Public perception of 3D visualizations of biodiversity and landscape information

By

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Abstract

3D visualizations have been improved as the breakthrough of the computer graphics techniques. Especially the combination of GIS and 3D visualization techniques have widen its application in biodiversity and landscape simulations. There are two parts in this study. In the first part, a 3D model of the whole campus of university of East Anglia (UEA) will be established by using 3D visualization software-Visual Nature Studio 2.8 (VNS 2.8) to represent the potential landscape policies of UEA. In the second part, an on-line Public survey will be carried out to study the public perception of 3D visualization techniques used in communicating with different stakeholders.

The survey showed that landscape visualization had a positive image among stakeholders such as students, staffs and residents nearby. According to the results of the questionnaire investigation, there were several requirements of biodiversity visualizations, including accurate presentations of relevant biodiversity information, interactive, interactive simulations of accurate information. Survey respondents had also expressed their concerns of these visualizations, including accuracy, validity and reliability. At last part of the survey, the strengths and weaknesses of 3D visualizations used in landscape and biodiversity information were evaluated compared with the other techniques existing in UEA. The result suggested that several merits of 3D simulations, such as higher information density, interactive, more natural presentation of the real world, allow users to better present landscape and biodiversity management strategies.

In conclusion, simulations of the campus area can help the public to better understand the landscape management strategies, and improve the communication between the public and environmental managers in UEA.
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Introduction

A 3D model of UEA campus will be created to visualise the potential changes in landscape and biodiversity under different enhancement strategies. Public perception and communication is one of the most important aspects in biodiversity and landscape management. The benefits of using 3D visualisation in communicating biodiversity management are also included in this paper.

After visualisation is developed, the public is queried with regards to their impressions of the proposed development for assessment purpose.

In the 1992 Earth summit in Rio de Janeiro, over 150 countries including UK have signed the ‘Convention on biodiversity ‘ and stared a concerted effort to conserve international biodiversity(EAUC, 2006)

In January 1994 the UK government launched Biodiversity: The UK Action Plan (BAP). The Action Plan formulates a framework programme for actions related to UK biodiversity over the next 20 years, key actions which include: developing of targets for the most threatened and declining habitats and species, improving accessibility and co-ordination of biodiversity data, increasing public awareness and involvement through targeting of key sectors (UK Government White Paper on Sustainable Development, 1999). The BAP is to be implemented at a regional level through local biodiversity action plans, Local Biodiversity action plans (LBAP) identify both priority actions as well as long term implementation through local partnerships (Earth watch, 2000).

3D visualization of biodiversity and landscape information is relatively new compared with its application in project assessment, such as EIA. Not many researches reported the direct data on public perception on biodiversity visualizations.
Aims of Project

The purpose of this project is to explore the public perception of visualization techniques in communicating biodiversity and landscape information in order to better integrate the biodiversity and landscape management into environmental management system. What is more, the benefits and limitations of using images generated by using 3D visualization techniques will be discussed in the context of public communication.

This paper will focus on:
1) Current situation and problems of biodiversity and landscape management existing in biodiversity and landscape management in an organization such as UEA. This will be done by interview with experts and data collection from authority organization.
2) Methodology of using VNS package to visualize future landscape strategies. The strategies for visualization will be summarized from the conservation plan for UEA (2006) and other relevant documents.
3) 3D visualized images would be generated for these chosen strategies.
4) Strengths and weakness of using images generated by 3D visualization techniques compared with the expert evaluation, maps and photos.
5) Evaluation of the overall perception of 3D visualization and effectiveness of images generated by VNS in public communication. Other ways of using visualization techniques in campus landscape management will also be evaluated.
6) A subjective ranking system survey will be used to find out relevant information to answer questions raised in (3), (4), and (5).
7) Discussion of benefits of using 3D visualization techniques in presenting and communicating biodiversity and landscape information with stakeholders.
Literature review

Biodiversity and landscape are two very important aspects in environmental management system in organizations including universities and colleges. English Nature (1992) has summarized four aspects of benefits that biodiversity and landscape bring to organizations: Appreciation (enjoyment and health), Knowledge (education and scientific), Products (sustainable harvests for fuel, food, medicines and materials) and Ecosystem services (life-support structures, e.g. air, soils, climate).

During the 1990s biodiversity loss became one of the ‘big’ environmental issues, comparable to acid rain, ozone depletion and climate change. In Rio de Janeiro in June 1992, biodiversity was the main issue on the meeting’s agenda together with global warming. During the conference the Convention on Biological Diversity was signed by 155 states.

However biodiversity and landscape were often neglected in the environmental management system although they are important environmental aspects (Paar, 2006). In UEA Corporate Plan 2008-2012, the strategies for environmental management are about low carbon initiatives, with little relationships with biodiversity and landscape. It could be explained that the management of biodiversity and landscape requires more time and its benefits need a long period. It is not easy for managers and the other stakeholders to perceive the future landscape benefits. As a result, new techniques to provide an information rich environment are needed to help engage stakeholders in making decisions in biodiversity and landscape management (McCullough and Hoinkes, 1995).

