind farm report was that Zones of Visual Influence (ZVI) are never accurate and other tools such as photomontage are never wholly realistic.

[31] WAAS is an FAA (Federal Aviation Administration) funded project to improve the overall accuracy and integrity of the GPS signal for aviation use.
[32] There are currently two WAAS satellites that can be received in the US, one over the Atlantic Ocean and one over the Pacific Ocean, in a geo-station any orbit over the equator. Effective use of the WAAS satellite signal may be limited by surveyors’ geographic location in relation to those satellites. WAAS satellite signal reception requires an absolute clear view of the sky and works best when there are no nearby obstructions such as buildings or mountains.

In the following sections, individual case studies are described in context, brief methodology, and what have been produced outputs.

4.2.1 Denham Hall Estate, Barrow

Table 4.3 Facts for Denham Hall Estate Case Study

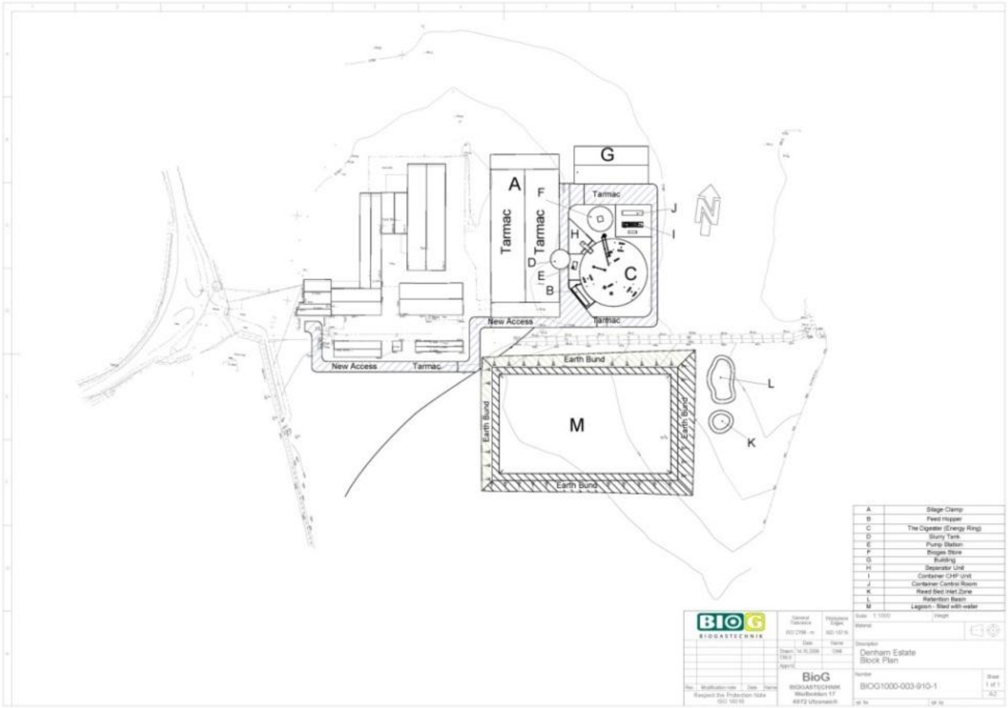
Project	**Denham Hall Estate Development Landscape and Visual Impact Assessment**
Date/Duration	2009-2010
Author's Role	Production of Photomontages including viewpoint selection involvement, site survey, modelling, and rendering.
Nature of Work	The development includes extension of anaerobic digester facilities within a existing farm land in Suffolk. AS a part of EIA and Landscape and Visual Impact Assessment, the photomontages were presented to the residents adjacent and submitted to Local Planning Authority.

Production of photomontages (five viewpoints) carried out as a part of Landscape Visual Impact Assessment on a proposed Anaerobic Digester Plant at Denham Estate, Barrow, near Bury St Edmunds. The purpose of the assessment was to consider the impact which the project will have during its development and operational phases and subsequent demolitions.

The construction of the on-farm Anaerobic Digester Plant also included a Combined Heat and Power Units. The proposed layout, landscape design and materials have been developed to ensure that they will enable the plant to function efficiently but also to appear as being connected or ancillary to the farm setting.

The environment consultants carrying out the assessment consulted with the Suffolk County Landscape Office and a landscape scheme had been prepared to address not only the visual impact of the proposed project, but also the intrusion on the landscape of the existing buildings of Denham Estate.

Figure 4.1 Layouts of the Proposals indicating the extent of the development (Little Green Consulting Ltd.)



By following the proposed layout of screen planting, together with the proposed planting mix, it aims to accommodate the proposal in the mitigated (screening) landscape. This is further supported by a maintenance plan that covers Year 1 to 5 in detail, and then sets out the requirements for Years 5 to 20, thus ensuring the healthy establishment and maintenance of the proposed landscape scheme.

Figure 4.2 Landscape Mitigation Proposals – Hedges, Screening Planting (Little Green Consulting Ltd.)

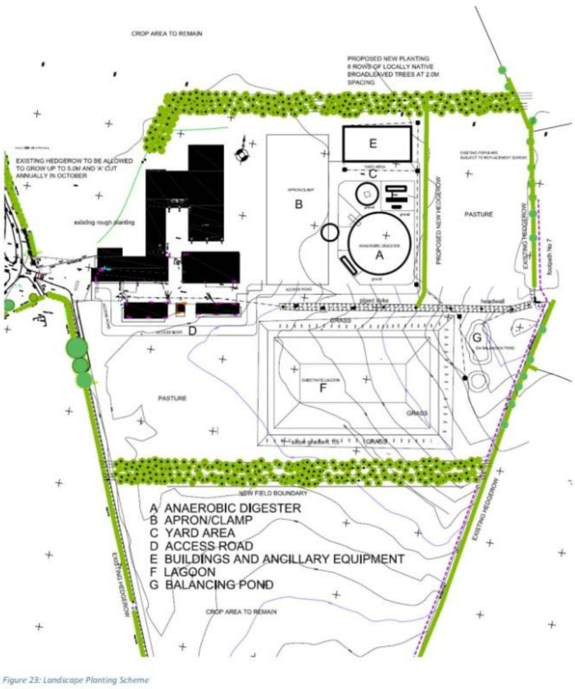


Figure 4.3 Viewpoint 3 Including Photo Location, Survey Information, and Existing Photographs

Day 1 (Wireframe)

Day 1

5 Years

15 Years

Viewpoint Location

Rendering of Landscape Mitigation

Growth Rates of Trees is applied approximately 30-50cm per year.
Landscape mitigation proposed (LVIA, Nov. 2009) that trees are planted in the height of between 600mm and 900mm.

	Day 1 (completion)	5 Years	15 Years
Hedgerows	450mm (note. annual maintenance trimming)	2m	2m
Tree heights (not exceeding)	600 - 900mm whips with plastic rabbit guards	2.5m	8m

Note:

- 3D models have been prepared based on site layout, BioG1000-003-910-1.dwg and elevation BioG1000-003-960-1.dwg.
- Landscape mitigation has been located in accordance with Figure 23. Landscape & Visual Impact Assessment - Denham Estate, An assessment of the Impact of an Anaerobic Digester, 11th November 2009.

Before (90 degree)

The proposed site for the Anaerobic Digester Plant is immediately to the east of the Denham Estate Farmyard. Figure 4.1 (page 85) shows the layout of the plant in relation to the existing farm buildings.

In order to understand the site, five viewpoints were considered with photographs taken from the south, east, north and west of the site together with views across Hallfield from Denham Hall.

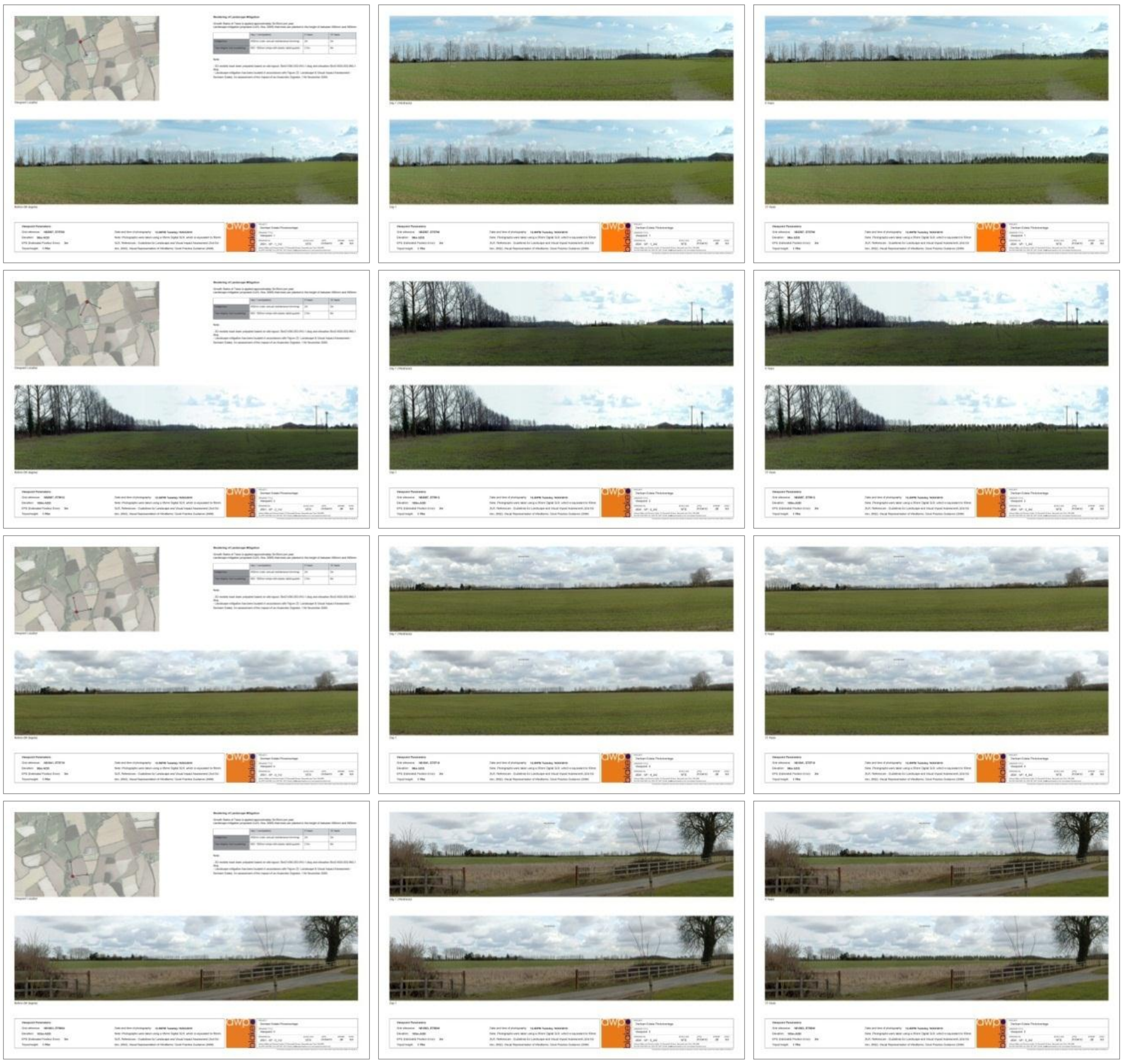
Whilst the project does not require the removal of any trees, shrubs or hedgerows, the opportunity is being taken to improve the existing visual impact of the Denham Estate through the planting of belts of trees to the north and south of the farmstead, which will extend to the field boundary to the east. The Phase One Habitat Survey has already identified that the predominant vegetation in the landscape is Hawthorn (*Crataegus Monogyna*), Field Maple (*Acer Campestre*), Grey Poplar (*Populus Canescens*), Ash (*Fraxinus Excelsior*), Elder (*Sambucus Nigra), and* Acer *(Pseudoplatanus*).

Figure 4.3 (page 93) illustrates one of the viewpoints in the full production process. It comprises of three A3 sheets per each viewpoint. The first sheet provides the existing view, proposed viewpoint, photographic survey information, and brief for landscape mitigation. However, the second and third sheets contain the proposed information, with wireframe, mass rendering in day 1, year 5 and year 15 with landscape mitigation (screening) options. In particular, information of proposed vegetation is important for estimating typical growth rates within the first 15 years.

Amongst the above photomontages, a wireframe view is included, which illustrates the extent of the development. It provides a comprehensive view without any obstructions such as built up structures and existing vegetation. Therefore, the wireframe view was utilised in order to view and measure the full extent of the development.

Figure 4.4 shows the remaining photomontages produced for the Denham Estate case study. These contain a mixture of long and short distance views from the objects. Mostly, they were selected on the basis of the visual sensitivity of the development by the local planning authority. In particular, some views from the adjacent residences from which objections had previously commented. All the photomontages are produced in the same format: three A3 landscape orientated sheets.

Figure 4.4 Viewpoint 1, 2, 4, and 5 (Courtesy of AWP and JBA Ltd.)



In 2010, the photomontages were submitted to the local planning authority as a part of Environmental Impact Assessment and Landscape Visual Impact Assessment. Planning permission was subsequently granted despite objections from some of the neighbouring residents.

4.2.2 Barnsley BSF, 5 Academies, Barnsley

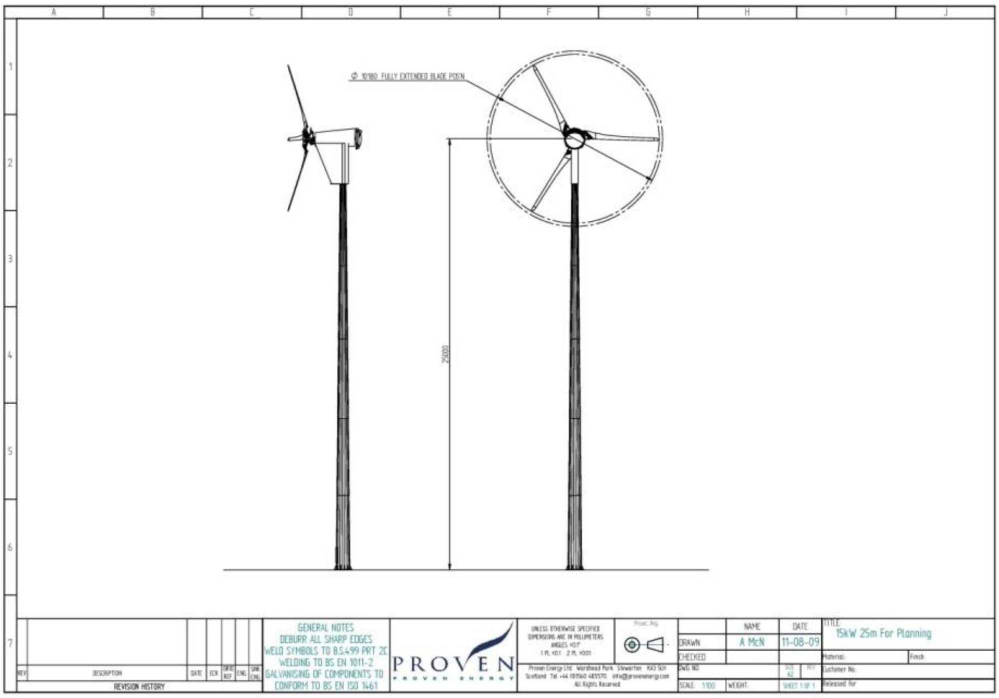
In the period between 2009 and 2010, landscape design consultants, Anthony Walker and Partners (AWP), carried out landscape designs for 5 academies in Barnsley. They are all constructed under the BSF programme and all these academies proposed wind turbines. The local planning authority requested photomontages as a part of the supplementary planning document and AWP was appointed to produce photomontages of the wind turbine for all five academies.

Table 4.4 Facts for Barnsley BSF Case Study

Project	**Barnsley BSF Photomontage of Wind Turbine for Development Management (Discharge of Planning Condition)**
Date/Duration	2009-2010
Author's Role	Production of Photomontages including viewpoint selection involvement, site survey, modelling, rendering, discussion with planners/ the school, and submission to Barnsley City Council.
Nature of Work	Building 5 news academies were proposed as a part of BSF (Building Schools for Future) programme. Single wind turbine were proposed for each academy and Barnsley City Council asked to landscape consultant to carry out feasibility studies, visual assessment and the Council imposed a planning condition of a Landscape Visual Impact Assessment for the turbines. After consultations with the schools and planning officers with the photomontages, the planning conditions were discharged.

The academy sites are all located in Barnsley and wind turbines are located either within the grounds or on the buildings. All the academies are located near or adjacent to residential areas; however, the visibility of the turbines is dependent on the actual location of the turbines within the sites. Turbine numbers vary between one and five and are relatively small at around 15Kw and 25m height from ground to hub level.

Figure 4.5 One Type of Turbine in Barnsley Academies



Data was collected within a radius up to 5km and included the following:

- Digital OS map information at 1:25,000 scale;
- Relevant Landscape Policies from Structure and Local Plans;
- Any other applicable plans or policies, i.e. the Tees Forest Plan;
- Regional /local landscape studies and character assessments;
- Listed buildings, Conservation Areas, Scheduled Ancient Monuments etc.;
- Definitive Rights of Way;
- Tree Preservation Orders; and
- Landscape features - vegetation cover, watercourses.

Wireframes were purchased through the Ordnance Survey to facilitate the production of photomontages.

- Digital OS and contour information of the site and surrounding area (up to 30km radius);
- 3D terrain information; and
- Full details of proposed turbine locations and locations of other site infrastructure (and of turbines).

Viewpoint locations were agreed with the Local Planning Authority prior to taking on-site photographs. Site visits were carried out by two landscape consultants. Similar to the other case studies, photographs were taken using a Nikon D70s Digital SLR with a 35mm fixed lens (with the magnification ratio of 1.5 the digital SLR gives a 52.5mm lens equivalent which is as close to a 50mm lens as possible using a digital SLR) mounted on a Manfrotto tripod with built in level for accuracy. Photos were then combined using PhotoVista Panorama software. Photograph locations were recorded using a Garmin Etrex GPS system and verified against Ordnance Survey data.

Two site visits were carried out, the first to verify/refine baseline data for the area and identify potential viewpoints and the second to undertake a detailed visual assessment. Information collected included the following:

- Record of land cover and features on the site;
- Record of the land use and landscape quality of the surrounding areas;
- Identification of key views and the principal visual receptors (or groups of receptors) within the surrounding area
- Identification of the approximate zone of visual influence; and

- Collection of photographic records of the site from an agreed number of key viewpoints (to be used for the production of photomontages).

Figure 4.6 Barnsley Greenacre (2 viewpoints) – Courtesy of AWP Ltd.

Figure 4.7 Barnsley Springwell (3 viewpoints) – Courtesy of AWP Ltd.

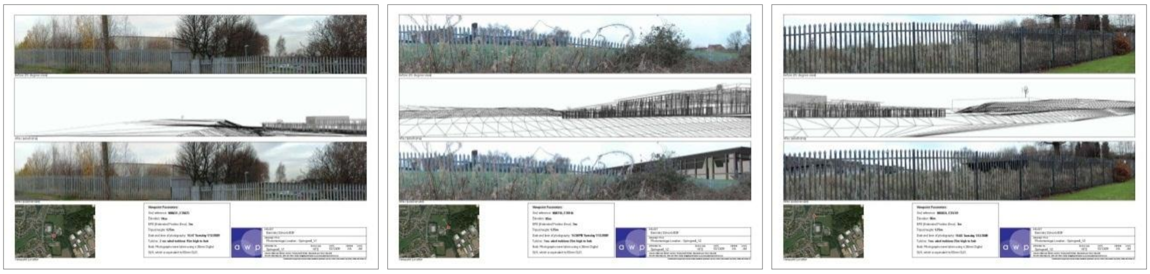


Figure 4.8 Barnsley Shafton (3 viewpoints) – Courtesy of AWP Ltd.

3D visuals were created using a combination of 3D Studio Max and Adobe Photoshop for the production of photomontages; wireframes were also created using 3D Studio Max. The 3D images were compiled into photo-sheets for each predetermined viewpoint location using CorelDraw.

The photomontages were produced successfully submitted to the local planning authority and consequently the planning conditions previously imposed were discharged.

4.3 Use of Alternative 3D Visualisation (Diverse in Media)

Three dimensional visualisation has been experimented with in some areas in planning in the last decades. Such experiments have included pre-set path simulation, real time rendering, and panoramic VR.

First of all, the pre-set path simulation (so called ‘animation’) is a simulation with a fixed viewing path. Since the viewers’ choice of viewpoint is restricted, such inflexibility means that animations are typically implemented within the later stages of a project such as a marketing or final presentation.

Nevertheless, pre-set path simulation can achieve a high level of realism (either photo-realistic or with 3D geometry textures). Hence, creating pre-set path simulations is more complicated than photomontages in terms of the physical 3D geometries involved. Producing animation requires particular skills from 3D authorisation to rendering.

Table 4.5 Software Usages for the Case Studies

Case Study	Modelling	Software
Herrington Country Park, Sunderland	Modelling of new community forest proposals. 3 real-time rendering, 3 photomontages, 1 interactive plan was produced for steering group meeting and consultation.	3D Studio Max 5, Adobe Photoshop, Adobe Premiere Pro, Director, Flash
Saltburn Top Promenade	Modelling of a public realm in Saltburn By the Sea. 5 pre-set path simulations produced including flythrough and walkthroughs for public consultation.	3D Studio Max 5, Adobe Photoshop, Adobe Premiere Pro
Windlestone Hall School, Co. Durham	Modelling of new school in County Durham. 3 real-time renderings were produced for public consultation.	3D Studio Max 5, Adobe Photoshop, Adobe Premiere Pro, Director

Moreover, in the last decade, researchers have begun to explore technology to represent virtual environments for planning as experimental platforms. Within the current technology, real-time rendering gains greater interactivity with viewers; whereas, realism is often compromised. Because of this nature of flexibility, it is usually employed as part of the consultation process.

In the case studies, virtual environment (real time renderings) was applied to both the stakeholders' consultation at Herrington Country Park Forest Management and the public meetings in Windlestone Hall School Relocation Project.

In those two cases, consultees/interviewees were aware of the development and knew the site fairly well, so realism was not quite as important as it otherwise might have been. In particular, the main purpose of the Windlestone Hall School Relocation Project was whether (1) the proposed buildings were visible from nearby house windows and (2) whether landscape mitigation measures were properly applied. In this sense most of the geometric elements on the ground were created in a simple geometric format such as elliptical lolly pop trees, simple roof line houses and straight lines of hedges and woodland blocks.

Moreover, this simplified geometric approach helped to present the model. By reducing the number of polygons and textures to render in real-time, the hardware[33] renders the model without any serious halts and flickers in normal graphic engines[34].

There are a number of software packages for authorising three dimensional geometries for both animation and real time rendering. In the case studies, Autodesk's 3D Studio Max was generally used to authorise 3D contents i.e. create environmental geometry, generating atmosphere, camera, and rendering. In addition, Adobe Photoshop was used for creating textures for 3D geometries.

In both case studies of Herrington Country Park and Windlestone Hall School Relocation, real-time rendering technology (virtual environment) was used with Adobe Director and 3D Studio Max software.

Macromedia Director software used to design navigation functions for the virtual environment. A 3D scene was built by the Lingo (an Object Oriented[35] Language), which

[33] 64bit Single Core 2.0GHz CPU and 128 MB Graphics Card
[34] OPEN GL used in the case studies
[35] A simple explanation of this made by UTIAN, D. 2003. Learning to program with Lingo. Available: http://www.fbe.unsw.edu.au/Learning/Director/Lingo/programming.asp [Accessed 16 January 2007]. Object Oriented Programming (also known as OOP) is a form of programming where the code is broken down into self-contained units (called objects), each of which performs a single function. When that function is needed, the application calls the objects by sending a stream of information (called messages). Unlike OOP, procedural programming is a way of writing code as a list of instructions, telling the computer, step by step, what to do. For example, a procedural program may instruct the computer to read a number, multiply it by 6, display the result. The instructions are activated in the order they are given. Computer languages like BASIC, Pascal, C and FORTRAN are procedural. Procedural programming is good for small projects. It is the most natural way to tell a computer what to do, and the computer processor's own language, machine code, is procedural. So, the translation of the procedural high-level language into machine code is straightforward and efficient. Lingo is an object oriented programming language, as is C++ and Java.

can read a variety of 3D formats (such as W3S). Having built the scene, a 2D map of the area is presented to help the interviewees identify view points and pathways between them. Several viewpoints may need to be specified for a walk through following a curved path. Each navigator was able to control the speed and direction of the walk through using the keyboard and mouse controls. As well as the navigation functions, background sky became changeable by a simple button click in order for viewers to explore the 3D models with a range of environmental options. In addition, options for different vegetation growth were offered.

Two sources of input data were used to provide terrain and texture surfaces: aerial photography and vector models. This combination takes advantage of digital photogrammetric techniques for creating the input DEM[36] including as it does certain terrain model features that will obscure the view of developments (i.e. turbines, warehouses, schools etc.) from an observer (such as a block of woodland), and the detail of specific features designed in CAD software, such as individual trees.