3D visualisation is one of the most effective ways of communicating environmental information including biodiversity with non-expert (Bishop, 1994). Visualisation is defined in Oxford English Dictionary as “the power or process of forming a mental picture or vision of something not actually present to the sight.” There are more descriptions of scientific visualization relevant theories given by many researchers (MacEachre, 1994; Card et al, 1998; McGrath and Brown, 2005). These definitions have one thing in common: scientific visualization is a great tool to assist people to perform distinct types of cognitive process. 3D visualization converts raw data into a
displayable image or a 3D model to present the real world. The breakthrough for 3D landscape simulations came as the image-processing techniques combined with modelling. These techniques have enhanced image quality and opened the door for real-time rendering of virtual models. There are two types of visualization techniques: static simulations, and dynamic visualization (McKechine, 1997).

The industry brought forth rapid new technology applications and fast visualization software package generation replacement. Recently many 3d software programs or landscape visualization tools such as 3D Max, or E-On software, and 3D Nature’s World Construction Set (WCS) enable people with much specialized skill and knowledge to simulate existing landscape or non-existing landscape (Sheppard, 2001). The tool used in this project is the new products brought by 3D Nature-Visual Nature Studio (VNS). This series of visualization products are highly compatible with GIS. New visualization tools can be quite powerful in combination with GIS (Appleton et al, 2002; Tress and Tress, 2003). Current methods of GIS-based landscape visualizations were evaluated by Appleton et al. (2002). After assessment of the advantages and disadvantages of these packages, it is found that there is no universal solution for landscape simulation all things can. Users have to balance the advantages of each package against the disadvantages to decide which visualization tool and the degree of realism. Researchers have identifies new development areas, including adding on users needs and capabilities (Tory and Moller, 2004); collaborative visualization with focus on software (Sengupta et al, 2006); integrating into real working environment (Burch et al, 2005), high-resolution displays and mobile devices (Chittaro, 2006). Especially the new devices of large screens to simultaneously display more data and mobile devices become common, the development of new display technologies will be faster than before (Wallace et al, 2006). The new trend of visualization tools would move towards the combination of availability, geographic detail, realism and interactivity (Appleton et al, 2002).

3D visualization could help people’s decision making from many aspects. Firstly, its strong ability in presenting future landscape varies in a natural way similar as the real world could make planners and the other stakeholders aware of the importance of biodiversity. 3D visualization Landscape and biodiversity researchers and planner have relied on abstract, 2D representation (Lange, 1999). Projects related with the
biodiversity and landscape have rarely presented in a stimulating way (Paar, 2006). Stakeholders especially the public who lack of previous experience and knowledge of 3D visualization are not easy to imagine the proposed landscape. Because the translation from the abstract information such as maps, engineering graphics into landscape images specialized background knowledge. Aided with the visualization software, potential environmental impacts of a proposed project could be anticipated. By doing this, biodiversity and landscape would be added into the scope of environmental management system. Secondly, 3D techniques have a positive role in the collaborative decision making. The important prerequisite for effective public participation is a common information base. An interactive visualization of the potential changes can clearly predict the future condition of ecology and landscape (Chan et al, 1998). It has been attributed with a great potential for assisting the effective visual communication of proposed polices or strategies. More people including those with different interests to the biodiversity and landscape (e.g. residents nearby, local Non-Government Organizations), are attracted to be involved in decision making by the directive viewing information. But what 3D visualization techniques could offer are richer information, not a guarantee of successful collaborative planning and communication. That could explain the popularity of visualization techniques have not risen in many area, including biodiversity management. In the past, there is only limited use of landscape visualizations. Evidences suggested that there is relatively little application of 3D visualization software in the areas of landscape ecology, landscape planning and natural protection (Hehl-Lange, 2001). Sheppard (1999) finds that its applications are relatively little even in government agencies responsible for landscape planning and resource management. It can be seen from that 3D visualizations have great potentials used in simulating biodiversity and landscape.

Biodiversity visualization is relative new compared with the research of simulating landscape varieties. Visualizing biodiversity means to achieve cognizance of biodiversity density according to spatial considerations. It integrates diverse data sources on biodiversity, such as habitats and vegetation types, and displayed in a computer environment. Accuracy and validity are two very important issues in 3D visualization which would explore in the section of discussion. There are some relevant research projects which might indicated the new trend of biodiversity
visualization. Interactive tree visualization –TaxonTree and coupled interaction with two trees were developed to explore the visualization of biodiversity information (Lee et al, 2005).