In the Windlestone Hall School case study, in particular, high resolution aerial photographs were supplied. Aerial photography means near vertical, panchromatic, aerial photographs, at a scale of 1:24,000, were scanned at 400 dpi[37], and supplied by the local planning authority to produce a DEM and the surface texture. Terrain surface needs to be a high-resolution DEM were derived, with a horizontal resolution of 1mX1m and a vertical resolution of 1m. Draping an ortho-photograph over the elevation data provided a textured surface within the VR model. The ortho-photograph was produced with an output resolution of 0.5m, using a nearest neighbour re-sampling algorithm in the image transformation, utilizing the Lingo in Director and 3D Studio Max software packages.

Vector models of surface features can be derived from two sources:

1. A CAD package (AutoCAD) was used to construct a model of the Windlestone Hall School and Herrington Country Park. These models were then converted into DXF format for use in AutoCAD.

[36] Digital Elevation Model
[37] Dot Per Inch

2. Modelling software was used for the creation of 3D models of trees and shrub vegetation, which enables a number of parameters that describe the shape, size and structure of a tree, to be set by the user.

A visibility census has been derived from the DEM by calculating the number of 2m x 2m cells that were visible from each other, to produce a score of relative visibility. That is, the greater the number of cells that are visible from any one cell, the higher the visibility score of that cell. The visibility of the locations of individual houses and woodland blocks can then be compared, and sites chosen according to their lower, or higher, levels of visibility.

The ground model is produced by draping the ortho-photograph across the DEM and then placing, scaling and orientating the buildings, woodland blocks and other built-in forms in the model at locations specified in the draft planning proposal. This step used the 3D Studio Max software from which the model was exported into W3D format, and this in turn produced a view of the landscape incorporating the development of the country park and school relocation.

The Panoramic VR format allows a full 360 panorama to be viewed on a normal computer monitor. The user can control their view angle and zoom extent and undertake quite a realistic exploration of either an existing location or one generated by computer.

The production of the specified environment requires the collection of photographs, their combination into panoramic images, and their geo-referencing and linking in software that will display them appropriately so that navigation can take place. The data collection aspect of this process is relatively straightforward, hence the attraction of the digital data type for fieldwork teaching. A digital camera with the equivalent of a 35mm lens requires nine pictures in order to record the compete horizon through 360 degrees with adequate overlap. Alternatively an analogue camera can be used and the developed images scanned. A 28mm lens uses approximately seven photographs in order to record the required information.

Once this data is acquired, a number of software packages are available to stitch the pictures into a single image. These include Spin Panorama, QTVR and PhotoVista. The process usually involves the selection of the images that make up a panorama, an automated preview and an element of adjustment by the user in order to ensure that the images are correctly matched. In the preview stage the software adjusts the image to take account of the distortions generated by the specified lens, detects common features in adjacent images, and overlays the images to create a single strip of imagery. The success of the initial operation depends upon the software, the degree of contrast between images, and the existence of recognisable shapes in the area of overlap between successive photographs.

The software is sufficiently robust to take account of minor variations in the height at which adjacent images are taken and so eliminates the need for a tripod or panoramic tripod head. The resultant data collection is a quick and simple process that simply involves pointing and clicking. The exact positioning of each image can be varied and confirmed manually before a final stitching process combines the photographs by blending the areas of overlap. If saved as standard images the data form a rectangular strip with left and right ends that represent a break in the information, but which join precisely and seamlessly if connected together. An alternative technique for collecting suitable photographic data is to use digital video and suitable software. By panning a video camera steadily around the horizon, data is recorded from which a single panoramic image can be created with specialist software such as Video brush Panorama.

A number of options exist for displaying panoramic images. Whilst proprietary software and formats allow spinning, zooming and linking to other images, the specification under consideration here requires the flexibility to embed the images within specifically-programmed software functionality. A number of options exist for doing this, including the Java API for QuickTime VR, which provides the ability to embed QTVR objects in Java programs. In this instance the data is presented using the Tcl/Tk[38] scripting language, which provides a series of high-level programming commands, functions and objects that are suitable for highly-dynamic cartography. These include support for the display and manipulation of digital imagery, the specification of vector graphics with particular observer-related behaviours, and the ability to issue external commands that run additional computer processes. The high-level nature of the environment makes it particularly suitable for the kinds of rapid prototyping associated with experimental software design and the investigation of new types of cartography and map use.

[38] Tcl/Tk is a scripting language. It is commonly used for rapid prototyping, scripted applications, GUIs and testing. Tcl is used on embedded systems platforms, both in its full form and in several other small-foot printed versions.

4.3.1 Herrington Country Park, Sunderland

Herrington Country Park is situated on the outskirts of Sunderland in the northeast of England. Originally an opencast mine, the park now provides an ideal attraction for outdoor recreation, picnicking and major events including the Durham County Show.

Table 4.6 Facts for Herrington Country Park Case Study

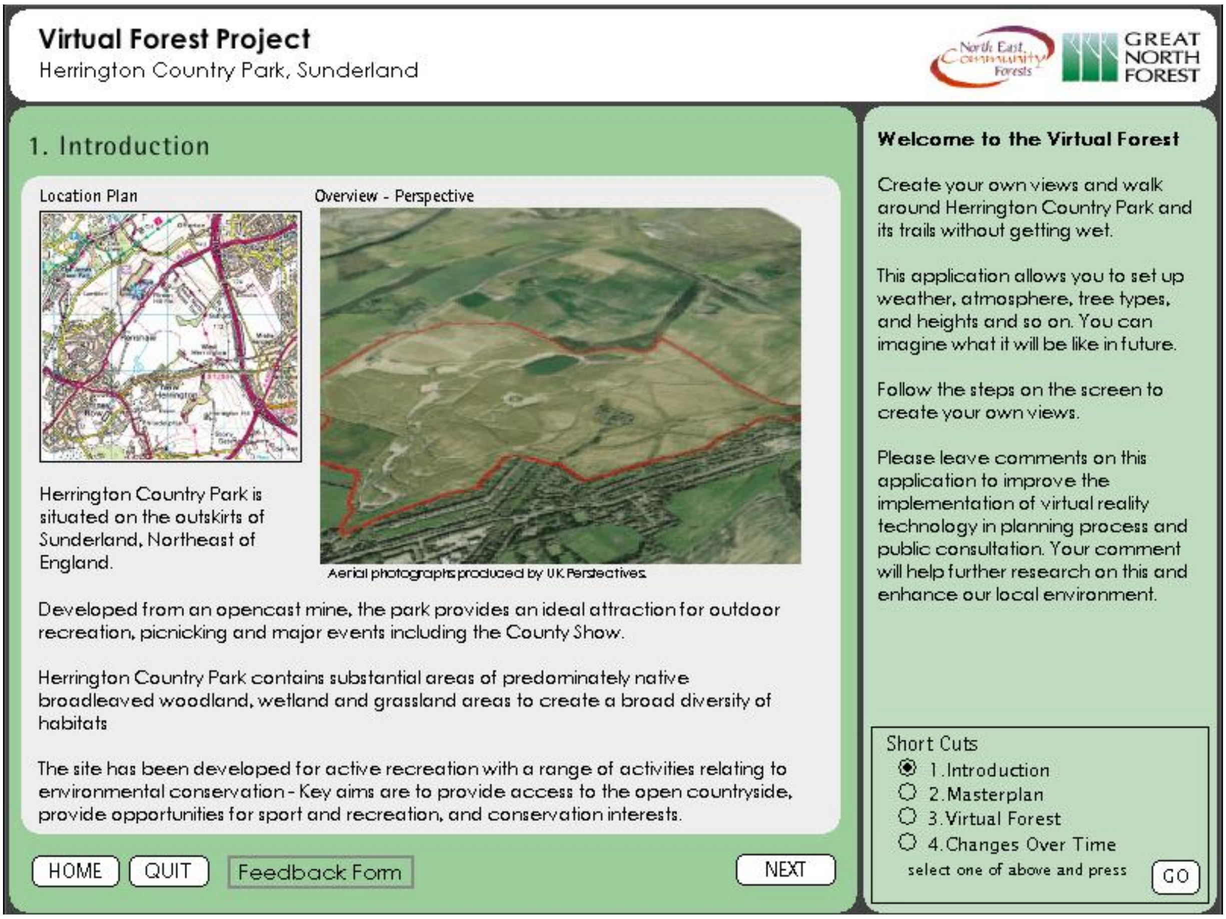
Project	**Herrington Country Park Forest Management**
Date/Duration	2006
Author's Role	Involving a community forest management project, carrying out forest modelling, producing media, visualisation, participating meetings with stakeholders, and presenting forest management models to steering group meetings.
Nature of Work	Great North Forest became a partner with the author producing computer visualisations for community forest management plans. Working with GNF, the author participated various consultations and produced computer visualisations were presented and utilised for many participatory events including steering group meetings. The computer visualisation produced became communication media to convey ideas, opinions of stakeholders.

The site contains substantial area of predominately native broadleaved woodland, wetland and grassland which together create a broad diversity of habitats. The site has been developed for active recreation with a range of activities relating to environmental conservation. Key aims are to provide access to the open countryside, provide opportunities for sport and recreation, and conservation interests.

North East Community Forest has prepared a forest management plan for the Herrington Country Park. This included consultation with local planning authorities, The Forest Commission and other stakeholders.

The management plan contains forest design, public footpath, location of artworks etc. and computer visualisation aided to produce the management plans setting up consultations and designing plans of the park facilities, forest growth and location of other elements.

Figure 4.9 Interfaces for Herrington Country Park Case



The case study includes modelling of various new visualisation media explored in planning: photomontage, panoramic VR, real-time rendering, and interactive masterplanning.

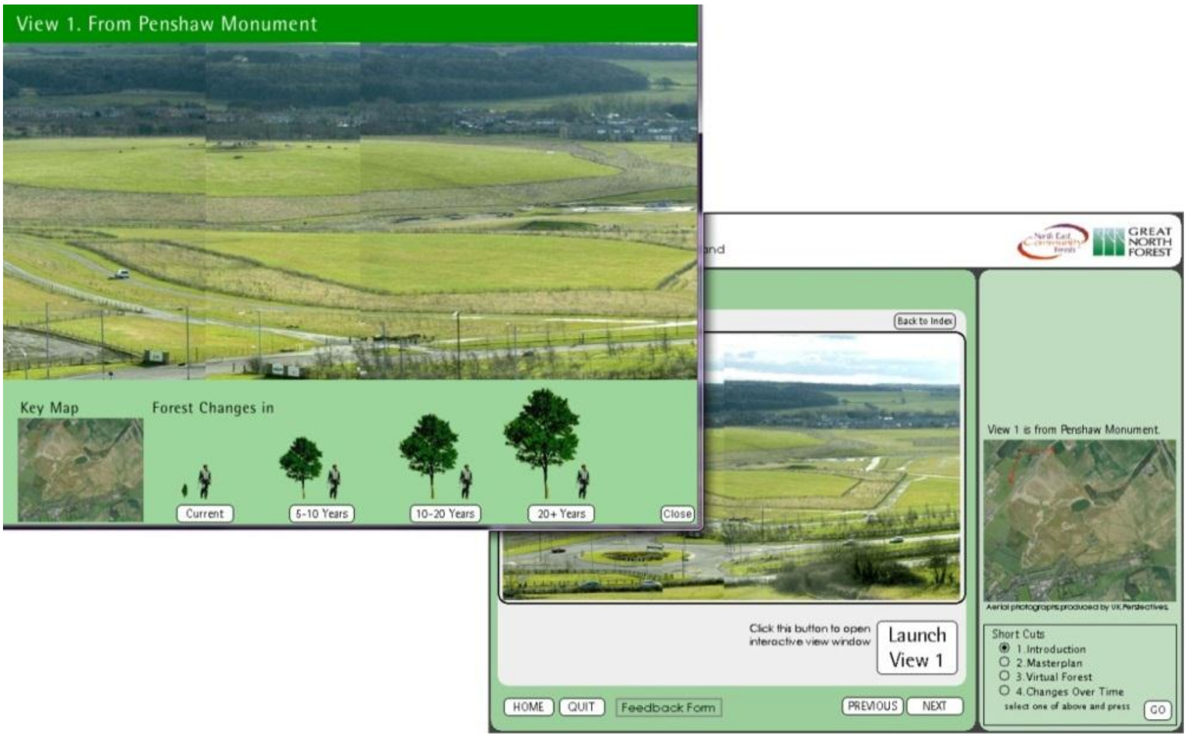
Figure 4.9 indicates the interface of the case study. It is composed with an introduction, masterplan, virtual forest and panoramic VR. The project provides shortcuts for visualisations and feedback, allowing users to record their opinions electronically.

The introduction describes the location and overview of the project. In particular, it illustrates the boundary of the project in pre-set path simulation: a flyover with the site boundary, which is a ground model (DTM) with aerial photograph draped onto and rendered in jpeg sequence.

A distinctive feature of the Virtual Forest is the ability to change the timescale viewed; the options of tree growth in 10, 20 and 30 years based on growth rates. This became significant in terms of planning footpaths and overall human usage within the management of the community forest. The interactive model also visualise artwork, footpath, board walk, park furniture which helped to design the park’s landscape in virtual space.

Moreover, panoramic VR with 10, 20 and 30 years forest change options (Figure 4.10) provided 360 degree landscape views in major viewpoints.

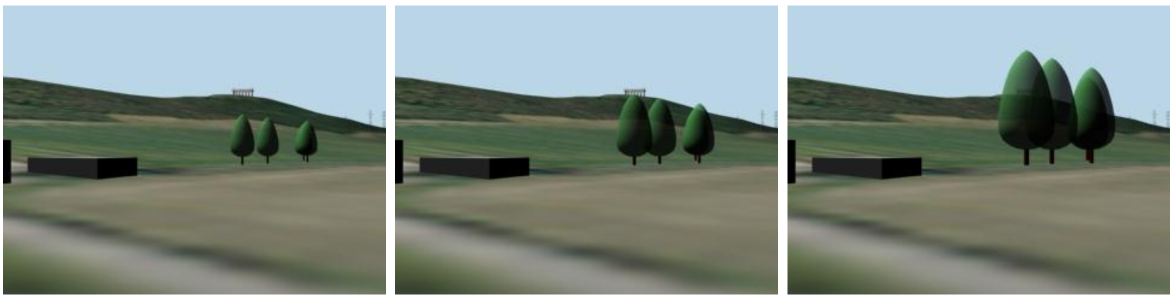
Figure 4.10 Panoramic VR in Herrington Country Park Case



In the case study, phasing of forest growth has been defined in consultation with North East Community Forest. For instance, Phase 1 indicates vegetation growth between years 0 to 10, Phase 2 simulates years 10 to 20, and Phase 3 represents vegetation the growth of years 20 to 30.

Average tree growth rates were applied into the real time visualisation to provide a representation at different timescale.

Figure 4.11 Indication of Tree Growth



As described in Chapter 3, Lingo scripting is extensively used for producing real time rendering visualisations. This includes modelling such as vegetation, path and atmosphere, keyboard controls for first person movements, and phasing interfaces.

Figure 4.12 Real Time Rendering in Herrington Country Park Case

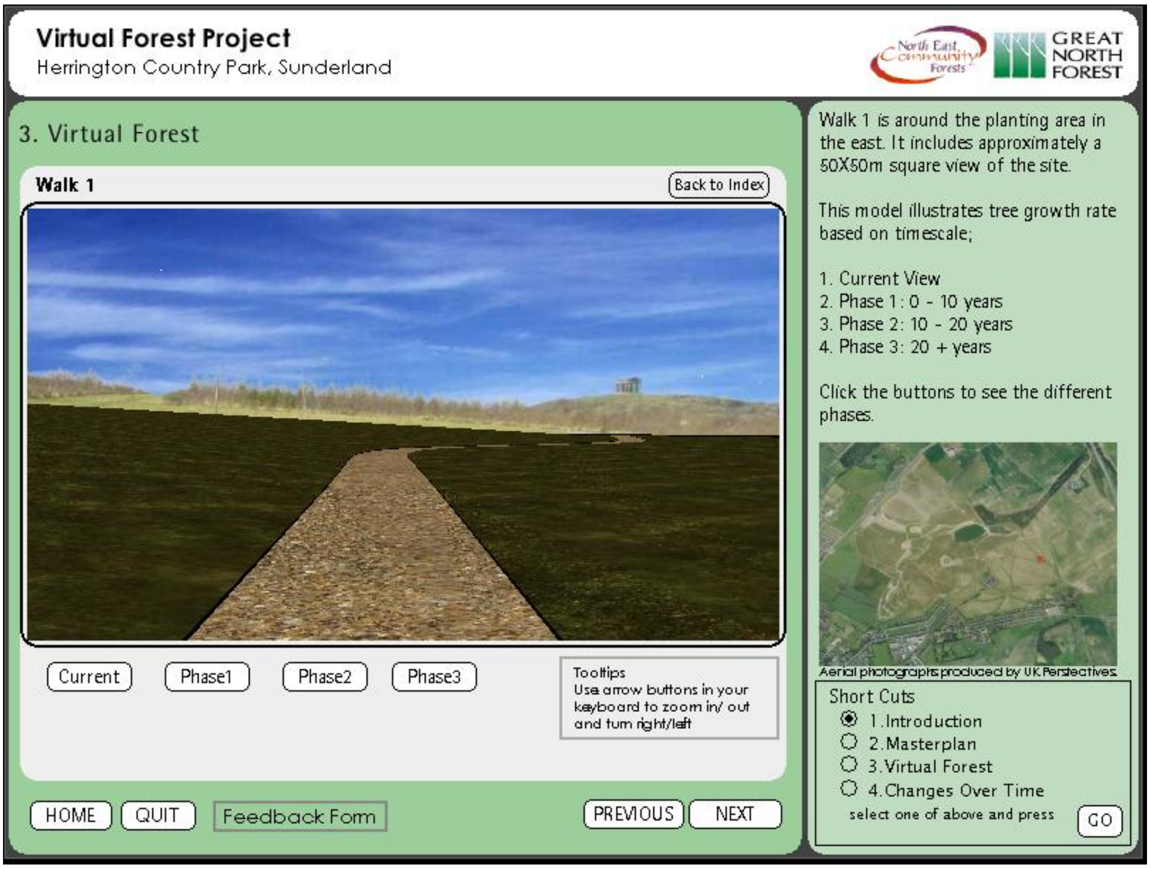
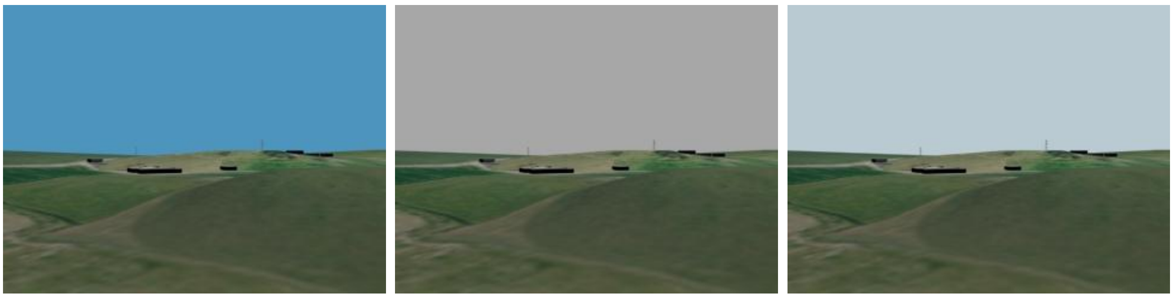


Figure 4.13 Weather (sky) Changes



Most of the interviews carried out in the Chapter 6 were also produced from Herrington Country Park case study, which includes the diverse range of computer visualisation currently used in planning. The models serve different purposes and perceptions are dependent on their profession and experiences. Chapter 6 will reveal the interview results and analysis.

4.3.2 Saltburn Top Promenade, Saltburn by the Sea, Redcar and Cleveland

Table 4.7 Facts for Saltburn Top Promenade Case Study

Project	**Saltburn Top Promenade Public Realm Project, Saltburn by the Sea**
Date/Duration	2007
Author's Role	As a project manager, the author carried out design development, construction detail and contract administration for the project. In particular, during public consultation, the author produced various computer visualisations for community groups, artists, public and other stakeholders to communicate. Throughout the process, computer visualisation was produced and utilised by the author.
Nature of Work	A public realm refurbishment project located in a Victorian town in North East England, Saltburn by the Sea. The project included landscape design, planning permission preparation, public and stakeholder consultation, and contract administration. Since the site was within well-developed communities areas, a number of interest, concerns, and attention were drawn into the project.

Saltburn Top Promenade and Cliff Lift are located in the eastern part of Saltburn by the Sea, Redcar & Cleveland in the north east of England. Opened on 28th June 1884, this is the oldest remaining water-balance cliff lift in Britain. The height of the lift is 120 ft. above the shoreline and the length of the track is 207 ft. The lift was refurbished with stained glass windows and links Saltburn pier, one of the few left in the country, with the town.

Saltburn was developed as a Victorian resort. The foreboding cliffs tower above the crashing North Sea which shadows the sand and shingle beach. A recently restored pier extends 200 metres from the shoreline. The sea at Saltburn offers some of the best surfing conditions in the country.

Figure 4.14 Site Photos - Exiting Cliff Lift (Before construction)

The project was managed by Groundwork South Tees and White Young Green Environmental was commissioned to provide design and contract administration services. Construction work was carried out by Seymour Civil Constructions who are based in Hartlepool.

As a community project, a number of consultations were made from conceptual development, funding and construction issues with Saltburn Forward, a community group, local residents, police and local planning authority. Moreover, a local artist was involved to design specific features such as fossil patterns in conjunction with neighbouring schools.

The promenade is located in a stunning position at the top of the Saltburn Cliff Lift, with panoramic views over the adjacent coastline. The initial scheme proposed a series of 'wave' pattern ramps and steps, a viewing platform, seating, paving, artwork and telescopes. A palette of pre-cast and in-situ concrete incorporating 'ammonite' features was utilised to construct the paving retaining walls and the fossil garden.

Most of the Ordnance Survey information including existing base plan, topographic survey and rasterised base map was supplied by Groundwork South Tees and Redcar & Cleveland Council.

Figure 4.15 Three-Dimensional Visualisation for Saltburn – Courtesy of WYG Environmental Ltd.

Existing survey drawings included a topographic survey (.dxf), and base plan (.dwg) that were in vector formats, which were compatible within AutoCAD software. The proposals were drawn in the same file format. Then, 3D Studio Max was used to generate a TIN[39] model and other three dimensional elements. Bitmap textures were superimposed on those elements to increase the level of detail.

Throughout the design stages, two forms of media have been produced; pre-set simulation and photomontage.

Computer visualisation models produced in the case study tried to contain as much information as possible including colour, texture, and materials. By doing that, local communities were well informed and able to be guided to make decisions on the design and construction issues. As an easy tool for communities, visualisations were implemented extensively for the project and decision making processes.

Figure 4.16 Community Consultation - Saltburn Forward Progress Meeting

Although initial proposals were agreed by local communities there were still a number of decisions to make as the project progressed. For instance, on the colours of materials,

[39] Triangulated Irregular Network, A TIN is a digital data structure used in a geographic information system for the representation of a surface. A TIN is a vector-based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates that are arranged in a network of non-overlapping triangles.

details of artwork and landscape furniture had to be tested and agreed by the residents. Periodical progress meetings with Saltburn Forward (community groups) were arranged with the local police force and artists also in attendance.

The progress meetings were held monthly and White Young Green, a community officer from Groundwork, and the local artist were all invited to attend the meetings. Decisions that were aided by the computer visualisation were:

1. Overall design
2. Colour of railings, ramp wall, ammonite artwork
3. Seating and telescope choices
4. Paving materials

Computer visualisations representing the above issues were shown through a projector on a wall in order to communicate to all participants at one time. Then discussion followed. Each session took about 30-40 minutes including a 10 minute presentation and a follow up discussion.

In terms of media types, animations were presented for overall design in most of the meetings. Photomontages were also used for individual decision-making process such as colour choices. After each discussion, revised models were prepared as a follow up and re-presented to the same participants before any construction works or ordering of materials was undertaken.

The revisions to the visualisation were backed up by paper-copies of each media which were made available to every consultee. In terms of colour and resolution, this is an important process to go through rather than relying on one media i.e. the projector and computer screen.

Detailed results and analysis including interviews are presented in Chapter 6. In summary, there was much appreciation of the use of computer models to aid the decision making process. In particular, computer models that contain options for alternative colour finishes to the railings and the gravel paving were the most favourably received.

However, most of respondents claimed that computer visualisation – as well as physical models - was still supplementary as opposed to traditional drawings such as plans and sections. All respondents were aware of the formal processes of the planning application and they had been involved from the concept and design development process, through to the submission of the planning application and to the completion of construction works.