Regarding biodiversity visualization, 3D visualisation has several advantages, including accessibility to a very wide range of people, more information, easily and quickly updated; interactivities with target audience (Badique, 2002; Robertson, 1993). Because of the characteristics of biodiversity issues, presentation ways need to be natural and high information density. 3D visualization techniques present objects in 3 dimensions which are similar with real world and carry more information than 2D ones. On the other hand, there are still many barriers to hinder the popularization of 3D visualization. New techniques bring more intensive computation and complex implementation as well as the benefits and convenience. The adaptation to specified devices and techniques requires longer period more investments. Nevertheless, these deficiencies of visualization tools would be rectified as the rapid development of computer techniques.

There are many empirical and other comparable researches which intended to help managers to explore the perceptions of 3D visualization software and the software packages. A German-wide survey aimed at a wide range of people (Paar, 2006) was carried out in 2001 to investigate the public requirements for 3D visualization software. Evidence suggested that 3D landscape simulation has a good image among German professionals and laypersons. Sheppard (2001) observes that documented evidence on the effects of visualizations on actual planning decisions is extremely limited, and highlights future research focus. A Feasibility study for a visualization tool has identified deficits of landscape simulation software and provided direction for both software developers and users (Chen, 2007). It can be seen from this that the past researches mostly paid attention to the comparisons of visualization software packages and its application on landscape simulations. The academic researches on the simulation of biodiversity and landscape are still placed in the start stage.

When it comes to 3D visualizations of biodiversity in a built environment such as universities campus, it involves many details to discuss. Many researches and studies of e-campus are available to learn from, such as 3D simulation project of the
University of Toronto (Pullar and Tidey, 2001). The simulations of existing landscape or non-existing landscape on campus might include terrain data, buildings with facades and roofs, roads, side walks, lakes or rivers, green lands and trees (Ranzinger and Gleixner, 1997). Buildings can be set by assigning the building heights, wall types and roofs, and then the building sides’ textures mapped using photographs of buildings (Hoinkes and Lange, 1995). Vegetation such as Trees, land covers could be downloaded from the components libraries in software package, or created a new component from 2D images. In order to create high degree of realism, effects such as shadows, waves could be added to 3D objects (Pullar and Tidey, 2001).

**UEA Background Study**

UEA is proud of the large natural landscape in campus and therefore issues related to biodiversity and landscape are prominent in its management (biodiversity and landscape working group in UEA, 2009). Biodiversity and landscape are important because they provide educational and development importance at all ages, enhance health and well-being and encourage interest from a range of stakeholders which could help gain recognition and resources form external parties.

The UEA campus is of high conservation value as it contains six recognized county wildlife sites. The whole UEA campus area was explored by collecting data about the various ecological ecology habitats types, rare species in danger and the topology. Information of typical habitats and important species found on these habitats was gathered from documents such as working paper 4 – biodiversity provided by the esteem office. Appendix 1 Map1 gives much greater detail on the type of habitats found at UEA and the important species which can be found at these habitats and the locations of these habitats. Appendix 2 outline the important species on each habitat in UEA campus adapted from habitat survey description in Working Paper 4 of Biodiversity (UEA Environmental Working Group, 2008).
Methodology

The whole process involved several interrelated and sequential steps.

**Step 1** understanding the problems existing in public communication of biodiversity and landscape information in UEA.

**Step 2** summarizing landscape strategies from Conservation Development Strategy for the University of East Anglia (Cambridge Architectural Research Ltd, 2006). Conservation Development Strategy is one of the most important documents which states the management strategies for landscape and management for the future 3 years. Because of time limited, only several of the most important strategies were chose to visualize.

**Step 3** using 3D Visual Natural Studio package (this package is often called world construction set) to visualize selected future landscape strategies.

**Step 4** making survey with the public (students, staff, and residents nearby) to find out what they think of visualization technique may bring to communication.

Interviews were given to experts, student societies and CUE East to find out the current situation of public communication in landscape and biodiversity issues. Experts who give important information were Mel Pascoe (Head of estates), Paul Donson (UEA health and safety advisor), Iain Barr (Lecturer in school of Biology) and Elaine and Dick Cobb (Lecturer in school of environmental science). Student societies included Env societies, Permaculture society, conservation and wildlife society and UEA volunteer.

Interview questions were developed to explore what people think the current ways of communicating conservation information and what is the public expectation of better communication ways. The questionnaire can be seen in Appendix 3 and the result are presented and discussed in Result Section.
Question 2: Which of the ways listed in the following options you know are effective in presenting landscape strategies?

A) Maps  
B) Authorized evaluation  
C) Photographs  
D) 3D visual simulation  
E) criteria weighting  
F) others

If others, please specify________________________________________________

Question 3: “what is your recommendation for better communication in landscape information?”

______________________________________________________________

**Step 2: summarizing landscape strategies from Conservation Development Strategy for UEA**

Conservation Development Strategy for UEA is one of the most important practical authorized documents for conservation related issues. It covers the site and buildings of the main UEA campus, which provides policies to retain the character and quality of architectural and landscape elements. The Strategy sets out principles and policies for future management, and identifies opportunities for the future landscape changes in UEA. The summary of the future policies in Conservation Development Strategy for UEA please see Appendix 4. Conservation policies of high significant Features were developed to improve landscape on campus.

Considering time limited and proficiency in using this software, only three strategies which were designed meet different goals were selected to visualize.

**Strategy 1 – the twin boiler flues**

This strategy was expressed like this: “When practicable and affordable, the boiler house, with the exception of the flues, could be replaced with higher quality buildings
making better use of the site”. These buildings were built between 1965 and 1966. The twin boiler flues have been painted. Although there are other examples of paired vertical accents are found in Lasdun’s work, the two more flues were anticipated, forming a square on plan with the existing flues. Models of the master plan show that the flues are located on the centreline of the Teaching Wall and harbour. So the twin chimneys were assessed to be significant and would be substituted by new developments to enhance the significance of landscape. But this new building was not indicated in the conservation strategy plan.

What kind of building should be to replace the boiler house to better use the site? In the 2008-2010 UEA Corporate Plan, the new ambitions of attracting more students and staff was expressed ‘to continue to increase the quality, number and range of student applicants’ and ‘to attract, develop and retain committed staff’. As a result, the occupation of large amount of green space, and the increase of the teaching and accommodation buildings was the main changes of landscape in order to meet the development targets of UEA. In order to keep balance of the cost and the demand for teaching and accommodation, renovation of the old building can be another method to save money and less damage the environment. So the building could be built for the accommodation buildings or teaching building to solve the problem of the growing scarcity of housing in the campus. what is more important, this new developed building should be properly designed to blend perfectly with the landscape so that it will not detract from the significance or present a threat to the fabric of campus. Taken all these into account, the new designed building should not be too high, for instance, 20-30 meters, and the colour of the main body could be similar as the other buildings in the campus, such as light grey as the Teaching Wall.

**Strategy 2 – Landscape between the Yare and the UEA buildings**

The view across the Broad to the ziggurats is UEA’s defining image. The landscape here was assessed to be very high significance. The visual impact of the lake water when viewed from the adjoining bushes was limited. So according to the original vision of the designers- Lasdun and Colvin, the margin of the Broad should be altered to create a more gradual slope or the bushes should be removed for better landscape amenity. After fully interpretation of the UEA environmental policies and relevant legal requirements, as well as the results of habitat survey by Ellis et.ac
(2006), we should notice that there are high densities of flora and fauna species, which are of great biodiversity value. Actions such as reducing the slope of the verge or removing the bushes alongside the lake cannot avoid causing impacts to the surrounding ecosystem.

The removal of the bushes to open the view of lake water from the Norfolk and Suffolk Terrace was still selected to visualize. Because the effect of visualization techniques could be evaluated more easily when used in communicating some contested strategies.

**Strategy 3 – Landscape of rear (north) elevation of ziggurats**

Contrast with the south elevation, landscape in the rear elevation of ziggurats was described as “absolutely nothing charming” “chaotic and ugly” (Cambridge Architectural Research Ltd, 2006). The further development strategy is expressed as follows: “undersized planting beds and planters should be removed; landscaping should match the vigour and scale of the buildings.” This strategy was chose to visualize because of the landscape here was assessed to be high significance and presentation of the future change is obvious. So the recommended action to change the landscape for aesthetics could be removing the suburban features of rear elevation of ziggurats, and rearrange the landscape according to the policies mentioned above. To match the powerful architectural gesture, new planting should be arranged orderly and big enough to form a suitable view. Based on these considerations, big trees alongside the road between the Norfolk terrace and Teaching Wall were chose to add in the place of the previous plantings.

**Current landscape**

The current landscapes of the three locations mentioned above were produced as a blanket controller. Based on the UEA dataset, main buildings, natural trees, designed trees, bushes and waters were built based on the ecology baseline study provided by UEA sustainable working group. The details of visualizing buildings, plants and waters were not discussed here for they were outlined in the visualization method part. Three small scenes were chose to highlight: the boiler house, landscape between the Yare and the UEA buildings, and landscape of rear elevation of
Ziggurats. Because time is limited, most of the trees and bushes were visualize by using similar pre-built components in component gallery in stead of using new components I made myself.

**Step 3: Visualizing the landscape scenarios**

Providing visualizations of the possible future landscapes was considered an important means of engaging stakeholders in discussion about the scenarios. The approach was to create a detailed GIS database of the current land use in the UEA campus, then import it into Visual Nature Studio to develop a three-dimensional landscape model to build a current landscape model. Then new plantings or building features are edited based on Step 2. By controlling the landscape components enabled or disabled, the relevant landscape features would appear or disappear according to different strategies. Then images of these visualized models were then generated by using the rendering editor.