4.3.3 Relocation of Windlestone Hall EBD (Emotional and Behavioural Disorders) School, Co. Durham

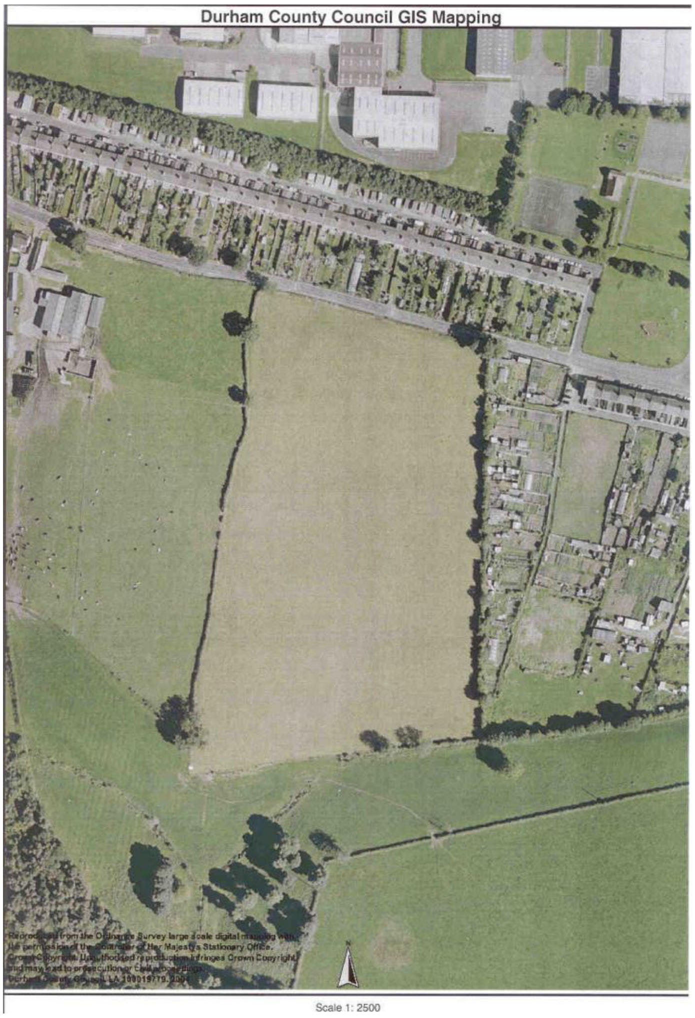
Table 4.8 Facts for Windlestone Hall School Relocation Project Case Study

Project	**Relocation of Windlestone Hall EBD School, County Durham**
Date/Duration	2006
Author's Role	As a private landscape consultant, the author was asked to produce computer visualisations for a public meeting for the project. The author produced computer visualisations (real time rendering) and participated in a public meeting which involved residents, planners, architects and school staff.
Nature of Work	As a part of feasibility study, the selection process for the ageing Windlestone Hall School was carried out. Together with residents and school staffs, this involved planning officers, Architects, Landscape Architects who acted as stakeholders. Initially three potential sites were chosen, and then computer visualisations were produced for an assessment of the most favoured site, near Deberidge Row. The selection process included a number of consultations and the computer visualisations produced played a key part in the communication.

The study area is the Windlestone Hall School, County Durham in the north east of England. The school caters for special needs children with particular emotional and behavioural difficulties. The Grade 2 Windlestone Hall was built in 1835 and was first developed as a school in 1958. It currently accommodates around 60 pupils aged between 11 and 16.

Figure 4.17 Existing Site Photograph (Windlestone Hall School Site)

Figure 4.18 Aerial Photograph (Windlestone Hall School Site) – Courtesy of Durham County Council



The basic problem is that, even after considerable adaptations and improvements, the 19th century country house is just not suitable for providing facilities for 21st century education.

Durham County Council decided to replace the buildings as part of a wider review of EBD[40] education. The other school for EBD pupils was located in the north east of the County; therefore, Windlestone's replacement needed to be in the southwest within the county and so a site near Deberidge Row was chosen as the new site for the school.

Macromedia Shockwave technology has been employed in the production of the Windlestone Hall School virtual environment. A scripting computer language 'Lingo[41]' was used to create basic geometry, texturing, and camera controller and atmosphere effects. Moreover, the interactive interface in the publishing stage was also prepared using Shockwave.

[40] Emotional and Behavioural Disorders
[41] Scripting Language of Macromedia Director

In order to create the ground model, an aerial photograph and topographical data was needed for the aerial draping process. A high resolution, true colour, digital aerial photograph of the site was provided by Durham County Council.

Figure 4.19 Windlestone Hall School Relocation – Real Time Rendering Model View 3 (Courtesy of WYG Environmental Ltd.)

A DTM[42] covers the area within which very detailed contours at one metre intervals were available for the ground model and the adjacent context. The topographic information was supplied by Durham County Council in .dxf format and was extracted from ArcGIS application.

A computerised model was presented to illustrate where a greater or lesser number of buildings would be visible (Figure 4.19).

This model used the visibility dataset as the surface over which the ortho-photograph was draped, and then the proposed buildings were added. This model is an example of a virtual landscape within which the shade of the surface represents the variable of interest to the

[42] Digital Terrain Model

user (i.e. the higher the surface, the greater the number of proposals that are visible; and the lower the surface, the fewer the number of buildings are visible).

In Figure 4.20, the height of the surface on the opposite side of the woodland block to the buildings is lower than the building side as a consequence of the screening effect of the trees which are embedded in the DEM[43] used in the analysis of visibility.

Figure 4.20 Windlestone Hall School Relocation – Real Time Rendering Model View 1 (Courtesy of WYG Environmental Ltd.)

In terms of software, 3D Studio Max uses a rudimentary approach to creating W3D files resulting in robust, but large files. These files can be modified to improve the efficiency and functionality of the model. For example, the VR model derived directly from Adobe Director[44] includes multiple copies of the same object (e.g. individual buildings and trees), with every detail of each instance described separately within the exported W3D. By defining one instance of the object within the W3D file, further instances can be created and locations allocated based on this definition. Further efficiency gains can be achieved by redesigning models to be created from primitive geometry (such as cones, boxes and

[43] Digital Elevation Model
[44] Initially it was Macromedia Director, but later Adobe acquired Macromedia.

cylinders), rather than importing them from 3D files. This can substantially reduce file sizes, and thereby improve rendering times. The models in Figure 4.21 were created using this approach.

Figure 4.21 Wireframe Model and Tooltips (Courtesy of WYG Environmental Ltd.)

A further modification to the original VR model is the addition of functionality to the virtual landscape. For example, simple program scripts have been added to the W3D file to enable to turn the turbine, and to change the height of stands of trees. These scripts are based on a subset of 'lingo' which is a high-level programming language that is widely used in the creation of 'pages' for the World Wide Web as well as Java.

Four viewpoints have been pre-set for the user, two to provide roadside views, one overlooking the site from an adjacent hilltop and a fourth a close-up view of the school.

The role of the pre-set viewpoint is to help the user navigate the VR model for two different reasons.

1. The visual impact of developments such as the location of a new school traditionally employs photomontages, with images of the view from locations of importance agreed between the planning authorities and the developer. The pre-set viewpoints in the VR model are indicative of the nature of those that would be selected for photomontages. That is, points of local interest (e.g. hill top viewpoint), laybys and road junctions. This sensitivity is significant and dependent on receptors such as listed buildings and historic monuments (views from living room could be more sensitive than from bed room). Within the VR model, the objective of

including pre-set viewpoints was to aid the users to evaluate for themselves the view from each point, and use that as a starting point for further movement around the model.

2. The second reason for identifying pre-set points is to provide the user with reference points to which they may return if 'freehand' navigation of the VR model leads them to a location, or viewing direction, within the model that is not of interest.

Extensive surveys were carried out to acquire existing information. A vegetation survey included the recording of species, height, and width within and beyond the site. Every built-up structure was surveyed and its physical dimensions and material were recorded.

Details of the proposed building (model) were supplied by the consultant architects. Other information including site history and previous land use has been collected from the local archives and during a series of site visits.

Initial consultations were held with teachers and governors at the School, who were in favour of the relocation proposals. More detailed plans were shown at a public exhibition held during May 2004 in the Town Council Offices, where stakeholders including members of public had the opportunity to review the proposals and share their opinions with representatives from both the local authority and from the School.

A real time rendering visualisation was presented during a public exhibition on May 2004. 20 participants who lived adjacent to the proposed site were interviewed. Since the participants are residents, they had much knowledge of the area and had been aware of the nature and context of the project. Other participants included the planning officer from Durham Country Council, the school staff, and Architects.

Following a brief introduction of the proposal and the visualisation exercise, all participants viewed the visualisations using a 4x3 screen ratio projector on one side of the room. All participants were given the opportunity to control views themselves through a camera controlled by a keyboard and a mouse. An open discussion then followed regarding the school relocation project as well as the real-time visualisation. After this free discussion, participants were directly asked formal questions which included:

- Their understanding of the project

- Their perceptions (benefits of computer models),
- The level of realism (level of detail), and
- The value of using such technology within the planning process (specifically for planners)

The consultation process and choices of the participants were recorded and all data collected was analysed. Prior interviews with the visualisation developer and the Planning Officers were added to the analysis process.

The most important feedback was on the level of realism. The medium used in this case was real-time rendering which gives full interaction at the expense of realism. Because the computer needs to render as the camera moves, there are certain limits on the amount of geometry, texture, and effects used in the models. Therefore, real-time rendering is usually created with simple geometry and low resolution bitmaps.

The participants indicated that the level of realism would not affect any judgement they made. Since they have detailed knowledge of the existing site, context and so on, the main focus was on the tree height, vegetation, and effectiveness of the screening rather than how realistic the models were.

4.4 Summary

As described in Chapter 3 - Methodology, five cases, which contain diversity in computer visualisation as well as typical planning applications, were examined. The preparation process for these case studies varies between months and years of consultations and public enquiry and the following modifications.

Case studies in this research are multiple and overlapped in order to investigate both the technical and UK planning aspects of computer visualisation. Hence, case studies here are divided into two main categories: case studies that examine diverse visualisation and ones that examine computer visualisations employed within typical planning applications. The Herrington Country Park case study involves both categories and is illustrated in Table 4.1 (page 85).

In terms of diverse computer visualisation, photomontages were produced for Herrington Country Park, Denham Hall Estate, and Barnsley BSF. Three dimensional visualisations such as animations and real time rendering techniques were utilised in the cases of Herrington Country Park, Windlestone Hall School (real time rendering), and Saltburn Top Promenade (animation).

On the other hand, in typical planning applications, consultations (stakeholders and steering group) were undertaken at Herrington Country Park; whereas, Landscape Visual Impact Assessment employed photomontages in the Denham Hall Estate case study. One of the planning conditions required the submission of photomontages of the proposed wind turbines at Barnsley Building Schools for Future case study.

The case studies demonstrated how the technology is used in development management processes such as planning decision making, consultation, and assessments. For instance, Herrington Country Park case study illustrated that real time rendering technology – with its flexibility - was implemented in promoting the project and comprehensively communicating it to the stakeholders. In later stages, computer visualisation media from this case study were extensively used within the semi- structured interviews the results of which are presented in Chapter 6.

A number of possibilities in implementing computer visualisation have also been shown in community forest management of Herrington Country Park. Various media were tested including photomontages, virtual environment, and QuickTime VR. In addition, most of interviews were carried out with Forest Managers, Planners, Landscape Architects, and visualisation preparers.

Pre-set path simulation and photomontages were utilised in the Saltburn Top Promenade case study. Notably, animations assisted local communities in the decision making process to comment on construction materials and other detailed design decisions. This contribution leads to the improvement of original design and to a reduction in the number of objections made by local communities.

The proposed relocation of Windlestone Hall School was a typical case that demonstrated how an interactive model could be used in public consultation. In a residents meeting, the participants revealed a great deal of interest in the project and a good degree of understanding of the context. During the presentations, real time rendering models were presented and the participants indicated a great level of interest on issues regarding views and vegetation screening rather than the levels of realism of the models.

Finally, two more case studies were undertaken for the research. Denham Hall Estate illustrated how photomontage technology was employed in an Environmental Impact Assessment process. The Anaerobic Digester Plant proposal were represented as photomontages in wireframe and simplified massing render, which were integrated with existing and proposed scenarios in day1, 5 years and year 15 in order to investigate measures to mitigate its impact. A Visual Impact Assessment of wind turbines for the Barnsley Academies was required as a planning condition by the local planning authority. During the assessment, photomontages were produced under current guidelines (Wilson, 2009).

This chapter is both technical and descriptive in describing the case studies. In particular, computer visualisation such as photomontage and three dimensional media can be dry; however, two analyses will follow in the next two chapters: potential roles of visualisation technologies within planning practice and interviews with practitioners.

CHAPTER 5 PLANNING APPLICATION WITHIN CASE STUDIES

5.1 Introduction

In the previous chapter, visualisations were created illustrating development proposals for a number of cases, such as Herrington Country Park and Saltburn Top Promenade. The format of the case studies combines with empirical modelling and production of visualisation with some informal conceptual discussion of the role played by environmental consultants in the story and how the planning actors in the drama attempted to influence the other stakeholders, communities, and finally the planning process.

However, in this chapter, in order to analyse the technological aspects of visualisation in some detail, the author argued that an empirical approach was required which addressed the implications of the media during planning. The case study analysis, therefore attempts to identify how the media has been produced for planning which varies in types of visualisation method, how they are prepared, utilised, and whether they are credible for planning.

Previously, Chapter 4 detailed how computer visualisations might influence planning decisions in the UK using case studies ; Herrington Country Park, Windlestone Hall School Relocation, Saltburn Top Promenade, Barnsley BSF, and Denham Hall Estate. Therefore, this chapter provides the reflections of the author on the technical aspects of computer visualisation through the case studies. In viewing the technological issues involved in visualisation, the chapter also carries out an assessment on a number of visualisation media and planning applications in the area. The case studies describe the contexts as well as reviewing the technical aspects and strategies employed in computer visualisations to assist in arriving at a decision.

The author’s involvement in the case studies includes the inception and design of the proposals and the production of the model used in the consultations, planning submissions and for the discharge of planning conditions. During the period of this research between 2002 to 2011, the author has worked with a number of environmental consultancies, landscape design offices, and international engineering firms providing UK, European, and international design and planning services.

In the previous chapters, five case studies have been detailed (Table 4.1, page 85). Within the case studies, a number of computer visualisations and planning applications were included. They are predominantly photomontages and alternative three dimensional visualisations which include pre-set path simulation (animation), panoramic VR, and real-time rendering. Those visualisations were made available for planning submissions, consultations, and for the process of assessment. It was also argued that the case study approach was essential in understanding the implementation of the computer visualisation in environmental planning in the UK (Table 5.1).

Table 5.1 Visualisation Media Implemented in the Research

Computer Visualisation	Description	Dimension	Realism Type
Photomontage	Photo manipulation, where a single image or combination of image and photographs combined	2D	High in photo-realistic level
Pre-set Path Simulation, Real Time Rendering	Image draping, where a single image or a combination of image layers is draped over a three dimensional representation of the terrain, Photo-realistic rendering, where vegetation and other landscape features may be incorporated to give a more realistic representation of an area Virtual worlds, which allow the user to interactively explore an environment; this may also include links to auxiliary information.	3D	Immersive 3D geometry
Panoramic VR (QuickTime VR)	Photo manipulation, which viewed similarly as 3D but actually 2D images synthesised.	Semi (pseudo) 3D	High in photo-realistic level
Interactive Maps, Zone of Visual Influence	Graphical representation of information, which uses single forms.	Plan, 2D	

As detailed in Chapter 2 - Literature Review, the issues emerging in the implementation of computer visualisation were found to be; technical scepticism (credibility), the level of realism, and the cost of production. This provides a framework for assessing visualisation medium used in planning. Table 5.1 above also illustrates how computer visualisation could be classified as dimensional aspects: two, three, and semi (pseudo) 3D[45].

To begin with, the process was started with (1) computer visualisation media as a component of the planning process, (2) the role and (3) technical assessment of various media. Again, this chapter is more focused on technical aspects and usage in planning. However, this is followed by an analysis of the planning implications and reflections from practitioners in Chapter 6.

5.2 Technical Aspects within Case Studies

Within recent technological developments, there are a number of methods to produce a graphical representation. This research cannot cover all contemporary approaches to create models and products; however, an attempt has been made to follow common methodologies and technologies employed within planning applications.

As computer technology develops, digital media is able to offer various roles for planning. This does not mean traditional visualisation – non digital - methods fail to deliver entirely, but computer visualisation can offer extra support, which conventional media cannot. Modern planning in particular has embraced digital technology into its processes.

Photomontages, for instance, have often been employed within planning. It is the most common visualisation medium to be employed currently in the UK. The reason behind this is that it can easily achieve a great level of *photographic* realism for a relatively low cost. Moreover, in the case studies – based on interviews with practitioners in Chapter 6, photomontage techniques are the most preferred media by planners, public, and professionals.

Reflecting the popularity of this approach, the ODPM[46] issued best practice guidelines in 2004. The guidelines consist of two requirements: compulsory requirements in applications for full planning permissions and additional information. It was suggested that photographs

[45] This is a term for three-dimensional visualisation without physical geometries. For instance, it includes photographic 3D such as QuickTime VR and Panoramic VR.
[46] Office for Deputy Prime Minister

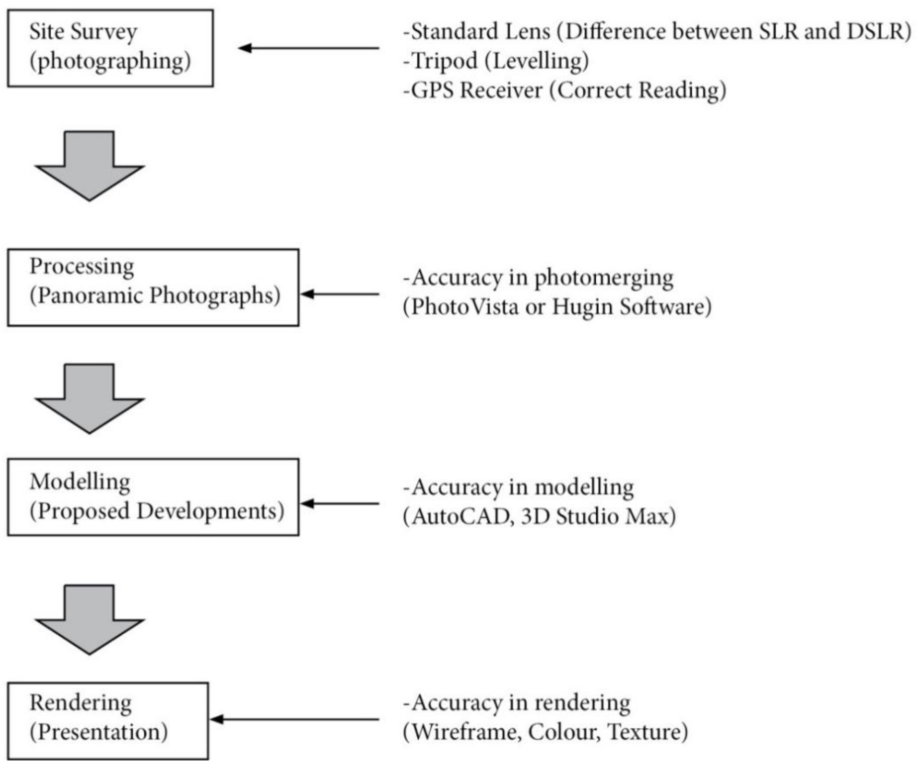
and photomontages could be requested by local planning authorities as additional information.

In some case studies, photomontages were requested for a Landscape Visual Assessment to illustrate ‘before’ and ‘after’ scenarios, particularly upon completion (day 1), year 5, and year 15. Consequently, photomontages can be used to visualise something that has not been built yet and this representations assists in reaching a planning decision.

Visualisation within planning is an abstraction of the real environment; therefore, it is important for visualisations to communicate to stakeholders or any participating actors involved in the planning processes. To take a decision on something that does not exist is always difficult. Nevertheless the traditional use of plans and sections has played a key role in communication with non-planning parties such as the general public.

Due to such planning use, the credibility of the visualisation is critical in decision making. Hence, planning decisions could be largely affected by the quality and validity of the visualisation. During the photomontage process, for instance, there are a number of check points that need to be taken in order to prevent any potential human errors for the use of planning (Figure 5.1).

Figure 5.1 Photomontage Production Process and Considerations



Photomontages are traditionally produced through a simple process of taking photographs, computer modelling, merging, and production. In each step, there are some details to be taken into account for credibility. For instance, photographing can be a cautious process since the development of Digital Single Lens Reflect (SLR) cameras because not all DSLRs are full frame[47] to match traditional SLRs. Matching computer generated models to existing photographs is dependent on the software packages employed. In research, AutoCAD and 3D Studio Max has mostly been utilised to coordinate camera matching – merging- process in photomontage. For presenting photomontages, it is recommended by Wilson (2006) that A3 paper format is used to present before/after or with landscape mitigation applied.

This research also investigates three dimensional visualisations including pre-set path simulation (animation), panoramic VR, and real time rendering. This media has not often been employed formally, but instead, often been experimented with in areas such as public consultation, design promotion, and marketing. These emerging visualisation methods are dependent on the technological developments including computer hardware and software programmes and this is discussed in greater detail later in this chapter.

Table 5.2 below illustrates how each case study used computer visualisation, software, and where it was applied within the planning process. Most of the photomontages were produced with raster editing and basic three dimension authorising software. After photographing, rendered or wire-framed three dimensional models are placed into the existing photographs and proposed vegetation added if there is any landscape mitigation.

Unlike photomontages three dimensional visualisations were authorised by using Adobe (formerly Macromedia) Director's Lingo scripts and a number of commercial software such as AutoCAD, 3D Studio Max, and Photoshop[48]. The Director software produced 3D models in Shockwave format (.swf) and it derived datasets showing a quantitative estimate of the rendering of the developments.

Lingo scripting and 3D Studio Max has been used for 3D geometry creation; whereas, Adobe Photoshop has been employed for rasterised-image editing including production of plans, mapping, material and masterplaning. In particular, AutoCAD and its plug-in

[47] In cinematography, full frame refers to the use of the full film gate at maximum width and height for 35mm film cameras.
[48] These are commercially available software packages licenced to Newcastle University, White Young Green Environmental Ltd, Great North Forest, Robinson Landscape Design Ltd, and Anthony Walker and Partners Ltd.

software, Key Terra-Firma has been used to produce Zone of Visual Influence (ZVI) and for general vector editing.

Table 5.2 Visualisation Media in Case Studies

Case Study	Year	Visualisation Produced	Software including scripts and programming languages	Planning Application
Herrington Country Park Community Forest Management, near Sunderland	2006	Photograph-based VR, Interactive masterplan, Real-time rendering, Photomontage	Macromedia Director (Lingo[49]), 3D Studio Max, Adobe Photoshop	Consultation, Steering Group Meeting
Windlestone Hall School Relocation	2006	Real-time rendering	3D Studio Max, Adobe Photoshop	Public Consultation
Saltburn Top Promenade, Redcar & Cleveland	2007	Pre-set path simulation	3D Studio Max, Adobe Photoshop, PhotoVista, AutoCAD	Public Consultation
Barnsley BSF	2010	Photomontage	3D Studio Max, AutoCAD, Photoshop	Planning Condition
Denham Hall Estate, Suffolk	2010	Photomontage	3D Studio Max, AutoCAD, Photoshop, PhotoVista	LVIA

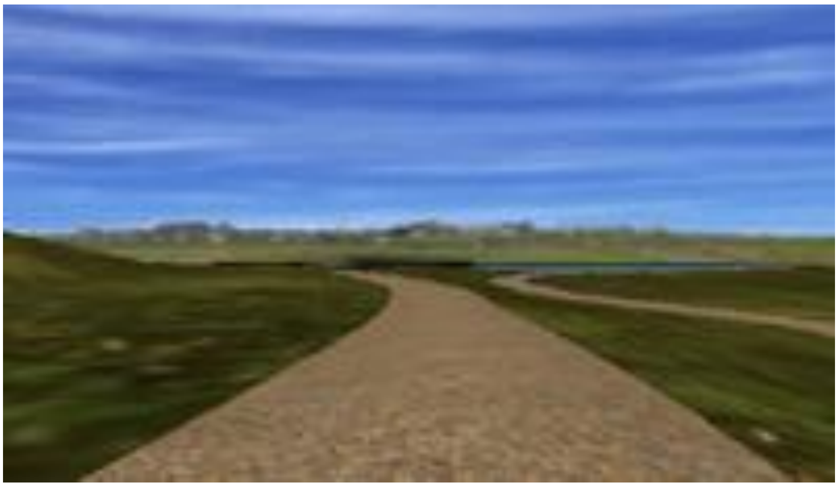
The Herrington Country Park case utilised the most computer visualisations in numbers commonly adopted within planning practice: photomontage, real-time rendering, interactive masterplan, and panoramic VR. In particular, every visualisation illustrated mitigation planting for day 1, year 5 and year 15 based on average tree growth. Average tree growth is dependent on the selected species and this data was provided by the Great North Forest. Panoramic VR also enables users to pan through 180 degree.