The following table outlines the details of visualized viewpoints.

**Table 1: Visualized viewpoints**

<table>
<thead>
<tr>
<th>Viewpoints Visualized</th>
<th>Current landscape</th>
<th>Strategy 1</th>
<th>Strategy 2</th>
<th>Strategy 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provide landscape feature in the locations as Strategy 2, 3, 4 indicated</td>
<td>Boiler house with the high chimney</td>
<td>Landscape between the Yare and the UEA buildings</td>
<td>Landscape of rear elevation of Ziggurats</td>
</tr>
</tbody>
</table>

1) procedure for creating scenes in VNS package

1. Set up UEA dataset.

   The GIS data of UEA campus wide was imported by using the import wizard and a separate project file was developed for the edited land-use data and landscape feature. These data included the polygons of buildings and points of the nature design trees and shrubs in main campus area.

2. Add main buildings in campus dataset.

   Buildings were generated by producing walls and roofs according to the building contours defined by the polygons of buildings imported in last operation.
Wall editor then was used to add building. According to the field survey of the campus, the typical walls of main buildings in UEA campus are:

A: general grey (30m high Grey wall, light grey roof)—boiler house and constable terrace, and buildings other than B, C

B: large grey (20m, grey wall, grey roof)—Teaching wall, Norfolk terrace, Suffolk terrace, library and lecture theatre.

C: large white (20 m, white wall, white roof) —Sainsbury centre for visual arts

D Chimney (40 m, light colour wall, no roof)

In the attribute of BUILD code, different values were attributed to different type of walls. By doing this, points with the BUILD attribute were then attached to different walls components. After doing this, click the render and preview button, buildings would appear as expected.

3. Set grass land as the main feature of UEA ground

Ecosystem editor were used to add vegetation to the ground and the place relevant. UEA ground was then set as grass land environment by using Ground editor in the land cover task mode. An overall baseline ground effect was created by sampling ground colours to represent the original ground, and then creating a gradient within the ground material diffuse colour editor fractal noise was used to blend the colour together.

4. Plant trees and shrubs in the defined points on the terrain

In order to put a large number of trees and bushes in accurate places in UEA campus, the vector of points of plants location were then attached to different trees and shrubs components by using Searching Query in Foliage effect editor. A Foliage Effect lets you place Image Objects or 3D Objects onto the terrain. The operation was repeated several times to add vegetation in the three strategy models and the current landscape model. The operation was quite similar as adding buildings to the terrain. A new attribute- TREE was added to
the points which identified the accurate locations of planting in campus. It allocated separate value to each type of vegetation.

Taking natural trees between the Norfolk Terrace and Teaching Wall for example, the location points of natural trees between the Lasdun’s buildings on the shape file were all given 1 to its TREE attribute. Then natural tree was selected from the component gallery to be planted onto the points with TREE value of 1. Because creating new tree objects from images require many time and higher practical skill, several pre-built component of natural trees and shrubs similar to the original types were used from component gallery in foliage editor.

5. Add individual trees and shrubs to form the future landscape strategy

The lined trees and hedgerows in Strategy 3 were produced by using the Individual foliage effects. The operation was quite simple. Click the create button and click the place you want to place the plantings, then trees and hedgerows would appear by rendering and preview. The foliage components – Big Maples and Bushes were loaded from the pre-built components and placed in a line order alongside the road. Appendix 3 figure outlines the specific details for each of the foliage effects generated.

6. Edit water of the lake

The characteristics of lake water could be changed by adding a pre-built component. The water gradient should change to match the colours present in the real lake. The water could be given a render depth of -20 metres. This effect was then attached to the centre line vector was created for the lake.

7. Adjust the camera location

In order to get a more appropriate view point to present the scenario, adjusted co-ordinates for the camera should be changed. So the camera was adjusted s
After this was done, film size was set to $533 \times 355$ mm, and all the other parameter were left alone.

**Table 2:** Parameters of camera positions

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation</th>
<th>Heading</th>
<th>Pitch</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler house—chimney</td>
<td>52.611289°</td>
<td>-1.2357271°</td>
<td>528.51367m</td>
<td>14.353553°</td>
<td>-3.6855415°</td>
<td>0°</td>
</tr>
<tr>
<td>Landscape of rear elevation of Ziggurats</td>
<td>52.611289°</td>
<td>-1.2357271°</td>
<td>564.71999m</td>
<td>12.082098°</td>
<td>1.1242714°</td>
<td>0°</td>
</tr>
<tr>
<td>Landscape between the Yare and the UEA buildings</td>
<td>52.611289°</td>
<td>-1.2357271°</td>
<td>564.71999m</td>
<td>15.194061°</td>
<td>8.41138°</td>
<td>0°</td>
</tr>
</tbody>
</table>

**Step 5:** making survey of the effects of visualization techniques in communication

**Survey strategy**

A public survey was carried out in order to investigate the perception of 3D visualizations and evaluate the visualization effectiveness in this project. Question 1 was dealt with questions relating with the realism in images generated in this project, while the rest of the questions in this survey were designed to explore the perception and expectation of 3D visualization techniques used in communicating biodiversity and landscape information. This section of questions was generated based on several survey techniques (Lange, 1999; Juba, 2001; Paar, 2006). Images of VNS visualizations were edited in Paint Shop Pro Version 4.15SE. They were reset to $4.82 \times 6.65$ cm$^2$ in size. This size was big enough to be present in the paper document. There were 8 images including the overall view by Overhead Camera, overall view by Perspective Camera, 3 images groups (each group with the current scene and visualization of the future).
Images produced from the visualization model:

1) Whole view of UEA campus

   a) Perspective camera

   ![Perspective camera image]

   b) Overhead camera

   ![Overhead camera image]

2) Images of Strategy 1

   View point: boiler house with the high chimney

   ![Current landscape image]
   ![Future scenario ----Strategy 2 image]

   Current landscape
   Boiler house with visual impact

   Future scenario ----Strategy 2
   Replace the boiler house of new designed college building
3) Images of Strategy 2

View point: landscape between the River Yare and UEA buildings

Current landscape
Keep shrubs and bushes on the lakeside alongside the lake

Future scenario — Strategy 2
Make the most use of the lake side as parkland by removing the bushes

4) Images of Strategy 3

View point: Landscape between Norfolk Terrace and Teaching Wall

Current landscape
Uncontrolled suburban landscape features

Future Scenario — Strategy 3
Arranged lined-trees and hedgerows along roads to achieve maximum amenity

Because of time limited, there were only 8 images available for evaluation in this survey. What is more, the interactivity characteristics of 3D visualization model cannot be well experienced by using only the simulation images. The quantity of images was too small and the main changes in the landscape feature were not highlighted in these images. This would produce errors. Additionally, the order of presenting these images was set as Strategy 1, Strategy 2, and Strategy 3. This may bring setting trends in the data that would bias into the survey results (Juba, 2001).
The sample size is 64 people, including 30 students, 14 staff, and 20 residents living nearby UEA campus who may have chance using the site. Participants were picked up randomly in the Earlham Car Park, Canteens and many other campus areas. They were asked to response questions on the questionnaire, and answers would be written down on a summary sheet. Participants of the survey were divided into students, staff and residents nearby based on the consideration that different factors such as education background, use of the site, may have impact in understanding of the landscape management strategies and requirements of visualizations used in communication may differ.

This questionnaire was divided into 3 parts. Part 1 was developed in order to evaluate the overall realism of these images. Part 2 in this survey were related to the public perception of this technique and special needs of communicating biodiversity and landscape information. Questions in Part 3 takes UEA as an example to investigate the possibility and ways integrate visualization techniques into UEA environmental management system.

Part 1:

Q 1: “In terms of realism, how would you rate the overall composition of these images?”

This question was adapted from the questionnaire made by Juba’s (2001). It was set to find out how real these visualized images appeared to survey participants. They were told to view these images randomly. This can avoid the bias which comes from a set order of images. They assigned 1-3 to the least real image –the most real one according. Also, the total score and the average priority are counted by weighted average scores.

However this methodology had its own defect. The number of staff participants was less than the other two groups. If the total scores were equal to all the scores given by these stakeholders’ groups, the weighting of the staff group would be smaller than the other two. This would make some mistake. So the weight arithmetic mean value was used to express as the average scores.
Average score = \[
\frac{(\text{Score N1})/(\text{N1}) + (\text{Score N2})/(\text{N2}) + (\text{Score N3})/(\text{N3}) + \ldots + (\text{Score Nn})/(\text{Nn})}{\text{N1} + \text{N2} + \text{N3} + \ldots + \text{Nn}}
\]

Score calculate method: scores (scenario N) = \[
\frac{3 \times \text{number of participants who chose the scenario N as the first priority} + 2 \times \text{number of participants who chose the scenario N as the second priority} + 1 \times \text{number of participants who chose the scenario N as the second priority}}{\text{number of participants who evaluate scenario N in this group}}
\]

Priority depends on the score each scenario gained. The scenario which gains the highest score ranks the first, in the same way, the second score made the priority of second, and the least scored one ranked the lowest.

Q 2: “Do you think these images can well present the landscape changes between the current situation and future strategies?”

In this question, the effect of the way of presenting future landscape strategies was evaluated. Survey participants were asked to view the images by groups to see whether this way can help them better interprets the landscape strategies.

Q 3: To what extend should the visualized image or animation used in presenting biodiversity and landscape management information be real?