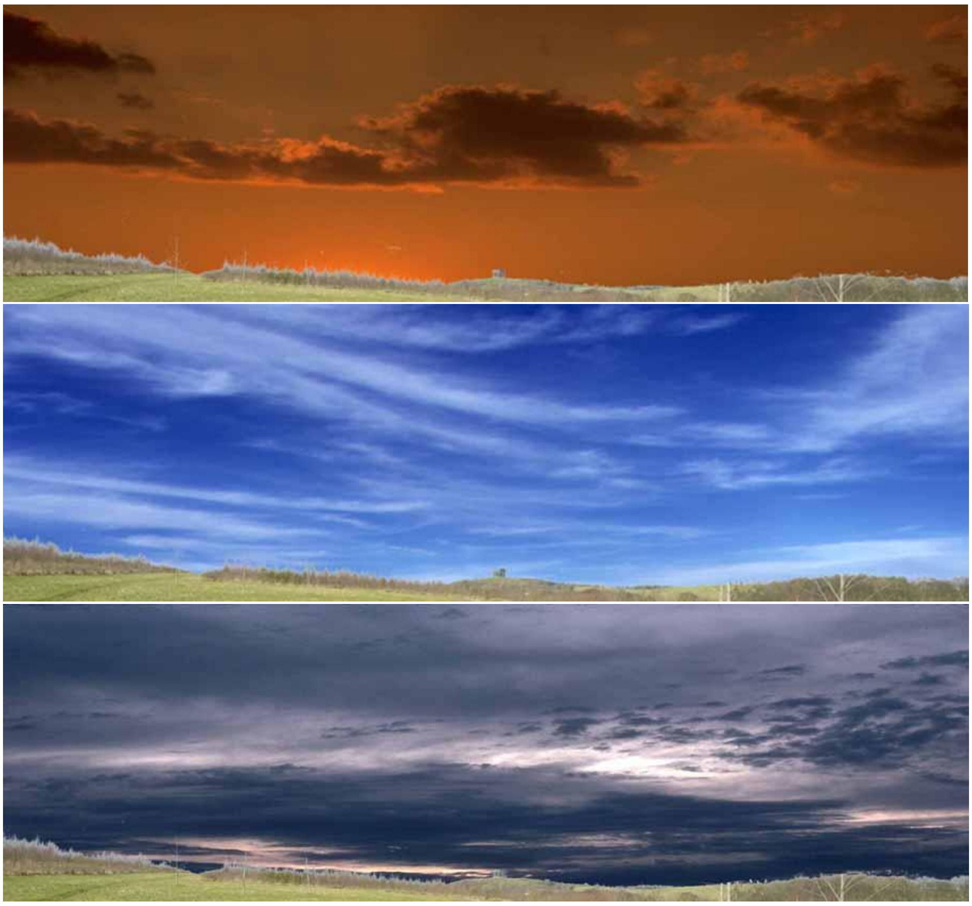
[49] The name Lingo has been used by several unrelated programming languages. Its most common version is a scripting language developed by John H. Thompson for use in Adobe Director (formerly Macromedia Director), used for regular desktop applications, interactive kiosks, CD-ROMs and Adobe Shockwave internet sites. HyperTalk is likely to have been one of the inspirations for Lingo.

Figure 5.2 Panoramic VR in Herrington Country Park

The Herrington Country Park case study also included real-time renderings – 3 viewpoints – within the phasing scenarios. In particular, it not only offered phasing but also viewers can change skies (weather conditions) and install park elements such as seats and sculptures.

Figure 5.3 Real Time Rendering and Sky Options





As an additional medium, the case study contains a multi-layered interactive masterplan. The interactive masterplan[50] contains a series of information as layers, which can be easily turned on and off. This enables viewers to filter information they want to view. In particular, it is a very effective way of presenting information when plans contain a lot of information to show on a plan.

Figure 5.4 Interactive Masterplan (Selective & Multi-layered)

[50] It is only tested within Herrington Country Park case.

There has been much academic research about forest management implementing computer visualisation in Scandinavian countries such as Finland (Tyrvainen and Tahvanainen, 1999). However according to the interview results with forest organisations, computer visualisation has not been highly implemented for practical forest management in the UK.

In this research, some 3D visualisations have been tested such as real-time rendering, pre-set path simulation, and panoramic 3D. During the case studies, those visualisations were implemented as experiments which then become tools for forest management and public consultation. However, in practice, 3D visualisation is not commonly utilised due to the cost of production.

Because of the production cost of 3D visualisations, which is relatively high (including the labour cost), they are often considered at particular stages of planning or are produced at later stages of the project such as for marketing. Moreover, photomontages and panoramic VR are commonly used in public consultation as an efficient communication method.

Nevertheless, once produced, pre-set path simulation (animation) could contain a high level of realism and is often implemented to publicise projects; while, real time rendering technology is able to produce high immersive reality experience to participants.

In the case study (Saltburn Top Promenade), animations were employed at regularly held public meetings and at the final presentation. Animations were presented at meetings in order to communicate between Landscape Architects, Artists, and the general public.

The initial motive to produce such visualisations originated from landscape consultants in order to improve the communication of design proposals to other parties. Since Saltburn Top Promenade was a community funded project, working closely with the communities was an essential part of the process. During the case study, computer visualisations (i.e. animation and photomontage) were presented for design development, construction detail, and decision making in a series of public meetings as communication tools. After the meetings, ideas and decisions were collected and evaluated and re-presented in following meetings. The interactive processes led to faster decision making and provided efficiency a cost savings to the project.

In the Windlestone Hall School case, real time rendering media were presented at a series of public meetings to indicate individual views from properties. Moreover, this media type was also used as a forest management tool at Herrington Country Park.

Real-time media was used at various meetings at Herrington Country Park including a steering group meeting where future illustrations of year 5 and year 15 (forest growth) was presented. Technically, real time rendering shares the same principle with photomontages; however, it contains additional immersive reality operated by a keyboard and a mouse.

This unique feature (real time rendering's immersive reality) provides viewers with the ability to navigate at their own will. Similar to a first person's video game, participants are able to explore in any direction they wish. A significant advantage of this to the planning process is that instead of pre-set views, participants can personalise their experience in the virtual world.

Virtual models used in this research were produced using Shockwave technology. Adobe Shockwave[51] – formerly Macromedia Shockwave – is a multimedia platform used to add animation and interactivity to web pages (Brown, 2011).

For example, in the steering group meeting in South Tyneside Council, both photomontages and real time renderings were presented with phasing options (year 5, year 15 vegetation growth). The steering group was composed of representatives from the local planning authorities, forest organisations, and the local communities. During the 1 hour presentation and interaction with participants, the most positive feedback was with the visualising interaction and with phasing the forest growth. Participants claimed that enabling them to visualise year 5 and year 15 forest growth and walk freely along the footpath were the most useful aspects of the photomontages influencing the design and maintenance of the community forest.

A ZVI[52] was produced for the Barnsley BSF case study as well as photomontages in order to discharge a planning condition imposed by the local planning authority. Viewpoint locations were agreed with the Planners on the basis of sensitivity. A number of photomontages were produced for the Barnsley BSF wind turbine case study. The photomontages were presented with the existing site condition, wireframe view, and a simplified massing render of the turbines.

[51] It allows Adobe Director application to be published on the Internet and viewed in a web browser on any computer which has the Shockwave plug-in installed. It was first developed by Macromedia, and released in 1995 and was later acquired by Adobe Systems in 2005.ELIA, E. 1996. *Macromedia unveils Shockwave and Director* [Online]. HyperMedia Communications Inc. [Accessed September 23 2010].

[52] Zone of Visual Influence

Denham Hall Estate is a farm and there was a proposal for constructing an anaerobic digester. The local planning authority required photomontages of the proposed development for the planning application. Five viewpoint locations were agreed and photomontages were produced incorporating landscape mitigation proposals.

5.3 Evaluating Credibility, Realism and Cost

As previously stated (in Chapter 1 and 2), the research framework consists of three components: credibility, level of realism and costs of production. Consequently, case studies and planning applications were analysed based on the components.

5.3.1 Technology scepticism (credibility)

The creation of credible photomontages is a complex process, the details of which are only summarised in this research. It is a process that requires a great deal of expertise and experience and should not be entered into lightly. It is to be assumed that the material produced may be subjected to expert scrutiny, especially if used as evidence at a public inquiry. It is essential that the utmost care must be taken at each stage of the process to avoid error and to use the most appropriate tools. Therefore, appropriate methodology and protocol must be established.

As Figure 5.1 Typical Photomontage Production Process (page 123) illustrates that in the production of photomontages certain protocols needs to be followed. At each step, there are points to be considered without which, credibility can be easily lost within development management.

Nevertheless, the author witnessed cases of errors whilst in the practice of producing visualisations. For example, during the case studies, it was often found that environment consultants often failed to understand the differences between digital and conventional (film) SLR including their conversion angles and ratio. Such a lack of knowledge can result in fundamental errors within the production of photomontages.

Modelling three dimensional geometries can be carried out using a number of methods. Regardless of whether it is for rendered/ wire-framed photomontage or more highly detailed pre-set path simulation/ real time rendering, there are a number of software programmers available to generate three dimensional geometries. Important points are to consider when or what to choose and the details of functions, views, and environment. In principle, a virtual camera needs to be compatible with the existing view in order to match both and produce comparison (such as Repton's *before and after,* page 15). In addition, environment conditions such as atmospheric effect, sun light, clouds, and weather could be rendered in order to resemble the existing images recorded.

In recent years, many practitioners have been able to produce some sort of three dimensional modelling in house. The level of skills varies in each practice; however, the quality and validity of production is dependent on the skill levels that a practice possesses. The realism level of visualisations commonly produced by environmental consultants ranges from SketchUp[53]-like (draft pen sketch type) to high realism rendering using sophisticated 3D software. The visualisations have been utilised for internal design studies, concept development as well as LVIA[54] and EIA[55].

Nevertheless, it is common in practice to be asked by clients questions such as '*Can you change the colour of the roof so that it looks greener?*' or '*Can you increase the proposed mitigation slightly to provide a greater level of screening of the proposed buildings?*' These critical elements - heights, screening, and colour of the development – are visually sensitive in an EIA or LVIA. In reality, those requests from clients, in the main developers, are accepted by visualisation preparers and environmental consultants as long as they are reasonable.

However, this phenomenon is based on the system of visualisation productions in the UK. Most of the current visualisations produced for development management processes in the UK are commissioned by developers. It is hard for environmental consultants or visualisation preparers to resist requests to amend a visualisation from their clients.

Therefore, most computer visualisations contain a certain level of credibility. However, when elements of the overall visualisation are outsourced - for instance in large projects - visualisation tends to be at the specialised preparers' hands hence there are often more emphasis on aesthetic value than the credibility of use within the planning application.

This research also finds that currently there are no separate teaching modules for visualisation within higher education curriculums; a position concluded after interviewing members of staffs of several leading universities in the UK[56]. Planning professions

[53] Google SketchUp is an open source software to design 3D and 2D models. It is a platform is open for Rubyscript programmers to develop plugins for this software.
[54] Landscape and Visual Impact Assessment
[55] Environmental Impact Assessment
[56] Email interviews were carried out with lecturers in University of Sheffield and University of Greenwich.

generally focus on planning matters rather than visualisations; whereas, visualisation preparers (technicians) tend to focus more on the aesthetic values of the computer visualisation rather than its validity in planning.

In summary, visualisation is an abstraction of the real environment and even with advanced technology; humans would not be able to create visualisations that reflect the real world perfectly. However, the planning process deals with something that has yet to be built and a decision making process based on predictions and foreseeable impacts. Therefore, visualisation is implemented as a language – communication medium – for actors in planning.

5.3.2 Levels of realism and perception

Visualisation is a simplification of reality and it cannot be a perfect reflection of the real world. For development management, a level of realism has to be decided upon individually for its purpose within the process.

For instance, photomontages are two dimensional images; whereas, three dimensional visualisations are rather immersive with 3D geometries. Since the photomontages are based on existing photographic information, the final output can be highly photo-realistic.

Before constructing a model or photomontage, it is important to establish the level of detail required. This will usually depend upon the stage of the project and the purpose of the photomontage. In the early stages of a project, a photomontage may be required as part of a "massing study" where no detail is shown at all and the proposed building is represented as a simple cubic form to illustrate the volume of the building. The aim of such images is to give an understanding of how the building may fit into the landscape and to inform the detailed design process.

Once all the field data has been collected and processed, a digital model of the proposed development needs to be constructed. Any suitable CAD software may be used but in the case studies, AutoCAD or 3D Studio Max was most commonly used. In some cases and depending upon the stage of the project, a CAD model may already exist, possibly constructed by the project architect. Providing this model is suitable for the purpose, it should be used in preference to the construction of a new model. The 3D models rendered onto existing views and the final production combines existing photographs with the rendered 3D proposed models. This results in the photomontage achieving a higher degree of realism (photographic) without spending a great amount of time and effort in its preparation.

At the later stages in the project, a full detailed model may be required so that photomontages can be used for publicity, public consultation or as evidence at a public inquiry. Naturally, the creation of such models is far more time-consuming and great care should be taken when estimating the time required. Not only must the geometric detail of the model be correct but the effects of the various building finishes (cladding materials, glass etc.) must be carefully considered in order to give as realistic a representation as possible.

Unlike photomontages, the nature of animation is based on three dimensional geometry; therefore, it can provide a high sense of immersion. However, in conjunction with texturing on 3D geometries, it can be a realistic (photo) as well as immersive[57].

Level of detail allows the dynamic representation of data taking the part of the scene people actually look at, and the distance. The representation of geometries and textures could be simplified in order to achieve an appropriate level of performance. The closer the object is positioned to the camera, the more detailed it is represented, until, at a specific distance to the camera, it loses all of its geometry and texture.

There were interesting points made during the case studies. It was found that the level of realism does not necessarily affect the credibility of the visualisation in planning. In the literature review, many claimed that there was a direct relationship between the level of realism and credibility; however, respondents – at the Windlestone Hall School Relocation and the Herrington Country Park case studies – revealed that an adequate level of detailed visualisation was acceptable or sufficient to form an opinion as long as the geometries were correctly presented.

When the question of realism and credibility was posed to residents living near Windlestone Hall School, the research found that realism – the level of detail- was not significant. The main concern of those attending the meeting was the visual intrusion of the proposed school from houses adjacent to the site. For the purpose of assessing the visual impacts of the proposed school buildings, most of residents claimed that there were no

[57] Immersion is the state of consciousness where an immersant's awareness of physical self is diminished or lost by being surrounded in an engrossing total environment; often artificial. This mental state is frequently accompanied with spatial excess, intense focus, a distorted sense of time, and effortless action. The term is widely used for describing immersive virtual reality, installation art and video games.

difficulties in perceiving and providing feedback. In short, the level of detail was not a significant issue for the residents as long as the geometries of the 3D models were correct. The level of detail of the presented models was sufficient for consultation purposes.

Moreover, in the steering group meeting held at South Tyneside Council, stakeholders for Herrington Country Park provided feedback. Some of the stakeholders were unaware of the project or the site. However, most of the respondents claimed that photo realistic detail was not required for consultation on forest management since forest management tools are generally focused on volume of vegetation rather than photographic representations.

In particular, real time renderings are always facing technical challenges of hardware and software. Despite recent technological advances and developments in the gaming industry, it will be some time (if ever) before planning adopts this technology for routine planning process due to cost and technical complexity.

Real time renderings were tested at a public meeting for the Windlestone Hall School Relocation case study. Residents were more focused on the height and screening aspects of the proposed mitigation within the models. Therefore, it is reasonable to conclude that graphical representations with high level of details are beneficial; however, high level of detail is not necessarily required for typical planning applications such as assessments and consultation. Basic 3D models – real time renderings in Windlestone Hall School - were sufficient enough for viewers to form an opinion.

Furthermore, contrary to the suggestions of many areas of research (Lange, 1999), the credibility of visualisation does not necessarily relate to the level of realism; credibility is closely related with accuracy. For instance, during case studies, most of respondents (stakeholders) were concerned about the accuracy of the models presented. They claimed that geometries such as shape and height were more significant than how close the models replaced the real world.

5.3.3 Production costs

In order to measure the cost of production, the common practice of creating computer visualisations needs to be defined. By doing that, appropriate cost comparison can be carried out within standard production ranges such as photomontage and 3D modelling.

In this research, the production of photomontages is measured with taking photographs, modelling, and rendering. Prior to photomontage production, sometimes viewpoint locations need to be decided as well as how many photomontages are required and so on. The cost measure of photomontage production in the research includes for the standardised process.

Therefore, the measurement of production costs can be divided into three components: surveying (photographing), modelling, and production (render). Each component contains individual dependent factors. For instance, the site location will affect the cost of traveling expenses. In the case studies, 1-2 days were allocated for the site visits. Photographs were taken and geographic information recorded.

The modelling process can also significantly affect the cost of production. Modelling time is heavily dependent on the complexity of the scheme as well as the level of skill of the preparer. In the case studies, the average modelling time was 1 day. The models consisted of farm facilities, wind turbines, and warehouses, all of which were relatively simple structures. Moreover, most viewpoints in the Landscape and Visual Impact Assessment were located some distance from the proposed development and did not require a great amount of detail.

Table 5.3 Approximate Cost of Photomontage Production

Parts	Process involved	Approx. cost (£)[58]	Factors
Survey	Taking photographs (existing), recording geographical information	500	Number of viewpoints, Site distance, Level of staff training
Modelling	3D modelling	800	Complexity of scheme, skill levels
Production	Rendering with existing photographs, publishing	500	Complexity of scheme, Level of staff training/skills

However, Table 5.3 only illustrates the approximate cost of production for a single photomontage. What if there is more than one viewpoint? Generally, more than one photomontage is required for the purposes of Landscape Visual Impact Assessment. It is

[58] The costs are based on at the time of writing (2011-2012).

interesting to note that the approximate cost of production of two photomontages is not twice the approximate cost to produce a single photomontage.

It is common to take photographs for an average of 5 viewpoints in a single day of site visit. This means that between 1 to average 5 views can be produced for a fixed cost. The same rules apply to modelling. Once a computer model is completed, then there is no need to add the modelling cost for additional views.

In summary, only the rendering cost will increase from the 1st photomontage to a certain number of views. Table 5.4 below illustrates actual cost of photomontages.

Table 5.4 Actual Cost of Photomontage Production

Case Study	No. of Photomontages	Fee Quoted (£)[59]
Barnsley BSF	5	2500
Denham Hall Estate	5	4000

In comparison with other medium, the preparation of photomontages is considered as a low cost option. Proposals can be modelled in 3D; however, photomontages are still represented as 2D. Since photomontages utilise existing photographs for background, they can be highly photographically realistic.

Compared to photomontages, in general, 3D technology is more expensive than 2D production. Pre-set path simulation and virtual reality are both forms of 3D and requires authorisation (creation) of 3D geometry.

Unlike 2D such as raster and bitmap, it requires intensive labour and skill. Moreover, authorising software tends to be more costly than any other software/hardware. For instance, the software used in the case studies, 3D Studio Max is one of the most expensive 3D authorising software are available in the current market at approximately £2,500 per single licence (Table 5.5).

[59] Year 2010

Table 5.5 Software Cost (2010)

Application	Software in Case Studies	Approx. Price in 2010	Medium Produced
3D Authorisation	3D Studio Max	£2500	Basic 3D
	SketchUp	£700	Basic 3D
3D Scripting	Director	£1000	Real-time Rendering
Raster Editing	Photoshop	£1000	All medium
Sequence editing	Premiere Pro	£1000	Pre-set Simulation (Animation)

Real-time rendering shares most of the characteristics of animations except the real- time immersive experience. Therefore, it is also dependent on the skill level of staff, labour time, and how much detail is to be visualised.

Table 5.6 3D Visualisation Case Studies

Case Study	Type	Realism Level	Approx. Skilled Labour	Notes
Herrington Country Park	Real-time Rendering	Medium/low	72 hours	3d geometries, scripting interaction
Saltburn Top Promenade	Pre-set Path Simulation	High	72 hours	3d geometries, rendering
Windlestone Hall School	Real-time Rendering	Medium/low	72 hours	3d geometries, scripting interaction

Table 5.6 above illustrates the approximate skilled labour time against the realism level for the types of visualisation produced. Compared to photomontages, 3D visualisations generally cost much more (twice/triple) than two dimensional representations in the case studies.

5.4 Implications for the Usage of Visualisation in Planning

Technical aspects of implementing computer visualisations have been investigated based on the research framework set out in the previous chapters. The framework is founded on emerging issues identified; technology scepticism, the level of realism, and the cost of production. In this chapter, technical analysis has been carried out on the case studies and the author's professional reflections on the issues stated.

Although there have been numerous attempts to implement three dimensional visualisations in the planning process, employing new technologies is not always common and straightforward in the formal process of planning. Instead, the 3D media are often used outside the development management process for example in marketing, design study, and any information based workshops.

The reason for such a lack of utilisation could be due to the cost of production and insufficient information beforehand. As mentioned earlier, as technology (i.e. hardware and software) evolves, three dimensional visualisation could be more accessible and affordable for environmental consultant and general public as ever before in modern planning.

While photomontages have been used for many years - as mentioned in the history section in Chapter 2 - and their usage continues to expand within planning, the adoption process of 3D visualisations has been slow. One of the reasons is that photomontages are a low cost option and generally can achieve high levels of realism (photorealistic), compared to alternative 3D visualisations. During the case studies, photomontages were mostly utilised in consultations (public and stakeholders), assessments (EIA, LVIA), and production process includes mainly photographing, 3D modelling, and rendering.

Firstly, in photographing (survey), standard focal length lens need to be used in order to match close enough to human view angles. As well as preventing distortion, a number of points should be taken into account for the process. This includes the use of tripods and GPS location devices. During the case studies, it was often found that environment consultants often failed to understand the differences between digital and conventional (film) SLR including their conversion angles and ratio. Such a lack of knowledge can result in fundamental errors within the production of photomontages.

Secondly, regardless whether 3D medium is real time rendering or pre-set path simulation, the modelling process is similar. However, modelling for the production of photomontages only requires the proposed development – i.e. buildings, wind turbines, and so on - rather than the surrounding context. In this sense, immersive realism is much lower but higher photographic realism can be achieved. That is why the production of photomontages is less labour intensive therefore it could be relatively affordable.

Finally, the rendering stage involves wireframe and massing output. The former is to measure the extent of proposals without any foreground obstructions. Often, proposed buildings and structures are blocked by the foreground, vegetation, and any built up structures in front of the proposed. The latter is for a visual assessment of actual proposals. The proposal can be rendered in simplified colours and textures but needs to be as close as possible to the proposed development.

At this point, this is where technology scepticism issues arise. During the production, there was certainly a degree of subjectivity. For instance, the colour or texture of the proposed buildings can be toned down or up. In some instances, despite RAL[60] colour specified proposals can be rendered differently within reasonable parameters of subjectivity.

The key point is not the fact that there are a number of variables such as atmosphere, sun, hardware, software etc., but the subjective alteration can cause damage to the credibility of the media used in the planning process.

Moreover, from the author's personal experience, various possibilities emerged for this explanation. Notably, one of the main reasons is that computer visualisation is usually funded and commissioned by developers. Therefore, due to the preparation process, it is often favours the developers' intentions.

Most environmental consultants prepare photomontages for their clients. Produced photomontages are for planning submissions or public enquiries. There is a great potential at this stage for the produced image such as photomontages or any graphical representations to be manipulated to reduce the impact of any proposed development below the level it would create in reality.

Unlike photomontages, 3D visualisations are less utilised in planning and mostly they are used for specific purposes. Strictly speaking, 3D visualisations are neither a prerequisite

[60] RAL is a colour matching system used in Europe.

nor compulsory in the development management process. However, they have been implemented on a voluntary basis within the private sector, particularly within the consultation processes, design studies, and for marketing/presentation purposes.

3D visualisations, despite the benefits, can be quite an expensive option. For instance, 3D authorising software is more expensive, rendering requires more powerful computers and staff need to be highly trained. Moreover, it requires a great amount of time and labour to achieve high levels of immersive realism.

As previously mentioned, the use of computer visualisation has not been widespread within the environmental planning process. Predominantly, photomontages are employed in planning as a supply of additional information and currently only photomontages are formally recognised in published guidelines (OPDM); however, other visualisation such as pre-set path simulation is used often in public consultation.

There are a number of different software programmes for producing computer visualisations. Even though, there are preferences among users and preparers, they generally range from free to highly commercialised products, which cost several thousand pounds per single license. The use of software is decided by the quality of software, compatibility, and reliability.

For instance, there is not much choice in wind farm software[61] in the current market and those that are available are very expensive. However, major developers prefer to use the software because by using the software, production of computer visualisation – such as photomontage, shadow flicker, and ZVI analysis - is considered credible.