How real is enough? This was the main point that Question 2 explored. A large portion of respondents may insist that 3D animation models, screenshot 3D images should be as real as possible, while some paid more attentions to the cost and benefits. Characteristics of biodiversity and landscape should be taken into consideration, such as the species of flora and fauna. The percentage of participants who supported each kind of opinion towards the realism of 3D visualization was made after the amount of each group of people would be calculated. Based on these data, the public expectation of 3D visualization could be known.

Part 2

Q 4: is there any special requirement of techniques when communicating biodiversity and landscape information?
Biodiversity and landscape information have their own characteristics such as more direct viewing than the others. In order to make it easy to calculate the results, several most common answers were given as options and particular opinions were recorded separately. This question intended to find out the special needs of ways in exchanging biodiversity and landscape information.

Q 6: To what extend do you think 3D visualization techniques are helpful to present and communicate biodiversity and landscape information?

This question was adapted from the Arrow IFPA Project (Salter et.al, 2005), Different stakeholders evaluated the effectiveness of landscape visualizations used in the public communication process of UEA biodiversity and landscape management. The number of people who found the use of visualizations helpful would be added up to be the final score of the “visualizations to be helpful” group. In the same way, the scores of groups of “very helpful, fairly helpful, unhelpful, and very unhelpful” were counted based on the amounts of assentients.

Q 7: Do you accept additional benefits as a result of the use of 3D visualization?

This question was quite simple to find out the acceptability of 3D visualization techniques used in presentation and communication. Reasons of accept or not could uncover the potential of 3D visualization techniques in public.

Part 3

Question 8: “what are the main ways in communicating biodiversity and landscape information in UEA right now? And what are the strengths and limits of these ways?

The options to be selected in this question were sum up from relevant materials such as Conservation Development Strategy for UEA. The strong points and deficiencies of these techniques used for presentation and communication were explored among participants.

Q 9: “Currently UEA’s Conservation Development Strategy do not use 3D visualization techniques. Do you think 3D images or 3D animation techniques should be used to visualize the future landscape strategy in the plan?
UEA’s Conservation Development Strategy is the most important document to present and communicate strategies of biodiversity and landscape management with different stakeholders. This question was designed to find out the possibility of using 3D visualizations and public perception of this technique. Respondents were shown the Linguistic description of those visualized strategies in the Conservation Development Strategy plan for UEA together with those simulation images before they responded this question.

Q 10: “what do you suggest ways to use 3D visualization techniques in UEA”

This is an open question to seek for the quest for better management in UEA’s biodiversity and landscape. Various ideas about how to use 3D visualization techniques could be collected from the answers to this question.

The completed questionnaire can be seen in Appendix 4.

**Survey Hypotheses:**

There are several hypotheses for the survey results.

Hypothesis one: People’s perceptions of the landscape changes were affected by factors such as related experience and knowledge, except of genders, ages.

The participants of the survey were divided into 3 groups: students, staff and residents living in the nearby area. The reason of choosing these stakeholders was that students and staff were readily available on campus, and these people are those who most concern the landscape and biodiversity on the site. It was hypothesised that there would be differences in their focus when responding survey questions. Staffs were expected to give answers in a systematic and relatively objective way, while students and residents nearby may pay more attention to issues close to their daily lives. These might be obvious in open questions, such as Question 5 about the perception of limitation and strengths of 3D visualization techniques.

Hypothesis Two: The effects of 3D visualization techniques were well perceived by stakeholders.
When considering Question 2, respondents were expected to have known 3D visualization. The most common evaluation of simulation images’ effects in presenting strategies was expected to be the moderate options such as generally good but still miss some important information. In addition, the respondents who choose the positive options of affirmation are expected to be more than those who hold an opposite attitudes.

Hypothesis Three: Different roles in environmental management would affect the perception of the visualization techniques.

The focus attentions will be different among different stakeholders’ groups. Regarding Question 3, most of survey participants who inclined to perfect the visualization images or models at any cost are expected to come from the group of residents nearby.

Hypothesis Four: The public have been aware of the benefits of 3D visualizations.

When considering Question 7, the majority of respondents were expected to accept the additional benefits of 3D visualization techniques. The amount of those who express no interests is anticipated to be quite small. The causes of their refusal may lie in the lack of experience of 3D visualization techniques.

Hypothesis Five: Participants in this survey are expected to have well involved in the public communication in UEA.

In Question 8, respondents were expected to be familiar with the communication ways in UEA. However, it all depends on who took part in the survey, and whether they are willing to join the public communication program in UEA.

**Data and Results**

The interview with expert, student societies and Naturalist groups revealed the current stakeholders’ engagement in UEA is not very satisfactory. Communication and integration appeared to be limited between students, staff and residents nearby. There is also little integration of student courses and societies in aiding conservation efforts on site. The CUE East program is a positive way for stakeholder engagement.
It encouraged students and staff to get involved in public communication. It includes many research projects related with the biodiversity and landscape in UEA. But most of these activities are external. Small groups, such as Bluebell primary, Earlham high, Notre dame high and some adult education groups, have been visited the site and used resources led by Iain Barr (lecturer in school of Biology).