The technology is still advancing and a number of new software programmes have been released at the time of the research. Some of them are free, upgrades, more efficient/effective, easy to use, and could be affordable. The research tries not to keep assessing new visualisation software. Rather, in this research classification of visualisation software was established to provide a framework on the technologies.

Producing computer visualisations is not only about representing a scheme aesthetically, but also it is an attempt to envisage how the scheme would look like on completion or at a certain period of time after completion. That’s why the representation must be as close to reality as possible and needs to minimise any human errors during the process.

[61] Currently in the UK, ReSoft’s Windfarm

Another key finding in this chapter was taken from two different case studies: Herrington Country Park and Windlestone Hall School Relocation. During the public meeting, the residents at Windlestone Hall School claimed that high levels of detail were not necessary in 3D models. Instead, basic geometry models sufficiently served the purpose, which was the assessment of and consultation on the visual impact of the new school buildings. Most of the residents, architects, planners, and school staff at the meeting know the site and the proposal well enough and claimed that the visualisation was credible enough to assist with discussions.

Moreover, at Herrington Country Park, stakeholders in a steering group meeting produced similar feedback as to which visualisation used had sufficient texture and geometry in order to carry out management and consultation. For discussing forest management, 3D models and photomontages were not required a high level of realism and as long as basic geometries such as heights and volumes, visualisations were valid for the purpose.

In conclusion, unlike 3D video games (such as first person shooting games), visualisations within the planning process do not require a high degree of realism. In common practice, implementing computer visualisation in planning has a certain purpose such as visual assessment, consultation, planning application, and discharge of planning conditions. In order to satisfy credibility in development management, visualisations require having correct geometries rather than be realistic such as accurately representing textures. In addition, increasing the realism of computer models makes production cost higher and this lead to it being less attractive to employ them in the planning process.

Developing computer technology can potentially provide the advantages of effectiveness, easiness and validity than ever before. Moreover, it is stressed that the technology is getting affordable. Therefore, modern planning is taking a great advantage of technology development.

This leaves us two questions: is there any possibility of human error for producing computer visualisation? and how are practitioners perceived? These questions will be answered in the next chapter 6.

CHAPTER 6 PRACTITIONERS' REFLECTIONS IN NORTH EAST ENGLAND

6.1 Introduction

In the previous three chapters - Chapter 2 Literature Review, Chapter 3 Methodology, and Chapter 5 Case Studies - it was assumed that using computer visualisation is constrained or encouraged by current issues such as its roles in planning, technology scepticism, level of realism, and the cost of production. It was also argued that a case study approach was essential in understanding the differing levels of usage of computer visualisation within the development management process in the UK. In particular, in Chapter 5 the technical aspects of computer visualisation were analysed based on the author's experience and observations.

There is also an understanding that computer visualisation in the UK has played a significant role in engaging more people and envisaging proposals, which may lead to the achievement of social sustainability (Roe, 2000). This leads to the following questions: how has computer visualisation been implemented within the UK planning system and what are the challenges facing computer visualisation when utilising computer visualisation within planning system. This chapter considers these questions through in-depth interviews with experts, environmental consultants, and planners (See Chapter 3 for a full list of interviewees, page79). The argument presented in this chapter cannot be a decisive one, but can contribute to the building of a more refined understanding of the potential for the utilisation of visualisation in the development management and project design processes.

Firstly, this chapter scrutinises current visualisation media, particularly those processes and analyses whether various forms of computer visualisation presently used reflect issues identified through the literature review and the case studies.

The analytic procedure follows the methods discussed in Chapter 3. In order to analyse the issues in some detail, it was argued that the identification of current constraints were required which addresses the issues of the technical implications of planning. The case study analysis attempts to identify issues faced within environmental planning with interviews and questionnaires with professionals, local planning authorities, and visualisation preparers.

Four criteria of emerging issues of technology implementation within planning were summed up in Chapter 3 as follows; *roles in planning, credibility of visualisation, level of realism, and the cost of production*. Therefore, this chapter details the issues identified in the research framework. How computer visualisation is valid and reliable, within which planning stage it is mostly employed, current constraints, and what degree of realism is available.

Figure 6.1 Emerging Issues for Interview Analysis

The interviews were arranged with private practitioners, local planning authorities, forest organisations, and technicians from the Virtual Realty Centre in Teesside University. Interviewees are at senior levels, where most interviewees possess over 10 years of professional experience in their field. During the interview, computer visualisations were shown – visualisations are mostly from the Herrington Country Park case study - and comments were requested, both on the planning issues and visualisation in general. Each interview lasted approximately 60-90 minutes and was semi-structured in that certain broad topics were covered. Those issues were based on the pilot case study, literature review and the author's experience (See Chapter 3 for a more detailed discussion of the methodology).

6.2 Computer Visualisation and Planning

This section deals with computer visualisations such as photomontage and 3D media as well as outlining the role within the planning process and development management; planning applications, Environmental Impact Assessments and public consultation.

6.2.1 Photomontage

As a result of the interview and questionnaire survey undertaken at Herrington Country Park and Windlestone Hall School Relocation, photomontages were recognised as the most preferable and affordable medium in terms of contributing to the planning process.

For instance, in Landscape and Visual Impact Assessment, photomontages have been predominantly used for comparative scenarios of day 1, year 5, and year 15. Particularly, this 'before and after' presentation is recognised as an effective tool in the consultation process. Currently, practitioners were found to use photomontages in various planning applications; moreover, it has become an easy tool for lay people to understand planning proposals (Figure 6.2).

Figure 6.2 Typical Photomontage Productions – Existing, Wireframe, Day 1, Year 5 and Year 15 (Courtesy of AWP Ltd, 2010)

The photomontages that were presented in the case studies comprised realistic, precise presentations of the ideas that people had. Moreover, they were relatively cheaper than other visualisation media. As photomontages provide a very close representation of reality, little interpretation was required to convey the design message to the public.

However, there were negative opinions on using photomontages in environmental planning. The most persuasive view was from the **Private Landscape Consultants Group**[62].

> I am not a great fan of the photomontage, but I appreciate the value of it. I think sometimes it gives a distorted view. I can totally understand that it makes a lot sense to use it. You have a real situation and you are putting something else into it, which isn't real. A lot of things need to be right for this including scale. Sometimes you can get greatly distorted views.
>
> I am not convinced by photomontages they are useful but they are less accurate than other visualisation. It is still an artistic impression for me. Photomontages are more of a distortion, that's my opinion.

The reason for the above opinion is due to the differences between three or four-dimensional[63] world and still images, which are still two-dimensional. Interestingly, this could lead us into misleading perception of what we would see in the future. Particularly, the comparison between three dimensional material and traditional communication methods were often made by interviewees. An associate landscape architect, Interviewee E illustrated this point as:

> I think photomontages cannot represent the world we live in. They are commonly used I think they've got problems. In my experience, from what I've seen they give an impression, no more than that. Whereas, in 3D computer visualisation if you have got a relatively accurate model or accurate platform, then you can see all mitigations, that's what I mean.

Another similar point was made by an associate landscape architect, Interviewee A.

> Normally, in photomontages you only ever get the existing, existing year, year one, and year two. You actually need to compare one page with another to see how the plants are growing (demonstrating with hands). You don't get this with a computer visualisation. You can click on buttons to see that the trees are getting bigger and bigger.

[62] Interviewee Details are illustrated in Table 3.6 Composition of Interviews (page 70) and Appendix C (page 187).
[63] In mathematics, four-dimensional space is an abstract concept derived by generalising the rules of three-dimensional space. It has been studied by mathematicians and philosophers for almost three hundred years, both for its own interest and for the insights it offered into mathematics and related fields. In modern physics, space and time are unified in a four-dimensional.

However, overall Interviewee A claimed that photomontages possessed a lot of advantages to employ in the planning process. This includes being faster to produce and relatively cheaper than other forms of visualisation. However, there are still concerns about accuracy issues because it is still a bitmap production, where some assumptions are required to produce the images.

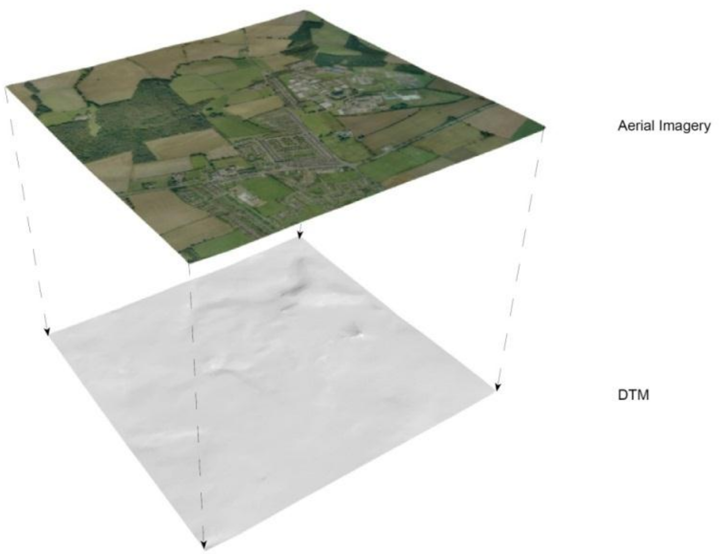
6.2.2 Three dimensional visualisation

As well as photomontages, interviewees showed a great appreciation for 3D visualisations, especially, image-draping technique for ground modelling. This can be simply modelled, represented in a great level of detail, and physical three - dimensionals. A community forest officer, Interviewee I in Forest Organisation Group claimed that;

> Image draping over terrain models is definitely useful. It is more valuable and gives the best view. And QuickTime view can be used in viewpoints at the human eye level; whereas, image draping over terrain is good for bird's eye and general overview.

Based on DTM[64] aerial images are draped on to DTM and it gives a sense of topography and reality of the context (Figure 6.3).

Figure 6.3 Images Draping onto DTM



[64] Digital Terrain Model, A digital elevation model is a digital model or 3D representation of a terrain's surface-commonly for a planet (including Earth), moon, or asteroid-created from terrain elevation data. There is no common usage of the terms digital elevation model (DEM), digital terrain model (DTM) and digital surface model (DSM) in scientific literature.

Moreover, interviewees from **Private Landscape Consultant Group** indicated that this was an efficient form of visualisation used in planning. Interviewee I pointed out that there are much greater benefits to be gained from having an image draped model in forest management. Therefore, aerial draped models give a great utility of forest changes, measuring impact, and terrain formations in a study area.

In addition, providing a pre-set path simulation (animation) with the image draped models, gives a high level of detail because it is based on topographical surveyed DTM from Ordnance Survey. When up-to-date aerial imagery is draped onto the DTM, the computer visualisation is able to produce a credible representation. Most interviewees indicated that they preferred 3D models with aerial photographs to two dimensional mapping. For instance, a Community Forest Officer, Interviewee I continued;

> If you have a lot of money you can use VR but I don't think we are far enough down the line of virtual reality at the moment. Specially, texture limits, rural elements, trees and woodland, trying to show the best of the woodland is hugely time consuming. Whereas if you are doing a brick building which has been modelled for an architect's drawing, that's the fixed plan whereas woodland takes a huge amount of time but still never quite get it right. We are modelling nature and it changes.

On the other hand, the three-dimensional models created by physical geometries are regarded as an expensive visualisation and, often, time-consuming to produce. However, unlike modern video gaming industry, 3D visualisation in planning has a comparatively low level of realism.

It is considered that there is a cost and effect justification point where cost meets professionals' and clients' needs. Nevertheless, when cost goes beyond a certain point, cheaper media are likely to be preferred.

For instance, 3D physical geometry created visualisations can be replaced with raster image generated 3Ds such as Panoramic VR or QuickTime VR and photomontages conserving the photographic quality and provide significant cost savings. This was illustrated thorough a comment from an associate landscape architect, Interviewee A;

> They are all useful for different reasons. Real-time rendering visualisations can be more fun. I think because you have to involve pressing buttons, navigate, controlling cameras with keyboards and mouse, children will love it but some public may not be able to use it particularly older ones. I think you've got to have some images because an image is really important for people to have a piece of

> paper such as photomontages, plans, and perspectives. It is quite important to have it on paper to discuss, to talk and to print out.

Some interviewees preferred 3D visualisations rather than 2D. They claimed that 3D visualisations read better for communication in planning. This is an associate landscape architect, Interviewee E's point;

> I don't like the flat on type of montages. Because if it is flat (2D) and when you put things in it, it isn't always right you will get distortion. That's why I like the three-dimensional approach. You are looking at something in real and it shows real whatever it is. If you show this in two dimensions such as sections or elevations it becomes hard to understand. That's why I think it is a way forward. I think sections and elevations will not be used in planning. One time, we will draw plans, sections, elevations and we will show sketches. We do normally use sections of a small area which isn't telling you much. I know in some occasions sections are good but in most circumstances, if you have three dimensional visualisations it explains a lot more. It is very important.

In addition, interactive layer mapping tools were presented to the interviewees. The majority of interviewees agreed that the tool was useful particularly in the consultation process because viewers can selectively choose the information they see. However, it is still two dimensional mapping; therefore, interviewees also indicated that it could not be easily read by lay people. Private Landscape Consultant Group recorded opinions on layer mapping as below;

> The plan you showed me at the beginning - the plan in which you can turn layers on and off - A lot of people still cannot read those plans. I know it is hard to understand, but a lot of people cannot read the plan because people don't know how to orientate themselves with plans. When you learn how to read a plan, you can understand. But some people cannot read ordnance survey maps either.

6.2.3 Visualisation in planning

Subjects voluntarily mentioned the technological advantages and disadvantages during the interview process. As hypothesised in the Chapter 1, the research found that cost is one of the main constraints. An associate landscape architect, Interviewee A pointed out:

> An obvious disadvantage of computer visualisation is that it is expensive. And small practices have a hard time trying to compete with larger practices. Producing computer visualisation requires certain skills. You have to actually recruit those people into your office or you use sub-consultants, or get freelancers. It is not a skill that a lot of landscape architects have. Younger ones often have; whereas, older ones don't.

In particular, a GIS officer, Interviewee K in Technician Group claimed:

> Cons of computer visualisation are that certain expertise is required, the cost of the software, and sometimes the cost to acquire of the data for modelling (particularly GIS).

As suggested within the interviews practitioners employ computer visualisation in planning mainly due to industry standards of production, ease of communication and to reach a wider audience engagement.

> Advantages are that it is an industry standard now to use them. You will struggle if you do not have these packages. Once you've got used to them, it is the speed of being able to change drawings quickly and using Photoshop to be able to get across the message to clients and site users. (an associate landscape architect, Interviewee A)

> Computer visualisation is much easier to understand than paper drawings. I am not saying for everybody. But almost everyone is going to understand computer visualisations - photomontages, three dimensional animation, etc. (An associate landscape architect, Interviewee E)

> Pros are that you can use it to deliver to a much wider audience whether electronically emailing at place in internet…greater accessibility as opposed to the paper map which can be on a display board. It is the potential to be interactive. (a GIS officer, Interviewee K)

Table 6.1 below briefly summarises the advantages and disadvantages recorded by interviewees.

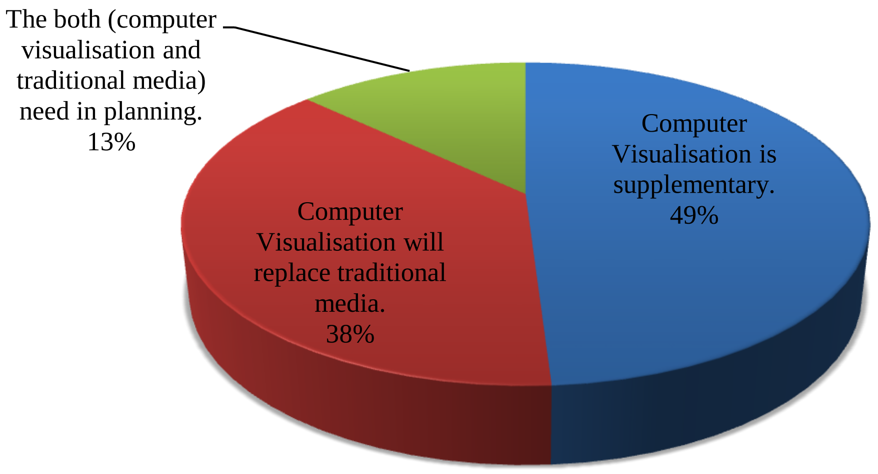
Table 6.1 Summary of advantages and disadvantages of employing computer visualisation in planning

Advantages	Disadvantages
• Easier communication (graphically in common language) • Inclusive (more parties can participate in development management) • Comprehensive (better than map reading - laypeople)	• Expensive • Sometimes, can be too many parties involved

The interviewees were asked to compare computer visualisation to conventional communication media such as paper drawings of plans and sections. Figure 6.4 summarised the results.

The majority opinion revealed that computer visualisation plays a significant role in the modern planning process and usage is increasing gradually. However, it is unlikely to replace traditional media. The majority of the interviewees claimed that computer visualisation is still supplementary in development management in the UK, in particular, some appealed that computer visualisation was a luxury and supplementary in planning.

Figure 6.4 Computerised visualisation and traditional media



The following comments were also made;

> At the moment, we need to have both (computer visualisation and traditional media) because if you put a planning application to a local authority you need to have paper as well as models. But there is increasing demand for landscape visualisation such as photomontages. It is becoming increasingly important. However, I don't think it will ever, be used to the same level nor replace paper drawings entirely. (An associate landscape architect, Interviewee A)

> I think computer visualisation is more supplementary. At the moment, it is more like a luxury. However, it tells so much more than anything else. If you have a three dimensional design illustration, as soon as you stand up it tells you more clearly about design than anything else. It is more like a luxury, isn't it? If you've got a big enough shop you can have it when clients require it but most shops are quite small so they cannot afford it. (A GIS officer, Interviewee K)

One of the reasons to keep traditional media such as paper drawings is because of official requirements including local planning authorities and its planning grant. In the development management process in the UK, planning submission formats are based on paper medium.

On the other hand, there could be a simple explanation for this phenomenon that paper drawings are cheaper to produce and something easily scribbled on. The most people in Group One illustrated this reason as below;

> I think the client has paid for something so you need to have it in paper format, but you've still got plenty of choices such as aerials, masterplan, photomontages… (An associate landscape architect, Interviewee A)

> I am quite interested to see how computers develop, so that this information becomes more available. But we still need to have paper plans to put a stamp on for showing this is the decision we've taken. Without that we will have problem. (An associate landscape architect, Interviewee E)

> I would have different image in my mind with the paper drawing. So computer modelling is very useful. Not knowing the site, not knowing what the surrounding area looks like or even the topography and you need to have detailed plans…series of plans to get across all contexts you've showed in the model. But probably paper drawings are a lot cheaper. (An associate landscape architect, Interviewee A)

> At the moment, I am still inclined…still people need to sit down and see maps. We need to sit down and draw/write on a map. It is becoming more a necessity to have them [computer visualisation]. 70% visualisation, 30% maps. (A GIS officer, Interviewee K)

One of the most obvious comparisons was the cost of production. Most opinions were complementary about computer visualisation but there was also an awareness of its major constraints.

> I think visualisation is very very useful. Probably, it is not as useful as it should be. I don't think it is used enough. At the moment, the technology probably hasn't moved on far enough where accessible for all, cheap enough for all. (An associate landscape architect, Interviewee E)

However, the advantages of employing computer visualisation in planning are undeniable. For instance;

> You have to understand that people do not understand plans, most people perhaps. If you look at a flat plan, which has all these items of it (place papers, pens, and mugs) and it is very difficult to understand what actually that means. And you often find that a lot of people sign up to our plan. And then say we didn't agree with that. I think one of the biggest problems is trying to get your ideas across. In the past, we used sketches and visualisations, which some people are very good at, some people aren't. Some people would exaggerate so it would look fantastic. Some people do very realistic drawings. Whereas, I would stay with the computer visualisation there is the opportunity to provide something fantastic and realistic. And also something visual, because it is three dimensions you've

> drawn in more people who can understand. Whereas, I think the plan is limiting and a number of people actually cannot understand what you try to do. I think it is a very powerful tool I think it will become more powerful I think it will become an automatic part of any design process. (An associate landscape architect, Interviewee E)

> If you bring paper drawings to experts, they understand because they have experience and trained. But, they don't always appreciate the implications; whereas, on that (computer visualisation), you can see straightaway where implications are of trees, and so on. (A GIS officer, Interviewee K)

The most convincing view on this is that computer visualisation is able to illustrate how proposals would look and envisage how changes will be made; however, the proposals cannot be built with computer visualisation. This is the nature of computer visualisation. A landscape architect, Interviewee C claimed that:

> Computer visualisation is more accurate than paper drawing. You are looking at a proposal and whole setting. But obviously you cannot simply just build with it. So it has two parts. It has a role to show to stakeholders and communities what it is going to look like. But it doesn't tell the builder how to construct it.

6.2.4 Assessments (Environmental Impact Assessment, Landscape and Visual Impact Assessment)

Within landscape planning, computer visualisations are extensively used in the assessment processes, including Environmental Impact Assessments, Landscape Visual Impact Assessments, and Landscape Character Assessments.

> Computer visualisation will help with a lot of EIA process because it is a more real life model. You can use it as a real planning tool. It is also possible to create various scenarios to help with assessment. (A senior landscape architect, Interviewee B)

Within a Landscape Visual Impact Assessment, currently photomontages are suggested to be provided in order to illustrate 'before and after' scenarios.

> … if we start to provide animated computer visualisation of the development within EIA you are going into a completely different ball game. You are going into something much more complicated and much more detailed. Often we don't get that. Often we just get a plan.… (A senior landscape architect, Interviewee F)

6.2.5 Planning stages to employ computer visualisation

As previously identified, computer visualisation is used mostly in environmental impact assessments, particularly Landscape and Visual Impact Assessment, but also in design proposals, planning applications, and public consultations.

Even though there is great potential for technology in planning, one criticism is that the employment of real-time visualisations at the planning stage could become supplementary. It was claimed that without an integrated connection with planning, computer visualisation could be just an expensive supplement to sell the final planning project (Lange, 1999).

Deciding on the planning stage of use, computer visualisation is also affected by the realism levels of computer models. Typically, in the early and middle phases it can be used to various degrees of realism; whereas, in the final phase including marketing, a much higher level of detail is required.

An associate landscape architect, Interviewee A claimed:

> Photomontages are commonly used in EIAs. Also computer visualisation is good to have in the early stages of projects before the masterplan decisions are made. You can estimate what sort of impact will be made, reflects on EIA masterplan content and make design changes and then show the implications of these changes. It could be a really good tool during the masterplanning process and design process rather than at the end.

As Al-Kodmony (1999) identified, of the three different media used in various planning stages, particularly community participation cases, his study found that freehand sketching was the most effective for problem identification and brainstorming, while photo-manipulation using computer imaging was the most useful for exploring solutions to previously identified design issues.

In this research, real time models were used in different stages of public consultation. During the case studies, it was also suggested that the technology is employed in the early stages of the planning application where people can see the existing problems and have more options to choose from. With traditional methods the proposals used drawings and written documents, which the public had difficulty understanding, compared with the real-time media used in later stages of the planning process.

An associate landscape architect, Interviewee D suggested;

> In the consultation stage, if we have computer visualisation, it would be more favourable. I think people would like to have it if they can. I've never heard anybody say No to this and it has been so helpful having photomontages. Most people say this is great, terrific, and incredibly useful.

However, in the early stages of planning, there is not much information available for computer visualisation to be created and provide reasonable assumptions to illustrate future options. Despite that, computer visualisation can be created with the information available.

An associate landscape architect, Interviewee A:

> Only scepticism I would have on that is that consultation often happens when the scheme is designed. People don't feel that they are been included in the process. And quite often in consultation, some people are very quiet; they don't say anything because somebody else is saying something very loudly. Whereas computers are good because they let people have their say. You are not being talked over by somebody else. So in the end, it would be nice to use the internet or something like that for feedback.
>
> It depends on which stage you employ computer visualisation. In the early stages you would have less information available for visualising which a lot of elements could be blurry and not clear whereas in the later stages you can get more information to produce computer visualisation. In the later stages you can generate almost close to the proposed design.

An associate landscape architect, Interviewee E:

> Planners say they accept and they are happy for stone finishes and materials etc. But when the building is completed, it is unacceptable. For example, when planners agreed a new building in the town centre, it was a building everyone can see and it was acceptable. But when it was built everyone says including planners it was horrendous. I think it is the lack of understanding in a lot of planning departments about what is a good design and what is a bad design and that's partly because they cannot read drawings and because they are looking at elevations and sections and stuff like that and they thought well that looks alright.
>
> I think in actual development control process and the actual process of giving planning approvals there is enormous potential. I think architects and landscape architects will be required to provide computer visualisations.

6.2.6 Public participation

As pointed out in Chapter 2, public participation is a statutory requirement of the UK planning system when drawing up development plans and there are currently two principal stages in the UK planning process at which members of the public can become involved: the stage of plan creation, with the planning authority considering many different interests before drawing up a plan, or in the form of an opportunity to object to a specific plan or development, where the planning authority must defend its position (Cullingworth and Nadin, 2006).

Each of these stages requires a different type of information and feedback from the interviewees; earlier stages should be concerned with the concept of a particular type of development or land use, while later stages should allow discussion of the details of a specific proposal. The benefits of early consultation are recognised and although it is not always utilised, many planning authorities are nonetheless finding innovative ways to involve a broader cross-section of interests. Some of the interviewees were making points as;

> In consultation, I am convinced that computer visualisation is making a lot of difference. No matter who is your client, who you are dealing with. Particularly people who do not have a planning and design background. People don't do design issues every day like people in the street, community groups. If they see this type of computer visualisation, they will have a very good idea of what they are buying into not buying into also they can engage with experts. You will engage a lot of people. You can set up a room where people come anytime and mark up things like that…so you've got a record of it as well. (An associate landscape architect, Interviewee E)

> If you don't have a visualisation in the consultation process, people might not get a true idea of what the site will look like. Bearing in mind that you might be talking to people who have not necessarily seen the site in detail and the most detail seen in a paper map, until you actually go out on site or look at some real model of the site, you are not entirely sure what is there. So people might request something on that site that isn't that practical but they believe it is because they see on paper. Computer visualisations will give more accurate information as far as the visualisation information is up-to-date. (A GIS officer, Interviewee K)

6.3 Evaluating Credibility, Level of Realism and Costs of Production

Together with Chapter 5 Planning Application within Case Studies, this chapter evaluate computer visualisation based on the research framework established in Chapter 2. The research framework mainly consists with three components: credibility, level of realism and costs of production.

6.3.1 Technology scepticism

In the research process, it was found that a number of planning professionals were aware of the potential risk of using computer visualisation. Even though there have been many recent developments in digital technology, scepticism[65] of the technology still exists. An associate landscape architect, Interviewee D particularly raised issues concerning this;

> I think there is a lot of - probably less now – of scepticism about almost everything computer generated. But that seems to be a lot more in terms of the acceptance of about the images computer generated.

This comment suggests that photomontages were most likely to be misinterpreted. Moreover, it was indicated that:

> [Photomontages] can be misleading. That is why I prefer VR models you cannot hide anything. Photomontages are theoretically looking at the nicest bit of the site. (An associate landscape architect, Interviewee A)
>
> That's the impression; looking at the computer screen it isn't always accurate whereas there is more confidence in drawings. It has a scale on it. People don't think it is real they think it is an artistic impression even though it is based on OS data. (An associate landscape architect, Interviewee E)

However, some interviewees pointed out that scepticism would be dependent on the age of the person viewing the image and/or techno-phobia. These suggestions were untested in the research.

6.3.1.1 Credibility, accuracy, and reliability of computer visualisation

The quality of computer visualisations is dependent on the current technology available and it is closely related to the level of detail. These issues will be dealt with in greater detail below. However, it is important for computer visualisation to be credible when it is implemented in the development management process in the UK. Therefore, there is a need to develop technology which meets scientific and social needs.

Earlier research by Sheppard (2004) suggested[66] that judging the quality of computer visualisation requires the setting of standards or thresholds along the various quality dimensions.

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[65] Appleton (2001) suggested that value judgements would always be present, and parts of the image would be selected and set up to show the scheme to its best effect. While this could be result of artistic licence, there are further questions of intentional incorrectness in visualisations, for example to reduce the apparent impact of a proposal.

[66] He also claimed that 'Better' is often interpreted to mean faster, higher tech, more realistic, more user-friendly. However, these aspects have as much to do with efficiency, profit, image, popular demand and selling a product or a design, as they do with more meaningful factors for protecting the public interest: e.g. safer and more informed decisions, defensibility and other ethical considerations. Ethics refer to moral principles, which distinguish between right and wrong; in professional practice, this usually means conforming to a recognised standard or codes of conduct. Validity generally refers to whether an instrument or finding is sound, defensible and well-grounded or appropriate to the issue at hand.

In the semi structured interviews, practitioners were asked 'how can you decide the quality of computer visualisation' and 'when do computer visualisation take a part in decision making'. Most practitioners indicated that there was a greater likelihood of influencing planning decisions if computer visualisation is used.

However, within these uses, the majority of practitioners stressed the need for credibility in the planning media used in the development management process even though there is a certain degree of artistic licence in the media. The real need for visualisation is to provide a better means of communication and to support more informed decisions.

However, during the case studies, computer visualisation models were prepared on the basis of the surveyed information. From the surveyed information, it has been found that there was much scope for artistic licence in the creation of real-time landscape models. Although it starts from surveyed information, virtual reality models in planning use these options for preparers to consider (An, 2005).

- Texture – type, variety, accuracy, resolution
- Camera – type, angle, position, focal length, movement
- Movement – speed, height, collision handling, terrain following

In addition, in the case of image manipulation, colour and scale options are to be considered for production.

A highly realistic image may in fact be very inaccurate[67] or even show a completely fantastic scene with no ecological validity. Common problem of credibility in visualisation is that sometimes computer visualisation is assessed as a subjective view; however, credibility of visualisation requires to be objective.

Credibility can come from scientific protocols. Without the scientific grounding, computer visualisation cannot be assessed by recipients, where accuracy can affect scepticism: it addresses the issue of truthfulness or fidelity of the visualisation imagery to the actual or expected appearance of the landscape in question. It is analogous to a response equivalence

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Reliability refers to consistency in repeated applications. Both these concepts have implications on the ethical use of landscape visualisation.

[67] Appleton (2001) also claimed that while some of those creating visualisations may continue to strive for maximum detail, it is worth bearing in mind this comment from one participant: "Wrong images can exist, but there can never be a completely 'right', totally realistic image. The information contained in the image will always be greater than zero, but can never be complete." Therefore, it may be better to work towards an appropriate level of detail, tailored to the proposal being illustrated.

in terms of before/after comparison, although it is directly measurable in terms of objective image qualities, rather than mediated through observer responses. It relates also to the concept of 'ecological validity' described by Palmer et al. (2001), referring to the assurance that the environments visualised are ecologically feasible.

Some of practitioners stressed that accuracy is the most important factor for the quality of computer visualisation;

> Accuracy is critical. Without that, we cannot use computer visualisation. We cannot defend what we are doing and what we are proposing. That is the key. It will be good if that looks good but accuracy is more important. (A director, Interviewee G)

> Computer visualisation needs to be based on scientific survey such as Ordnance Survey. Then we can say the computer visualisation is accurate. (A GIS officer, Interviewee K)

> Accuracy…it gives more information and it is easy to understand what the project is going to be like in the model. So in some aspects 3D visualisations are more accurate because it is 3D also it is based on OS information. So I would say computer models are more accurate. (An associate landscape architect, Interviewee A)

Sheppard (2004) suggested that scientific definitions of reliability[68] refers to internal consistency of methods: 'the degree to which an instrument … can retrieve the same answers when applied under similar conditions'

In terms of a planning application, some practical implications were raised on credibility by practitioners.

> It does bring in more accuracy to subjective view when you know how it has been done and you know the method used to create the model and the assumptions made. EIAs have to be done by landscape professionals because their subjective views are much better than somebody else's subjective view. Yes it would affect the subject view. (A senior landscape architect, Interviewee F)

> Landscape architects are doing the design and then are sending it to someone else to visualise. That's why you pick on this issue. That level of information you might get when you have to generate computer visualisation, how accurate the information is you get and how much information you interpret that's the problem we are going to have. Is that the plan that you can see technically accurate or not? It's got a scale. Buildings are that big and trees are that high. Now somebody is putting

[68] He continued that in practice, reliability requires consistency in the visualisation process, and consistency in objective: opponents to a project may create a very different set of visualisations than the applicant, using the same datasets but with different motivations. The reliability of visualisations can potentially be affected by many diverse factors, such as data quality, operator procedure and skill level, deliberate bias or stakeholder influence, 'bugs' or data incompatibilities in the software, etc. most of these factors also threaten the validity.

> something into a landscape and if you are putting an animation together, you might be ending up with 50% of information that is real. And you have made up 50%. (An associate landscape architect, Interviewee E)

An associate landscape architect, Interviewee E's 50/50 theory above did not come from any research figure. This was based on his own judgement. However, it has valuable points. In fact, this comment contains the risk of credibility loss in computer visualisation production.

6.3.1.2 Scepticism continues

Interestingly enough, one interviewee indicated that if people wish to manipulate the information to provide a biased perspective, they can do this without technology. This is a problem that is inherent within planning and not just a problem of computer visualisation. Given the importance of the issue scepticism was explored further.

Generally speaking, computer visualisations were much appreciated by the practitioners. They make the planning process more comprehensive and using visualisations we can see what is going on and see what we were unable to catch with traditional media. It is claimed that:

> Yes, they [consultants] can possibly manipulate computer visualisation. But they can do that with drawings anyway. As long as you are showing 5 to 10 years down in the line on your model or you honestly believe what it will look like but you cannot legislate for vandalism or any of the kind of damage of sites. So any type of consultation tool is open for argument in terms of issues on accuracy and it depends on what information you want to put in. (A GIS officer, Interviewee K)

> I think people need to be aware that visualisations represent one person or group of people's view on what it might look like in year 10, year 20, and year 30. It is not exact. Nobody is going to predict the future. This [visualisation] has given people a better indication of what the end product might be and the aim is to have…it as presented in the visualisation. It is not going to be an exact replica of what it might look like in year 5.

Moreover, the majority of the Private Landscape Consultant Group recognises that computer generated visualisations are as accurate as traditional paper drawings even though it always contains assumptions on visioning. The Forest Organisation Group also indicates that computer visualisation is as accurate as paper drawings because it is based on the same Ordnance Survey information.

Another difference between computer visualisation and paper drawings is how you present the results to viewers.

> We've asked to review photomontages done by some other company. Someone is doing EIA, and someone did photomontages. Photomontages were so misleading. I can understand why they've taken the photos from those points. They are taken from points which probably show the building in the best setting so the photomontages were there to sell their building. They won't demonstrate the impact if you see what I mean. Everything was badly misleading. If you read the text you can clearly find the differences between the photomontages and the description in the text. Materials they said they were using in the text is different. All this sort of things added together…I thought that it wasn't a true reflection of the scheme. (An associate landscape architect, Interviewee E)

However, the case study (in Chapter 5) indicated that the level of realism would not affect any judgement they made. Since respondents are aware of the site, context and so on, the main focus was on the tree height, vegetation screening rather than how realistic the models were[69].

6.3.2 Level of realism

Some practitioners interviewed suggested that the images, especially in the foreground areas, need to be as detailed as possible for the identity[70] and to ensure the various elements are clear. One interviewee even suggested "the more realistic the better," since a certain amount of imagination is still needed to imagine the real thing from an artist's impression. However, such a broad statement may not be appropriate given some of the reservations expressed by other participants.

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[69] During the Windlestone Hall School case, participants produced the most important feedback was about the level of realism. Interviewees were residents, school staff, and planners who were well aware of the site and the development context. Moreover, the computer models presented were real-time rendering which gives full interaction but at the expense of realism. The real-time rendering was based on simple geometry and low resolution bitmaps.

[70] According to Appleton (2001), confusion over parts of the visualisations would be distracting or even misleading for the viewer, possibly leading to inappropriate decisions being reached. She concluded that the inclusion of a large amount of detail might lead to many questions about aspects of the proposal that aren't the primary focus of the images, distracting the viewer's attention from the main issue. "People do pick up on details like that because that's what they understand," said one respondent, suggesting that looking at the 'bigger picture' may be difficult for certain audiences. In the same research, it was also thought that very realistic imagery might fix certain details in people's minds when those details may not be set in the proposal. Such details might also lead people to comment on the level of detail, which is inappropriate for the stage of consultation, especially if that is at the expense of feedback at the desired level. These and other issues regarding realism in relation to the proposal being illustrated are expanded upon in the next section. Appleton (2001) also pointed out that another advantage of increased realism is the reduction of similarity within the visualisation, so as not to imply that everything is uniform. Furthermore, the representation of elements that already exist in a location must be realistic if the local viewer is to be convinced that the image is accurate. Elements which are seen as incorrect may be distracting as well as potentially leading to a loss of confidence in the part of the image showing the changes. Such problems may stem from a difference between the visualiser and the audience in the perceived importance of various elements of the image. Density-based representations, as used for some vegetation, may be a particular problem, but there will always be more variety in the real world than in a computer image, even with the use of textures and other randomised variation. A high degree of realism implies a high degree of accuracy – if accuracy can be disproved for existing elements of a particular view, it is likely to be affected with regard to the proposed changes.

Much has been written in the academic press on the issues of realism and the level of detail in visualisation. It has been a major issue since it was introduced into planning and a number of studies have dealt with these issues in conjunction with its implementation within planning.

The level of realism in the visualisations was generally felt to be high and provoked a large number of comments. A few respondents felt that some parts of the images appeared less convincing than others; despite the fact that they were all produced using the same software with no difference in approach, there are obviously some unintended differences.

Several interviewees suggested that visualisations, especially the foreground areas, need to be as detailed as possible for the identity of the various elements to be clear, since a lack of clarity could be distracting or even misleading for the viewer and may lead to inappropriate decisions.

In the interviews, an associate landscape architect, Interviewee E commented;

> It isn’t necessary for it to be a highly detailed model. I think if you are talking about any small size or reasonable size of development even sports park, at the end of day you should have papers to put a stamp on but computer visualisation will be a major part of the design process. It will become big and bigger. People will require it and it will become a part of planning process. Because it is about engagement everyone is tied into computers. Kids play games…. 3d is familiar. My son is good at computer games. He showed me one day. He goes into tunnels ups and down and it is almost similar to designing a path.

It was also thought that very realistic imagery might fix such details in people’s minds when those details may be incidental to the proposal, or may have been selected at random, taken from the software’s texture library, or chosen artistically by the developer who created the images.

A point[71] raised by some practitioners was that the representation of existing elements in a location needs to be realistic if the local viewer is to have confidence in the whole visualisation.

[71] This has been noted in other research (Lange, 2001), and substantial degree of realism implies a high level of accuracy (Bishop and Lange, 2005) – therefore if accuracy can be disproved for existing part of the image, doubt is case on the representation of the proposed changes. Density-based representations, used in this case for some vegetation, may be a particular problem, but there will always be more variety in the real world than in a computer image (Ervin, 2001), regardless of the technique used. All representations require selection of the elements to be represented, which may introduce unintended bias and lead to questions over the simulations’ objectivity (Hall, 1996)

The relationship between the level of detail and the certainty of the proposal formed an important sub-theme. Several interviewees felt that more realistic images may cause viewers to have higher expectations that the finished development will look exactly like those images, when in fact they can never be an exact prediction of the final state. While viewers may relate the artistic licence implicit in hand-drawings to a lack of certainty about specific details, such licence is far less apparent in visualisations.

It was considered that the visualisations that showed the proposal in a high level of detail are of great benefit. Moreover, there is a clear need to consider what level of realism is appropriate for a particular project or stage.

For instance, in Windlestone Hall School Relocation, participants indicated that the level of realism would not affect any judgement they made. Since they were familiar with the site, context and so on, their main focus was on the height of proposed tree planting mitigation and vegetation screening rather than how realistic the models were.

Computer generated visualisations and virtual reality are becoming popular in planning processes in the UK. Despite the limits of real-time technology, even ten years ago, four out of twenty local authorities and eight out of thirty housing associations that had used virtual reality or something similar[72]. Virtual reality and computer animations are being used in 'scenarios' on various developments such as ZVI, Visual Impact Assessment within Environmental Impact Assessment, and Landscape Character Assessment.

In the UK planning system, there are no constraints on the use of visualisation nor does it have a codified constitution of the type common to most other countries such as US and Korea (Kim, Kim and Lee, 2011). Such a lack of constraints allows for a wide degree of discretion in the UK planning system, enabling visualisations to be included within this process.

Under such discretionary planning structures, most development management decisions relate to individual applications; therefore, it is considered that communication media may be more important than within other countries, which tend to be based on binding zonal plans.

As demonstrated in Chapter 5, residents near Windlestone Hall School were not, concerned about realism in the visualisation. Again, the 3D models were not necessarily to be in high

[72] Martin et al. (2002a)

level of detail. Instead, basic geometry models were sufficiently served the purpose, which was assessment and consultation of visual impact of the new school buildings.

Therefore, it could be considered that visualisation models do not necessarily have to have a full degree of realism in planning circumstances. As illustrated in the previous section, it could vary in planning proposals and purposes of the implementation.

Moreover, in the Windlestone Hall School Relocation case, the real time models were presented in a room with monitors and data projectors. The impact of these conditions on the decision made by the respondents cannot be quantified, but it can be considered that it is reflected in the answers to questions about similarities to the real environment.

6.3.3 Production costs

In the Chapter 5, an assessment of production costs for computer visualisation was based on the author's hands on experience during the case studies. The processes and figures in the chapter are a true empirical reflection of the field.

In this chapter, despite the benefits, using the technology can be expensive. For instance, 3D authorising software are often expensive, the rendering process requires powerful computers as well as highly trained staff.

However, the technology is still evolving and a number of new software programmes have been released at the time of this research. Some of them are commercially free, more effective, intuitive, or easy to use, and could be affordable. Moreover, developing computer technology can potentially provide the advantages of effectiveness, easiness and validity than ever before. Moreover, it is stressed that the technology is becoming more affordable with the result that modern planning is taking advantage of technological developments.

In addition to the technical and empirical analysis on production costs for computer visualisation, this section aims to demonstrate what the practitioners within the semi structured interviews think about cost issues. At the same time, based on the author's experience and a practitioners' point of view, it tries to analyse perception and constraints of the costs.

As stated earlier, the practitioners interviewed in the research are senior landscape architects, directors, associates, and forest officers all with more than 10 years of experience. Therefore their views on computer visualisation were as expected mature and reasonable.

Most interviewees indicated that cost is the most common constraint. Other points were made by practitioners which included staff skills, project types etc. however, those are also strongly linked to cost constraints. For instance, a GIS officer, Interviewee K claimed;

> Money, expertise, staff…are constraints. If [computer visualisation] becomes quick and easy so that people can access it, it will become very popular.

Moreover, an associate landscape architect, Interviewee A added;

> Using AutoCAD is common. But GIS? Probably only two landscape companies can afford this in the UK.
>
> Disadvantages are the time and skills required. Most practices won't have kit, people, and time to develop something like that. Not many clients can afford that [computer visualisation].
>
> Maybe things get cheaper…but it is going to take time.
>
> Generally public expectations are so high because technologies moved on such as mobile phones [smartphones] become so complex. So people expect more than plans. They expect to see photomontages. Clients expect things very quickly as well. Most of the small offices cannot afford these things, high spec computers, and so on. That's the cons.

So far, little research has been carried out on the costs associated with the preparation of computer visualisation. One of the reasons is the fact at the pace at which contemporary technology is being developed with the result that measuring costs is an ever changing computation. The cost of software such as three-dimensional creation and GIS could be key elements as well as acquisition costs for digital data and skilled labour.

Moreover, the cost of visualisation models is very dependent on the types of models (mainly the degree of realism) and the services provided. As a result, it is difficult to illustrate a specific cost figure; however, the findings of Chapter 5 suggested that it generally ranges between £500 to £20,000 for a single visualisation, typically £5,000 in normal circumstances in planning in the UK (Table 5.3 and Table 5.4, page 135 and 136).

An associate landscape architect, Interviewee E claimed;

> Cost and time are major constraints to employing computer visualisation. Actually cost and time is actually the same thing. The other constraint is that it is also a fact that not many people can do that at the moment properly.

In addition, there are many computer visualisation software providers who operate in the current market place and their products range from simple photo manipulation to highly sophisticated three-dimensional software.

During the interview process, the research identified that employing software is highly particularised in individual practices and cases. For example most of interviewees were using Autodesk's AutoCAD as a drafting tool. In particular, an associate landscape architect, Interviewee A claimed that AutoCAD is now known as an industry standard application and its associated '.dwg' format files are the industry standard format for the exchange of drawings in the planning process.

Moreover, GIS applications are normally used within academic areas and large organisations. However the cost of these applications is much more than CAD-based authorising software in terms of data acquisition and its management. Unlike these large organisations who have access to GIS-based applications, most real-time models in planning are prepared by individual consultants. As a result, CAD-based applications have been predominantly used for visualisation by planning practitioners because of the prohibitive costs of GIS applications. A GIS officer, Interviewee K's comments supports this;

> Smaller firms won't use GIS. Because the difference between GIS and CAD one of them is that CAD is developed more an engineering structural tool based on geometry and design; whereas, GIS has been able to give data you collected at geographic reference on the earth. So you can put a point on a map and the point links to the data behind the point; whereas, CAD doesn't work like that. CAD is a design tool. GIS is a combination of graphics and data together with location of reference, two different things.

Generally, the case studies have been carried out utilising scripting-based software. Similar to Shockwave Lingo, there is a number of commercial and non-commercial tools to create real-time visualisations including VRML (X3D). Unlike GIS based applications, those are free or relatively affordable to the organisations who actually prepare visualisation such as environmental consultants.

One of the disadvantages of employing computer visualisation is obtaining the base data. In the UK, Ordnance Survey information is the main source of data such as DTM, vectored base map and colour raster. However, during the case studies, all the data was provided by the clients

6.4 Conclusion

This chapter reflects on the utilisation of visualisation in planning practice using the analysis framework adopted: planning roles, technology scepticism, level of realism, and cost of production. During this investigation, interviews with practitioners were carried out using a mixed methodology of focus group and semi-structured interviews in order to investigate practitioners' views on the implementation of computer visualisation within planning practice.

While Chapter 5 analysed the planning applications within the case studies partially based on author's hands on experience, this chapter has focused on views of practitioners who have been involved in development applications. Throughout this research, the cohesive analysis framework has been adopted for the analysis. The analysis framework is based on emerging issues identified earlier in the research; the role of planning, technology scepticism, the level of realism, and cost of production. Therefore, questions for interviews have been established by the framework (See Appendix A Semi Structured Interview Questionnaire, page 189).

The results of the interviews have exposed a variety of professionals' reflections of computer visualisation implemented in planning process through the framework, discovering the importance of the communication media within development management in the UK.

First, the interview analysis has indicated that the computer visualisation is employed as a communication tool in the development management process. Accordingly, much, even if not all of media is understood as being the token of communication amongst actors involved in planning. Planning professionals preferred to use the planning tools, which are cost effective and presents credible representations for communication. Currently, the answer has been photomontages.

Secondly, the credibility of computer visualisations used in planning is significant. Science purports to have its theories and robust facts; whereas, the arts concerns itself much more with qualitative information. Within the development management process, every media for planning decisions requires to be credible for decision making. This is where scientific protocols need to be in place for a valid media production. However, during planning processes, some practitioners claimed that there are stages such as design development and conceptual stages, exercising artistic licence with computer visualisation and those processes need to be encouraged.

During the interviews, it became clear that there must be an appropriate balance between the sciences and the arts. However, it has been absolutely clear that within planning application and the decision making process such as assessments and public enquires, producing credible visualisation is essential to prevent biased information to planning audiences.

As similar as the findings in Chapter 5, during the interviews, some practitioners indicated that computer visualisations in planning are often produced in favour of the developers' intention since the majority of computer visualisations are commissioned by the developers.

Interview results also find that there is a risk of providing misleading results when employing computer visualisation during the planning process. In particular, photomontages are indicated as one the most likely biased medium and many of interviewees suggested that some form of guidelines are required in planning industry. Despite few objections, the majority of practitioners suggested introducing production guidelines without limiting creativity and artistic licence of visualisations.

Under the UK's discretionary planning system, more consultation and negotiations are generally required. During these processes, computer visualisations are often employed mostly for stakeholder consultations, public enquiries, and Environmental Impact Assessments (including LVIA).

Third, the research found that one of the major constraints on employing computer visualisation is its cost. It is generally agreed that visualisation production becomes easier and less complex as a result of the development of new software and hardware. However, the research concludes that staff with relevant levels of experience and an appropriate timescale are still required to produce credible computer visualisations in environmental practices.

Finally, the level of realism seems to play a key role in preference, perception and the cost of computer visualisation media. However, the level of realism is subjective. Different practices and practitioners are able to read representations of the environment in different ways. How much detail do people need in order to judge or accept a landscape as 'real'? In fact, it depends on the recipients, the project and the purpose of the visualisation.

Of course, there are many benefits in having higher levels of realism. However, it is not a prerequisite within development management process. In particular, residents' responses and planner's comments in Windlestone Hall School case study suggest that the credibility of computer visualisations is more important than the realism of the model (please refer to Chapter 5).

The medium used at the Windlestone Hall School case study was real time rendering which gives full interaction but at the expense of realism. The real time rendering was based on simple geometry and low resolution bitmaps. However, participants[73] indicated that the level of realism would not affect any judgement which they made. Since they were familiar with the site, context and so on, their main focus was on the height of proposed tree planting mitigation and vegetation screening rather than how realistic the models were.

Interestingly, the practitioners interviewed shared the same view on this matter. Most practitioners claimed that despite technological advances, planning and development management would not necessarily follow video gaming or media industries. Planning actors are more concerned about credibility of computer visualisation when they make planning decisions rather than realism of computer models utilised as planning tools.

Moreover the various planning stages in which to employ computer visualisation have been examined. For example, public participation is one of the potential and consequently, general public, local authorities in particular, have had some degree of preference to use.

In addition, the interpretation of visualisations is highly subjective. It is depends on the viewers' age and experience or could be merely related to the techno-phobia of particular individuals. This subjective of visualisations affects decisions on level of realism, credibility and production cost for computer visualisations in planning use.

[73] Local residents and planning officers

CHAPTER 7 IMPLEMENTING COMPUTER VISUALISATION IN UK PLANNING

The aim of this thesis is to understand and reflect on computer visualisation in current planning practice. This was explored by considering how computer visualisation in the UK has been implemented; examines the visualisation production processes, and suggest some of the implications of the experience of computer visualisation for the planning process. In addition to the use of the technology, the research is questioning the media used for individual visualisations currently in use within planning practice. In order to achieve these aims, two main research questions were established in Chapter 1; *how computer visualisation has been utilised within development management? and what are the challenges computer visualisation is facing when implemented within planning consultancy practice?*

In addition, based on a review of existing literature, this research explores in particular the issues of *technology scepticism, realism, and production costs*.

In order to tackle the research questions, the methodology has been developed from two different perspectives: *1. In-depth study of individual applications* and 2. *Reflections of consultancy practitioners based on their experience through semi-structured interviews.* Throughout, the research has adopted the lens of the landscape consultant, which has focused on the process of visualisation design and implementation as part of the development application. This perspective has uncovered the practicalities of the actual usage of visualisation and the challenges emerging identified as the key questions within this thesis.

Firstly, the individual planning application cases were selected based on typical planning applications and utilisation of computer visualisation in order to investigate the empirical implementation of the technology within real development management. Moreover, the author was personally involved in the creation of models for these case studies. With the case studies, the research will be able to scrutinise the empirical utilisation of computer visualisation in the development management process in the UK as well as investigating individual media employed in planning.

Secondly, the other element of the methodology is employment of semi-structured interviews with planning practitioners. Through interviews with experienced professionals, the research is able to explore their reflections on issues and challenges of technology implementation in planning. Therefore, this element of the methodology has explored current challenges faced by consultancy practitioners with regards implementing technology in the planning process.

This final chapter is made up of six sections. The first section elaborates on the research results and the main findings of the case studies and interviews with practitioners. The second assesses the constraints of technology in planning use established in the research framework: *role in planning, technology scepticism, level of realism, and costs of production*.

The third section encapsulates the role of visualisation in the planning process; whereas, the fourth section examines what contributions this study has made to the understanding of the utilisation of computer visualisation and explores what theoretical implications result from these findings. In particular, the value of the media of visualisation to understanding the planning process is examined.

The fifth section sets out the limitations of the study. The chapter is then concluded with an agenda for future research on computer visualisation.

7.1 Research Results and Findings

Recently, demanding utilisation of visualisation has brought its own issues such as credibility, realism and cost. In particular, credibility became significant when computer visualisation was implemented in the development management process and a planning decision could be affected by the form that the visualisations took when they are implemented in assessment and consultation processes. Realism and cost are equally important. Those emerging issues were identified in Chapter 2 and became part of the analysis framework in this research.

This study has also provided a better understanding of the use of computer visualisation in planning and makes some recommendations for the improvement of its usage through the case study analysis and semi structured interviews with practitioners.

The case studies have brought into focus the dynamic interactions between the technology, perception and implementation behind the planning management process. A noteworthy feature of the process is that at the early stages of the case studies, the involvement of preparers - i.e. private environmental consultants - was significant; whereas, as time passes, instead of preparers' involvement, client and planner - i.e. local planning authorities - influenced the production process in terms of level of realism and the types of media implemented.

The research also adopted a semi structured interview technique as part of the methodology. Key practitioners from private environmental consultants, a planner working in a local authority and forestry officers were interviewed.

The research undertook a review of the modern technology and implementation. While no single factor appeared to explain the dynamics behind the implementation process, some factors were more likely to be important at various times than others. Indeed, a hierarchy of influences appeared to exist. The first level of this hierarchy included two prerequisites for understanding the nature of modern technology and computer visualisation media utilised within the planning process, and reaction from the stakeholders - at the later stage. These results coincide with the results of the case study analysis, which showed that the issue of credibility is very important at the visualisation preparation stage; whereas, the level of realism is not a major issue at the consultation stage. Clearly the level of realism has to be such that the stakeholders can recognise the development site and its surroundings, but it does not need to be photo-realistic visualisations to be useful within consultations.

What is noticeable in this analysis is the role of the environmental consultants in the planning process. The role played by the private sector in influencing the planning process had been given very little attention in previous research. However, this thesis showed that visualisation preparation has a fundamental impact on the planning decisions. For example, the introduction and adoption in practice by the private sector has been instrumental in fashioning the utilisation of the technology in planning since planners, developers and environmental consultants have been in favour of computer visualisation for their proposals and professional bodies and institutes have been encourage to implement the technology.

One of the conclusions that can be drawn from the case studies is that the employment of computer visualisation within the planning application process is a complex field of credibility, efficiency and affordability on various planning applications with many stakeholders. Thus, whilst local planning authorities in the UK appreciate the efficient and powerful tools, some experts who were perceived to maintain an anti-technology culture or who suggested an intermediate level of utilisation, were forced to change their attitude because the expectations from the general public is becoming higher and compatibility issues over standards of the planning process amongst private consultant, public and the local authorities increase.

While the development management elements in the UK, including planning policies in particular, have helped explain the general pattern of adoption of the technology over time, the ways in which they affected the planning decisions were far less difficult to predict because of the clear nature of the computer visualisation and the preferences on the media from stakeholders involved. In other words, how the elements should exhibit such different levels and stages of the planning process could not be explained adequately within the case study analysis. As a result of these findings, the thesis has identified the emerging key issues.

Whilst it has been difficult to describe the very complex nature of the interactions between technology and its adoption in UK development management process, the case studies have clearly demonstrated some of the ways in which the computer visualisation have acted both as a constraint in cost/skills and as a propellant in consultation capabilities. Therefore, it is clear that the implementation of the technology has not been the result of a simple process. Rather, the planning process, in any particular location, evolves a series of actions and interactions which may have the effect of enhancing the process of planning or developing barriers, in the form of modern technology, to this change.

In other words, the semi structured interview results have indicated that the implementation of the technology within planning is characterised by a complex series of diverse linkages between modern technology and planning utilisation associated with the politics of development management.

One of the most important findings of this research is that the parties preparing planning applications could try to influence the planning decisions in their own favour, where most computer visualisations are commissioned by developers. For that reason, the credibility of

Table 7.1 Summary of Research Findings

	Visualisation Medium	Role in Planning	Technology Scepticism (Credibility)	Level of Realism	Production Cost
2D	Photomontage	Considered to be the most accessible technology in planning. Formally recognised and used. For consultations and various assessments (EIA, LVIA) Used within public/stakeholder consultation, design development and development management	Recognised formally in planning. Good practice guides are already in place. Scepticism still exists (certain degree of modelling still involved). Appropriate methodology and protocol need to be established to produce.	It is 2D and very photo realistic; whereas, it lacks immersive sense in 3D. It also can be very powerful graphics because it departs from existing photographs. Scale of change involved.	Perceived as low relatively. Simple photo editing can be done instead of extensive 3D modelling. Because of its low cost production, it is most favourite medium in planning
Alternative 3D	Panoramic VR (QuickTime VR)	Rarely used in planning. Similar to photomontage plus interactive movement and more angles. Used as a marketing tool	Similar to photomontage process but the only difference is interactive viewpoint movement. Guidelines are same as photomontages for production.	As with photomontages very photo realistic.	Cost is not much more than photomontages (extra skills in production require to set up the interactivity)
	Pre-set path simulation (animation)	Use largely confined to large projects. Considered as final production. Rarely used in development management process but often used for public consultation. Used as a marketing tool and within design development.	Animation involves a great deal of 3D geometry modelling. The elements to be taken into account can include: built up structures, atmosphere, movement, vegetation, water, and weather. Very difficult to control credibility issues – geometry, texture, atmosphere.	It depends on geometry and texturing. Usually very high sense of immersion but low in photographic reality. This can be improved but this increases production cost. Interactivity closely links to realism.	Usually very and high skill and labour required for production. It depends on level of geometry and texturing.
	Real-time Rendering (virtual environment)	Not very often used in planning. Could potentially be used within public consultation, promotion and marketing.	This is the most technically advanced visualisation to produce. Similar to gaming, rendering real time limits for a number of elements i.e. texturing and geometry.	Because of real time rendering, quality of visualisation is significantly compromised. Limits realism dramatically. Maximum level of immersion.	Similar to animation but this requires additional interactive skill and labour. Usually highest cost for production

computer visualisations is highly significant and could play an important role in planning processes.

On the case study analysis provided in Chapter 5, the usage of visualisation media within planning practice and a comparison of their strengths and weaknesses is provided in Table 7.1.

The findings also suggested that photomontages were considered to be the most accessible technology in planning such as EIA (LVIA) and stakeholder consultations. Moreover, they are formally recognised in development management processes in the UK. However, other computer visualisations were relevant, although their usage varied: panoramic VR (rarely), animations (occasionally), and real time rendering (sometimes). For instance, within marketing or promotional presentation stages, the alternative 3D media are most commonly utilised.

The research also finds that scepticism exists in production of photomontages even though there is some published guidance. The findings from the practitioners interviews suggested that there are some concerns that introduction of guidance can limit artistic licence of designers; however, majority of the practitioners suggested the necessity of good practice guidance or protocols for photomontage production in planning use.

There are also credibility issues in other media. However, panoramic VR, animation, and real time rendering are not recognised formally in planning processes; therefore, utilisation of those visualisations are limited and to only certain stages of planning such as marketing and promotional presentations.

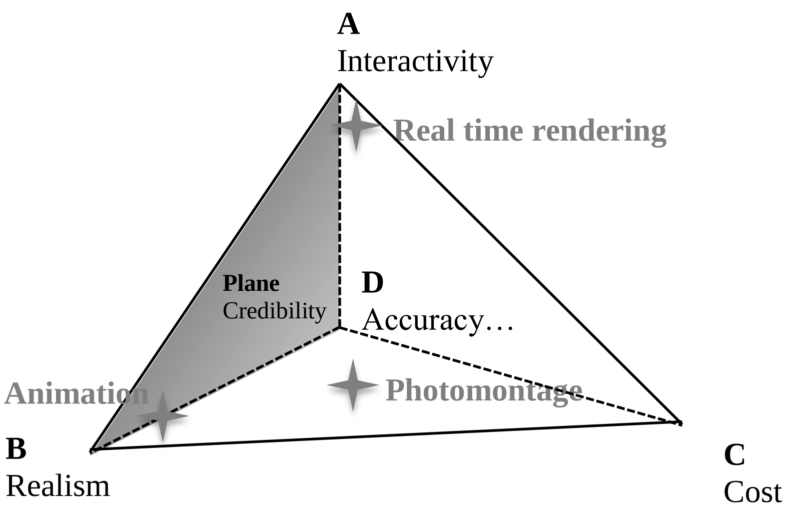
Nevertheless, most of practitioners interviewed envisaged that the alternative 3D visualisations would be implemented in planning processes as technology advances. Then, sooner, appropriate guidance of implementation will be required.

Moreover, most of interviewees claimed that planning audiences still needed to use their imagination to go from the visualisations to understanding how future scenarios will look. Because the real world cannot be copied perfectly, the level of realism used within visualisation needs to be decided for planning use. The extent of realism is just one aspect within the development of a credible visualisation and may not be the most important.

In addition, the research finds that interactivity is also an important element in order to achieve social sustainability. In planning context, interactivity refers decision-making, public involvement and participation during planning process. Interactivity within computer visualisation requires less realism – in current technology - and also leads to increased production costs.

Finally, deciding the level of realism and extent of interactivity is closely related to production costs. Each visualisation media has its own advantages and disadvantages in terms of production cost. In planning practice, cost may be a significant factor in employing computer visualisation. Therefore, those media can be placed within Tetrahedral Dilemma of Computer Visualisation in relation to individual media (Figure 7.1 below).

Figure 7.1 Tetrahedral Dilemma of Computer Visualisation (in relation to individual media)



A and B but not C: commonly produced computer visualisations

B and C but not A: pre-set path simulation and photomontages

A and C but not B: real time rendering and panoramic VR

There was a general awareness of the subjectivity involved in the production of visualisations and that they will inevitably only produce a simplification of reality. However, the findings suggest that unlike video gaming industry, computer visualisations for planning use do not need to be produced to a highly photo realistic standard.

Moreover, within photomontages, realism is related to photo-realistic realism; whereas, realism in animation and real time rendering refers to immersive reality. This interactivity is often valued higher than the photo realistic nature of a limited number of imagines from selected viewpoints. The credibility of the images remains crucial to the acceptance of the visualisations within the planning process. Agreement can be made between the planning actors and the stakeholders in terms of the level of realism required.

The main reason of the popularity of photomontages is due to costs of production. Photomontages are generally generated based on existing photographs and modelling is required only for proposed elements. This character keeps the costs down within production without compromising on the photorealism of the individual images.

In contrast, the cost of production is a major constraint on the usage of computer visualisations such as animations and real-time rendering. Consequently, large (budget) schemes can afford the use of animation or real time renderings in certain planning stages such as consultations, marketing and promotional presentations.

For that reason, dealing with costs of production is closely related with realism and its consensual degree of realism in planning implementation.

In summary, it remains reasonable to conclude that computer visualisation is important to the planning application processes in the UK including consultations and assessments. Whether computer visualisation is implemented through Landscape Visual Impact Assessment or public consultation, its application in planning is dependent on purpose, type of visualisation, and stakeholders involved in the process.

7.2 Planning Constraints of Technology Implementation

The case studies and interviews examined in this research have demonstrated the importance of computer visualisation in the planning process for an understanding of why it is important and why guidelines are thought to be required to be introduced for the credible planning process of consultations and assessments. In particular, the study shows that the context and processes of computer visualisation are not static but evolve in a highly dynamic fashion.

The research has already elaborated and illustrated some of the roles computer visualisation has played within the planning process in the UK. *How computer* *visualisation has been implemented by consultancy practitioners in UK planning application process? and what are the challenges computer visualisation is facing when implemented within this practice?*. These fundamental questions become even more important in the view of the observation that technological implementation is complex and dynamic, and the costs of media are falling gradually in all contexts.

Unfortunately, the same analysis also points to the difficulty in giving any general answer to such a question. Firstly, the emerging new technologies reviewed here are still supplementary to the planning process. Traditional media such as plans and documents still play a key role in UK planning submissions. Secondly, there is currently a range of visualisation media to assess and the technology is still developing. Only a limited number of computer visualisations have been dealt with in this research. Therefore any general implication of computer visualisation in planning must be tentative.

However, many of these balancing considerations are well understood, whereas the recognition of the role that computer visualisation plays in the planning process is relatively new. Therefore, it is worth pointing out and stressing the implementation of the technology to the understanding of the planning process. Therefore, this research offers some tentative speculations and suggestions. This begins with summarising three main themes that appeared frequently in the case studies and interviews. These themes will answer the questions raised above.

The first theme is that at the moment, the role of computer visualisation is supplementary to the UK planning process. There are many attempts to utilise technologies such as photomontages, animation, panoramic VR, and real time renderings. However, with the exception of photomontages computer visualisation is not formally recognised within the statutory planning process.

In UK planning, there are a limited number of options to facilitate the dissemination of information about a proposal to the stakeholders and thus to enable discussion and evaluation of the consequences of a change in completion. In most planning scenarios of assessments, that audience includes both members of the public and planners involved in the conductance of the planning process. There are advantages and disadvantages associated with each visualisation. Current approaches often include:

1. Paper maps, showing Zones of Visual Influence (estimates of the land area from which features may be visible),
2. Physical models – Planning for Real,
3. Photomontages of current and proposed landscape views,
4. Video-montage of fly-through using pre-set routes, also showing the landscape before and after the proposed development has been implemented,
5. Presentation at public meetings.

In planning, the above elements could affect planning decisions. However, formal planning submissions are still made using plans, sections, construction detail, and written text.

Secondly, the credibility of the usage of computer visualisation in planning practice can be tested. In the UK, visualisation techniques (including computer generated) have been used for many years. This includes the so called ‘traditional media’ such as plans, sections, sketches etc. However, as the technology develops more of those visualisations are generated by computers. Moreover planning requires the media to be more accurate, effective and to be valid.

Implementing computer visualisation in the planning process needs to be separated from using the media in concept development and any other design process/stage such as the presentation of artistic impressions. In particular, in an assessment process in planning, computer visualisation used requires a great deal of credibility since planning decisions could be affected by validity of the media presented. For instance, computer generated media used for a public enquiry and any planning process must have credibility through minimising any human errors. Computer visualisation requires being close enough to actually reflect on what it is going to look like following completion.

In the UK, photomontage techniques are only formally recognised in the planning process through ODPM guidelines. Moreover, there are some guidelines for the production of photomontages currently available. Table 7.2 (page 179) indicates current guidelines in the UK.

Table 7.2 Current Guidelines for Photomontage

	Guidelines	Year	Prepared by
1	Visual Representation of Windfarms: Good Practice Guide	2006	Scottish Natural Heritage, The Scottish Renewables Forum and the Scottish Society of Directors of Planning
2	Guidelines for Landscape and Visual Impact Assessment	2002 (2nd edition)	The Landscape Institute, Institute of Environmental Management and Assessment
3	Photography and photomontage in landscape and visual impact assessment: advice note	2011	Landscape Institute

During the semi structured interview, the majority of practitioners agreed with the introduction of some form of media guidelines; whereas, some of them disagreed due to concerns that they would restrict creativity and artistic licence.

Unlike the formal planning process of development management, computer visualisations are also used for design development, study, marketing and presentation which do not relate to formal planning decisions. However, this research does not suggest that validity is not required in the above cases, but in those circumstances, artistic licence could be more practised.

Therefore, it should be recognised the full set of constraints of the technology: limits, credibility, and advantages/disadvantages. It appears that utilising computer visualisation is challenging. Whilst the technology can be beneficial, there is the potential for parties to attempt to influence their application.

The use of deliberately misleading information might be an extreme assumption; however, a number of practitioners raised their concerns on this credibility issue during the interviews. The main reason is that usually computer visualisations are commissioned or funded by developers and this production structure makes credibility of media produced at risk.

As stated earlier, photomontages are formally employed as a medium of planning. According to the interviews, it has been the most preferred tool in planning by practitioners because it is efficient, credible, and affordable.

One of the interviewees (a landscape director) in the research stated that:

> It is like having an SLR camera. It can be any make such as Nikon, Canon, and Olympus whatever; however, the photos are produced in the same format in order to use common format films.

He continued that;

> We are not restricting any artistic licence; we are more promoting artistic production within the same platform.

In recent years, there have been tremendous developments in computer hardware/software. As a result, software for production of computer visualisation has become more popular and easier to use. However, the more accessible visualisation software is, the more difficult it is to control the credibility of visualisation media in the planning process.

In summary, the UK planning process utilises both computer visualisations as well as traditional media. However, implementation of technology is still not fully explored and some critical issues emerge; therefore, guidelines protocols for the productions required to achieve a certain level of credibility for making planning decisions as well as play a key role as communication tools. During the interviews, this argument is illustrated in Table 7.3 below.

Table 7.3 Pros and Cons of Introducing Guidelines – Interview Results

Opinions on	**Advantages**	**Disadvantages**
Introduction or existence of guidelines for planning medium production.	Minimise human error, use of deliberate misleading images	Limiting artistic licence
No guidelines required.	Freedom of expression	Cannot establish validity of production

Thirdly, the level of detail together with the cost of production played major roles in determining when and where to employ computer visualisation in planning.

An important point raised within the case studies, was that it appears that respondents were concentrated on selective information rather than on the level of detail in general. For instance, height and screening are significant elements rather than colour of bricks, grass and etc. therefore; the research findings also suggest that a high level of detail is not required for an observer to form an opinion (page 141).

Finally, regardless of how good computer visualisations are or how effective the technology is, implementation of computer visualisation is dependent on the cost of production. During the research, it was found that cost was the most decisive factor to employ the technology in the planning process. As the technology develops, it is anticipated that the cost of hardware and software will fall; hence, the production cost of computer visualisations will decrease. This means that more computer visualisations will be employed in development management. Affordability is a significant factor for utilisation.

7.3 Role of Visualisation in UK planning

As discussed above, the regulation of planning media production by introducing guidelines is still controversial; however, this research finds that it is generally accepted that some forms of guidelines or good practice guides are required. It is not purely regulating production of those media but also, providing an indication of protocol within UK planning.

In comparison to many countries, 'the UK planning system is not traditionally plan-led. Instead of the painstaking construction of binding zoning plans, the British method for managing urban growth revolves around the building application itself' (Hallsworth and Evers, 2002, page 300). This process is known as development management and is guided by the criteria which is issued and updated periodically by the UK government. The discretionary planning system allows more involvement by related parties in the development management process.

The constitution of many countries, places limits on governmental action in relation to land and property. However, the UK does not have a written constitution of the type common to most other countries (Yadley, 1995). In South Korea, for instance, there is little to compare with the central power which is exercised by the UK government. South Korean planning systems are based on zoning, which means central regulations decide what is permitted development and what is not. Unlike UK planning, this leads a little (or no) room for discretion[74].

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[74] A lack of constitutional constraints allows for a wide degree of discretion in the UK planning system (Cullingworth and Nadin, 2006). In determining applications for planning permission, a local authority is guided by the development

So far, photomontages have been developed more than other kinds of visualisations and guidelines are currently available (Table 7.2, page 179). Moreover, some environmental consultants have the expertise and format to produce developed templates under the guidelines. Fees for the work have been formed rationally as discussed in the previous chapters (Chapter 5, page 134).

In the UK, photomontages commonly used within planning applications include some sort of built up structures. They are not just used within Landscape Visual Impact Assessment but also within conventional planning processes; local planning authorities tend to ask to applicants to produce photomontages and use them within public consultation.

Alternative 3D visualisations – in this research, animation, panoramic VR, and real time renderings - are sometimes used in the early stages of planning. They have seldom been implemented formally in planning in the UK. Currently, they are tools for the applicant to develop concept/designs and a medium for consultation, and for marketing/promotional purposes. However, they are becoming a very powerful tool for design development and marketing, however powerful they are; there are no formal grounds for the local planning authority to request to submit those technologies yet.

However, this research found that the alternative 3D visualisations are extremely useful for public consultation and engagement purposes (Saltburn Top Prom and Windlestone Hall School cases). It would seem that local planning authorities take the results of computer visualisation into account within their planning decisions. Therefore, it is fair to say the alternative 3D visualisation can affect planning directly. Current utilisation of the alternative 3D visualisations are summarised below.

Table 7.4 Planning Use of Computer Visualisation

Computer Visualisation	Direct Implementation	Indirect implementation
Photomontage	Planning Decision / submission	Consultation
3D Visualisation	Consultation within stakeholders	Consultation

plan, but is not bound by it: other ‘material considerations’ are also taken into account. In most of the rest of the world, plans become legally binding documents.
In terms of public participation, it was argued that the switch to a plan-led system is unlikely to spur greater general public involvement in plan-making (although it has generated much more interest from certain interests) and attention will continue to be focused on development management (Edmundson, 1993). It was initially reported (Skeffington, 1969) that it would be reasonable to expect the public to see public participation as an entity in itself. Public participation would be little more than an artificial abstraction if it becomes identified solely with planning procedures rather than with the broadest interests of the people. However, they also pointed out that the recommendations made by the Skeffington Report in 1966 did not carry not carried issues much further such as participation.

7.4 Contributions and Implications

The rapid growth in the utilisation of technology in the planning process within the last 10 years represents a technical revolution in computer visualisation as a whole. Computer visualisation studies in planning have advanced from debating whether to employ new digital technology in order to assist the planning process. However, what remains largely unexplored is the question of what are the main factors affecting their usage and how their usage affects planning decisions. This study has synthesised previous work on technological studies and literature in computer visualisation. It can therefore not only describe modern media of planning but also provide a prescription for the implementation of the technology. Thus it is hoped that this study will advance our understanding of the theoretical issues of modern computer technology within planning practice.

Literature (Sheppard, 2001 & 2004 and Gerring, 2007) on computer visualisation, as a foundation of the analytical framework developed for the case studies and interviews, has provided a primarily abstract conception of the planning implication – role in planning, credibility, level of realism, and production cost – suggested by this study. Except for some, which focus on GISs, few studies on the empirical implication of photomontages and 3D visualisation and observed by practitioner’s point of view. Furthermore, few studies have explicitly claimed and identified any intertwining relationships and interplay between technical aspects in relation to the UK planning process.

Equally, through the use of case study analysis this research has identified the main factors that underlie the utilisation of computer visualisation. The identification of such underlying factors has furthered our understanding of the major ingredients of planning utilisation. The semi-structured interview analysis results links the major factors of perception from practitioners of the technology to planning process should also help to direct researchers’ and public policy-makers’ attention towards how the technology needs to be implemented in an appropriate manner, credible enough and production protocols and guidelines requires to be provided.

Finally, few, if any, studies of computer visualisation in planning have attempted to systematically link photomontages and alternative 3D visualisations to the planning implementation process. One reason for the lack of such research may be that an appropriate methodology that captures the multi-dimensional views of practitioners is not readily available. This study, through the application of planning context in the UK, has attempted to offer an approach, which establishes the interrelationships between planning policy and the utilisation of computer visualisation.

This research might provide a starting point for combining modern technology and planning practice through the use of the concept of the computer visualisation. This will allow other researchers to build on the concepts and technical aspects designed in this model and possibly create a more comprehensive model of the use of various media in planning.

While much of the present debate and literature on both the types of technologies and credibility of computer visualisation has in general revolved around normative bases, this research is an important step in focusing on how and why computer visualisation imposed from above results in different planning applications at the local level. It is expected that the realisation that extensive employment of the technology has been implemented differently because the scale and nature of planning applications have functioned differently will help the theorist develop more informed theories concerning both the implementation and the credibility of the computer visualisation.

In the UK, computer visualisation has been utilised in many ways and its level of use is constantly increasing. Regardless of whether it is photomontage, animation, real time rendering or panoramic Virtual Reality, this research analysed in a technical point of view a number of considerations and methodologies in order to establish credibility for planning use.

First, to implement successfully a technology, policymakers, in establishing scope of planning requirements and interacting with local planning authorities should focus their attention on the technology’s pros and cons and cost, which this research has identified in general, and the dimensions’ sub-issues in particular. In practical terms, this research should allow academics, planners, and private consultants to understand why the technology has been utilised in different planning stages and possibly to take a close look at the roles in planning.

Secondly, production costs should decrease as technology develops. As more technological benefits (software and hardware) become available, it is important for whole planning industry to monitor the process of implementation in order to keep the credibility of computer visualisation in place.

Thirdly, the principle information and guidelines should be adequate for deterring local planning authorities and developers from their potential tendency to manipulate and exploit in which might cause serious and unresolvable problems for planning decision making processes. Policymakers in central government should pay more attention to, and spend more resources on, designing and implementing information and guidelines. Specifically, professional bodies and institutes must maintain the capability to effectively advise local/central governments in whatever way necessary and must show a determination to enforce penalising actions when predetermined conditions occur.

At the same time, central government should also alleviate the potential for the inappropriate use of visualisation, either through changes to the planning submissions or through the introduction of credible guideline mechanisms. Unless there is a fair assessment methodology and reasonable framework for the interested parties in the planning process, the process is likely to become a cat-and-mouse game, resulting in endless efforts to use, shift or manipulate the technology to the party's own end in addition, local governments, when renewing scoping in planning submission, must take their awareness of technology into consideration in determining planning assessment and decisions.

Finally, the data contained in this study is qualitative. It provides the reader with 'behind the scenes' explanations of why and how stakeholders in planning process have different levels of interest. The advantage of this approach is that it reveals qualitative aspects of planning process, allowing the reader to become much better informed than if he or she had relied exclusively on qualitative data.

7.5 Limitations of the Analysis

The implementation of computer visualisation for the case studies has some limitations. The first is concerned with the dimensions associated with the emerging issues of the technology in planning. The framework for this study consists of three aspects: *scepticism of technology, levels of realism, and costs of production*. The first question, then, is, are there only three significant aspects? Is there any other critical aspect which is missing from the research framework, but which actually has a significant impact on the technology and implementation within planning interacting with stakeholders in planning procedures?

In any empirical research, in deciding what to include and what to ignore the researcher requires a set of taxonomic categories as a basis for classifying data and documents. However, our understanding of what should constitute real cases is too underdeveloped for the taxonomic categories within it to be clear and unambiguous. For these, the research is still largely dependent on conceptions which are theoretical, in the sense that they derive from case-by-case understandings.

The second possible limitation concerns the relative importance of the three aspects in this framework. The question is whether these three aspects have equal influence in affecting the planning process. Assuming that planning decision is a result of the interplay between planning subject and communication (technology and implementation) are these aspects of equal influence? Similarly, it is difficult to determine which components, even within the same aspects, are the major influences in the process. While the problem of relying on single sources of information was minimised by the use of a wide variety of data sources, it was often difficult to determine the relative importance of certain influences. Accordingly, much remains to be done in this area.

A third problem concerns the selection of interviewees. In this study there was only one interview with private visualisation specialists, one of main interested parties in the technology implementation in planning process. Analysis of visualisation preparers (technicians) was conducted using a combination of the results of the interviews with private environmental consultants and analysis of their specialties on computer visualisation in individual practices for each case. Therefore, some gaps in information about computer visualisation specialists were inevitable.

7.6 Recommendations for Future Research

In this final section, an agenda for future enquiry into the technology implementation in planning process is discussed. Basically, future research should consider the limitations of this study as set out in previous two sections (Contributions and Implications/ Limitations of the Analysis). The limitations of the study suggest some future research directions. Apart from the recommendations derived from the limitations of the study, some additional recommendations for future study are suggested below.

First, the utilisation of computer visualisation in the development management processes should be monitored by appropriate protocols or guidelines. The types of computer visualisations vary in planning applications in the UK. Moreover, developing such guidelines is process embraces both contemporary planning phenomena and academic research on modern technologies. Therefore, future research based on observing the validity of computer visualisation media used in planning to be continued in conjunction with other approaches if it is to be explained more credibly and more fully.

For example, issues to be considered in the guidelines are procedural points. Those procedural guidelines could contain methodology and presentation including the following points below that could be taken into account;

1. Photographic survey procedure: standard lens with human eye similarity, scientific reading on locations and height,
2. Authorising 3D geometry: software module and how to authorise geometries and texture,
3. Rendering procedure: camera (viewpoint) matching, atmospheric settings, renderer applied,
4. Presentation procedure: screen size, paper format, mitigation presentation.

The above points are only guidelines as an example and are focused on procedural protocol. However, the points to consider in each computer visualisation vary in each stage of production.

Secondly, the use of more appropriate visualisation media should be taken into consideration, because the planning costs associated with the media do not necessarily occur while, or shortly after, the planning professions employ the expensive visualisation media in the planning process. For this reason, many conventional research designs are not sensitive to the true reflection of the media. The present study is cross-sectional and longitudinal in nature. However, more strictly speaking, it also lacks any real-time tracking of events over a long-term period. Implementing computer visualisation, for example, often looks at very temporary process within planning process. To cover the whole process of planning would be highly time-consuming. Even so, a more systematic longitudinal analysis of cost could, if possible, help in identifying technology, perceptions and implementation issues related to the nature of the technology cost.

Finally, in the future the adoption of a specific methodology or design should be more holistic and balanced in dealing with the diverse and multi-dimensional aspects of the implementation process. The complex methodological philosophy behind case studies and semi structured interview approaches still makes research design difficult. For this reason, this research has not been able to construct a single holistic and integrated analytical framework which might embrace both case study and interview analysis. As a result, the two methodological perspectives have been separated. Thus, future research is recommended which will adopt a specific methodology or design which can embrace a more holistic and balanced approach. It will be more useful for explaining the dynamic interrelationships between planning applications and the technology implementation than otherwise.

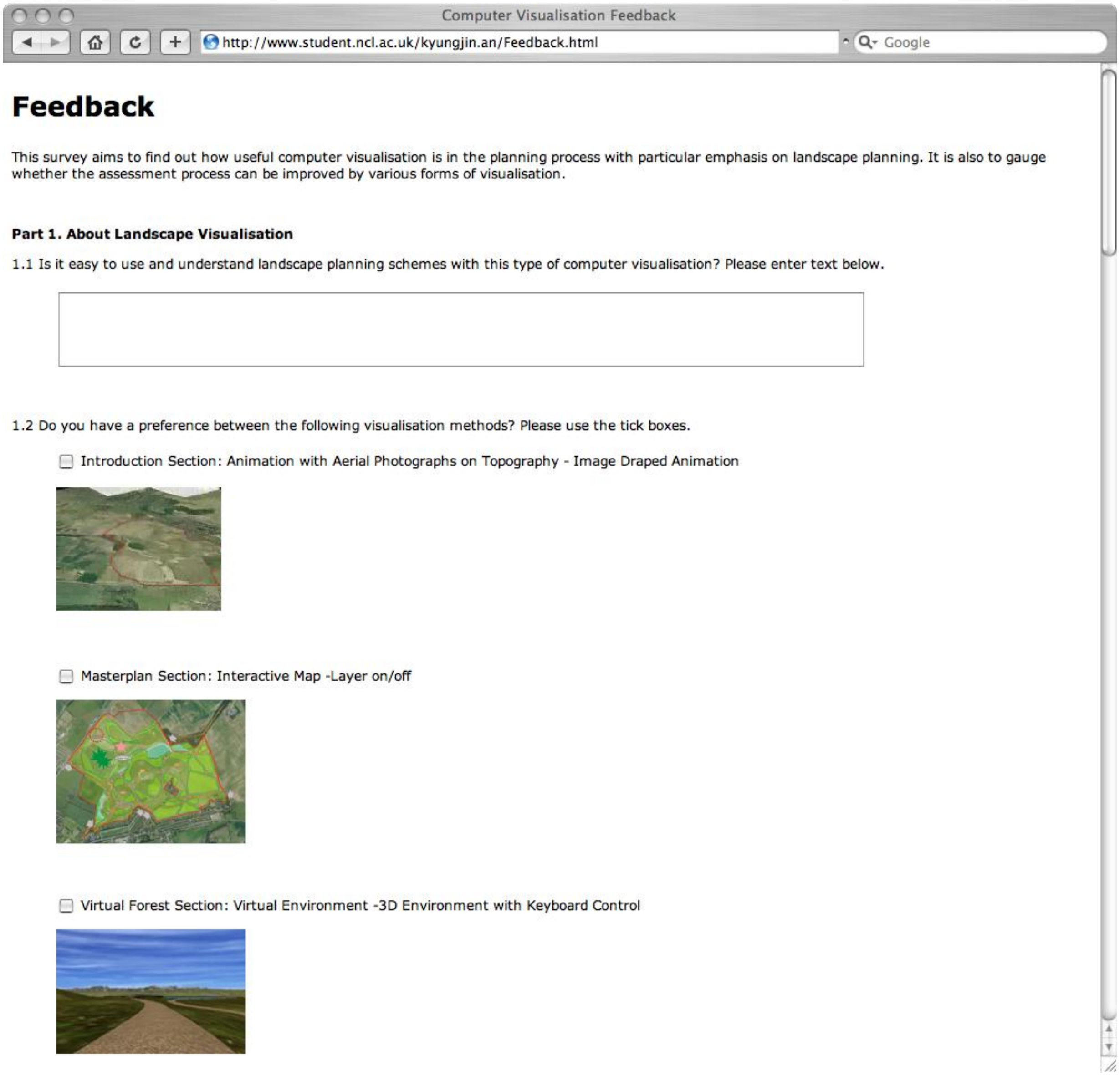
Despite current relationships between realism, credibility, and cost of computer visualisation (Figure 7.1 Tetrahedral Dilemma of Computer Visualisation with Media, Page 175), this research is able to forecast the technology may be more widely implemented within development management process in the future. In particular, real time technology and interactive tools are likely become more popular for transparent and inclusive elements in the planning process. Consequently, realism and interactivity are likely to increase in usage; at the same time, the cost of production should decrease significantly considering the technology developments in past decade.

Then a further study on the relationship between all sorts of computer visualisation media and planning must be followed. With no official survey published about this specific issue, it was hard to estimate the precise scale of available technologies and their usage in planning in the UK. Therefore, together with the study on the technological aspects of the media, a planning analysis of the implementation must be taken.

APPENDIX A SEMI STRUCTURED INTERVIEW QUESTIONNAIRE

This interview is aimed at collecting information concerned with the impact of the introduction of computer visualisation in planning. Accordingly this interview only covers issues associated with the technologies in particular, photomontage and three dimensional visualisations.

In this interview, I am interested in learning more about use of computer visualisation in UK planning procedures. Not only do I want to know more factual information about the technology, but I would also like to hear your point of view and opinions about your experience with them. Therefore, many questions will not have a strictly right or wrong answer, since people see things differently. I assure you that the responses you give will be kept confidential. Your answers to all questions will be used for academic purposes only and will not be examined on an individual basis. In the interests of time, please try to keep your answers short and to the point.


Computer Visualisation Feedback

http://www.student.ncl.ac.uk/kyungjin.an/Feedback.html

Feedback

This survey aims to find out how useful computer visualisation is in the planning process with particular emphasis on landscape planning. It is also to gauge whether the assessment process can be improved by various forms of visualisation.

Part 1. About Landscape Visualisation

1.1 Is it easy to use and understand landscape planning schemes with this type of computer visualisation? Please enter text below.

1.2 Do you have a preference between the following visualisation methods? Please use the tick boxes.

- [ ] Introduction Section: Animation with Aerial Photographs on Topography - Image Draped Animation
- [ ] Masterplan Section: Interactive Map -Layer on/off
- [ ] Virtual Forest Section: Virtual Environment -3D Environment with Keyboard Control

Computer Visualisation Feedback

http://www.student.ncl.ac.uk/kyungjin.an/Feedback.html

☐ View Section: QuickTime VR -Interactive Photomontages

☐ Changes over Time Section: Aerial Photo Photomontage

Part 2. Comparison to Traditional Media

2.1 In comparison with any other traditional media in planning, e.g. paper drawings, which one is easier for you to understand? Please select.

- ○ Computer Visualisation
- ○ Paper Drawings
- ○ Both computer visualisation and paper drawings

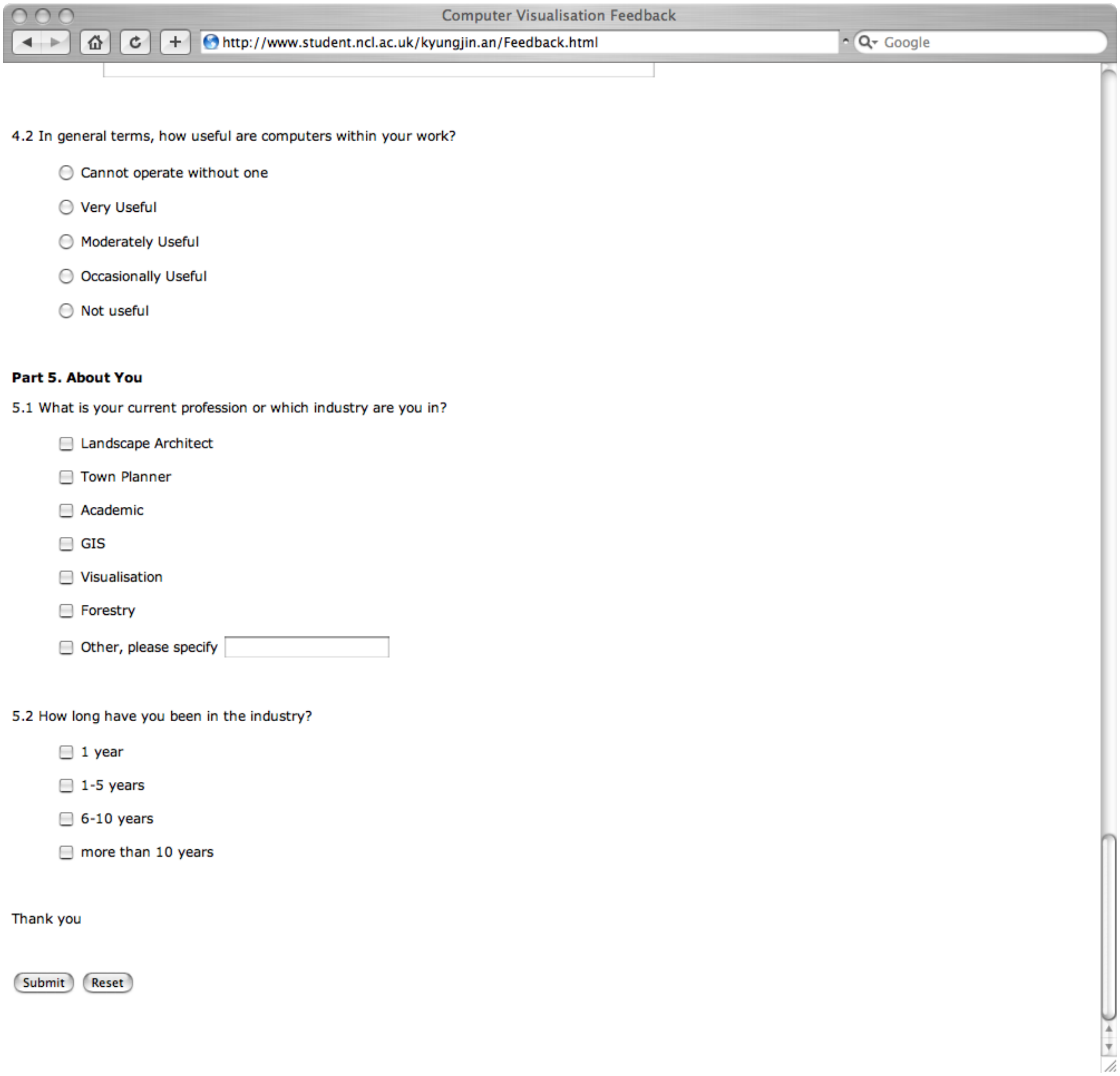
2.2 Can you explain why? Please enter text below.

2.3 Which would you say is more accurate: Paper Drawings or Computer Visualisation? Please select.

- ○ Computer Visualisation
- ○ Paper Drawings
- ○ Both computer visualisation and paper drawings

2.4 In relation to above question, which one is more reliable? Please select.

- ○ Computer Visualisation
- ○ Paper Drawings
- ○ Both computer visualisation and paper drawings



4.2 In general terms, how useful are computers within your work?

- ○ Cannot operate without one
- ○ Very Useful
- ○ Moderately Useful
- ○ Occasionally Useful
- ○ Not useful

Part 5. About You

5.1 What is your current profession or which industry are you in?

- ☐ Landscape Architect
- ☐ Town Planner
- ☐ Academic
- ☐ GIS
- ☐ Visualisation
- ☐ Forestry
- ☐ Other, please specify ______

5.2 How long have you been in the industry?

- ☐ 1 year
- ☐ 1-5 years
- ☐ 6-10 years
- ☐ more than 10 years

Thank you

Submit Reset

APPENDIX B DIGITAL DATA AVAILABILITY IN THE UK

Visualisation resource data availability

Current resources for 3 dimensional visualisations in the UK context

Academia-Digimap service

Land-Line Plus

Large scale 1:1250, 1:2500, 1:10000 depending on area), comprehensive data depicting an extensive range of both man-made and natural features

Master Map digital map data is digitised from Ordnance Survey Large Scales maps and surveys which show the accurately surveyed positions of the natural and man-made features of the topography. It derived from three source scales of mapping.

- Urban (1:1250)- major towns and cities
- Rural (1:2500)- smaller towns, villages and developed rural areas
- Moorland (1:10000)- mountain and moorland areas

The data includes outlines and divisions of buildings, land parcel boundaries, road kerbs, rivers and water features and feature names.

It supports software applications such as: Digital Mapping and Asset/Facilities Management.

OS Meridian 2

Comprehensive road network, railway lines, urban areas, boundaries, water features, woodland and place names, with a nominal scale of 1:50000.

It is a district based dataset useful for activities such as decision making in planning. It is a geometrically structured vector database customised from a variety of OS data sets that define the real world geographic entities (objects) as point and line features. Each feature consists of geometric and attributes data. The key feature is the detailed road network.

The data set can be used for site location analysis, environmental analysis, network analysis.

1:10,000 Scale Raster

High resolution scanned image of 1:10000 scale mapping. Detail includes fences, field boundaries, road names and buildings.

1:25,000 Scale Colour Raster

High resolution scanned images of Explorer mapping providing national coverage of Great Britain. Includes right of way information for England and Wales, hill contours, height information and field boundaries.

1:50,000 Scale Colour raster

The definitive raster database providing national coverage for Great Britain. This dataset mirrors the popular paper OS Landranger series.

It is the definitive raster dataset providing national coverage of Great Britain. It is comprised of 812 20Km by 20Km tiles, offering seamless coverage of Great Britain.

The 1:50,000 Scale Colour Raster data product mirrors the popular Landranger map series, Britain's most popular map series. It can provide the ideal mapping backdrop upon which to overlay other information and is useful as a drape for 3D modelling and visualisation.

Land-Form PANORAMA

Contours and digital terrain model (DTM) data at 1:50000 scale. This data is no longer supported by Ordnance Survey and will not be updated after 31 August 2004.

It is a digital representation of the contours from Ordnance Survey's 1"50,000 scale Landranger maps. Contours are at 10 metre vertical intervals together with breaklines, lakes, coastline and a selection of spot heights to the nearest metre. Digital contour accuracy values are typically better than 3 metres root mean square error.

The Ordnance Survey has used the dataset to derive mathematically a digital terrain-model (DTM) dataset. The dataset consists of a grid of height values at 50 metre intervals interpolated from the contour data. Height values are rounded to the nearest metre. Accuracy varies according to the complexity of the terrain, from 2 metres in a hilly rural area to 3 metres in an urban lowland area. This data is only available for downloading to your machine.

DTM data can be used for terrain analysis of lines of site and in applications such as visual impact studies, drainage analysis, site planning.

Land-Form PROFILE

Contours and digital terrain model (DTM) data at 1:10000 scale

OS Strategi

"Road atlas" scale mapping, showing major settlements, roads, railways, water features and land use.

It is a regionally based dataset useful for activities such as decision making in planning. It is a geometrically structured 1:250,000 scale vector database that defines the real world geographic entities (objects) as point and line features. Each feature consists of geometric and attribute data. Coordinate resolution is 1 metre.

1:50,000 Scale Gazetteer

Containing over 260,000 placenames, derived from 1:50000 Landranger mapping.

With over a quarter of a million entries the 1:50,000 Scale Gazetteer is a comprehensive guide to place names within Great Britain from ‘A Bheinn Bhan’ to ‘Zulu Fm’. The gazetteer contains all place names that are present on Ordnance Survey’s published 1:50,000 Landranger maps. Each entry is referenced to the National Grid to an accuracy of one kilometre.

For each entry in the 1:50,000 Scale Gazetteer there is a range of additional attribute information present. Covering the type of feature represented by the name; the latitude and longitude; the 1 and 20Km National Grid squares; the county the entry is in; the number(s) of the published Landranger mapsheets; and the data the entry was added to the gazetteer.

Initially the 1:50,000 Scale Gazetteer will be available for download as a single file. In the future there may be the possibility of selecting portions of the gazetteer for download, for example all the names in a single county.

Code-Point with polygons

National Grid coordinates for a point within each postcode unit in Great Britain, and the digital postcode unit boundaries for use in a GIS.

APPENDIX C INTERVIEWEE AND COMMUNITIES DETAIL

Name	Date	Title	Organisation	Computer Visualisation Presented (Case Study)
Nancy Corbett	2005	Associate Landscape Architect	Robinson Landscape Design Ltd.	Herrington Country Park
Phil Reddie	2006	Senior Landscape Architect	Sunderland City Council	Herrington Country Park
Paul Whittle	2006	Landscape Architect	White Young Green Environmental	Herrington Country Park
Emma James	2006	Associate Landscape Architect	Southern Green Ltd.	Herrington Country Park
Peter Welstead	2006	Associate Landscape Architect	White Young Green Environmental	Herrington Country Park
Mark Ashton	2006	Senior Landscape Architect	White Young Green Environmental	-
Stephen Laws	2006	Director	Anthony Walker and Partners	-
Steve Scoffin	2005	Executive Director	Northeast Community Forest	Herrington Country Park
Sue Mullinger	2005	Forest Officer	Northeast Community Forest	Herrington Country Park
Roger Smith	2007	Senior Planner	Durham County Council	Windlestone Hall School Relocation
Chris McGloin	2006	Forest GIS Officer	Northeast Community Forest	Herrington Country Park
Pravin Jetwa	2006	Teesside VR Centre	University of Teesside	-
Saltburn Forward	2007	Community	Saltburn Forward	Saltburn Top Prom
Windlestone Hall School Community	2007			Windlestone Hall School Relocation
Tom Turner	2005	Lecturer	University of Greenwich	-
Andy Clayden	2005	Lecturer	University of Sheffield	-
Maggie Roe	2005	Lecturer	University of Newcastle upon Tyne	Pilot Interview
Ian Thompson	2005	Lecturer	University of Newcastle upon Tyne	Pilot Interview
Sue Jackson	2005	Lecturer	University of Newcastle upon Tyne	Pilot Interview

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