In summary, the public involvements in UEA’s landscape and biodiversity management were limited, and new presentation ways were needed. It is quite common that biodiversity and landscape are often neglected in the environmental management system. It might be explained that biodiversity and landscape managements are not as measurable as other environmental aspects such as waste. So managers would like to pay more attention to those aspects that could reflect their efforts. The following data were collected for part I of the survey:

Part 1:

1) Responses to Question 1: Ranking of the realism in 3D simulated images

Table 3: Rating of realism of the overall composition of these images

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Students</th>
<th>Staff</th>
<th>Nearby Residents</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score1</td>
<td>Priority1</td>
<td>Score2</td>
<td>Priority2</td>
</tr>
<tr>
<td>Strategy 1</td>
<td>2.53</td>
<td>1</td>
<td>2.29</td>
<td>1</td>
</tr>
<tr>
<td>Strategy 2</td>
<td>1.53</td>
<td>3</td>
<td>1.57</td>
<td>3</td>
</tr>
<tr>
<td>Strategy 3</td>
<td>1.87</td>
<td>2</td>
<td>1.86</td>
<td>2</td>
</tr>
</tbody>
</table>

The average priorities are given in Table 4:

Table 4: Ranking of realism in images

<table>
<thead>
<tr>
<th>Priority</th>
<th>Student</th>
<th>Staff</th>
<th>Residents Nearby</th>
<th>Average Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strategy 1</td>
<td>Strategy 1</td>
<td>Strategy 3</td>
<td>Strategy 1</td>
</tr>
<tr>
<td>2</td>
<td>Strategy 3</td>
<td>Strategy 3</td>
<td>Strategy 1</td>
<td>Strategy 3</td>
</tr>
<tr>
<td>3</td>
<td>Strategy 2</td>
<td>Strategy 2</td>
<td>Strategy 2</td>
<td>Strategy 2</td>
</tr>
</tbody>
</table>
2) Responses to Question 2: Evaluation of simulation images’ effects in presenting strategies

Table 5: Data summary of evaluation of simulation images’ effects in presenting strategies

<table>
<thead>
<tr>
<th></th>
<th>Great presentation of information needed</th>
<th>Well presentation of key information</th>
<th>Generally good but miss some important information</th>
<th>Can not present the key information</th>
<th>Not good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>8</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Staff</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Residents nearby</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>32</td>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Percentage</td>
<td>26.56%</td>
<td>50.00%</td>
<td>4.69%</td>
<td>14.06%</td>
<td>4.69%</td>
</tr>
</tbody>
</table>

3) Responses to Question 3: The degree of realism in 3D visualization

Table 6: Data summary of Question 3

<table>
<thead>
<tr>
<th></th>
<th>As real as possible at any cost</th>
<th>High quality visualization to provide enough details</th>
<th>General real to provide key information</th>
<th>No need for 3D visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>8</td>
<td>17</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Staff</td>
<td>0</td>
<td>6</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Residents nearby</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>29</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Percentage</td>
<td>28.13%</td>
<td>45.31%</td>
<td>25.00%</td>
<td>1.56%</td>
</tr>
</tbody>
</table>

4) Response to Question 4: requirements for communicating biodiversity and landscape

This is an open question which is expected to have multiple answers. However, responses collected were quite similar and simple. Even some of the respondents skipped this question. This problem should be anticipated in the designing questionnaire.
The following statements describe some expectation of respondents. But due to the limited number of written comments received; these cannot be considered to be representative.

1) Can accurately represent the information of the plant species and amounts

2) An interactive simulation model with accurate information, such as the fauna and flora species and density

3) Should be easily access to the public

4) Should be interactive and multimedia.

5) Response to Question 5: benefits and limitations of 3D visualization

<table>
<thead>
<tr>
<th>Strengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
</tr>
<tr>
<td>Enable people to explore the campus themselves</td>
</tr>
<tr>
<td>Presents the outline defined stereoscopic effect</td>
</tr>
<tr>
<td>Update easily and frequently</td>
</tr>
<tr>
<td>Staff</td>
</tr>
<tr>
<td>Better to present the future strategy</td>
</tr>
<tr>
<td>Provide Multi-Angle details</td>
</tr>
<tr>
<td>Interactivity of 3D animation</td>
</tr>
<tr>
<td>Residents nearby</td>
</tr>
<tr>
<td>Can help image the future scenario</td>
</tr>
<tr>
<td>More direct viewing and easy to interpret</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
</tr>
<tr>
<td>Not Real Enough, not beautiful enough</td>
</tr>
<tr>
<td>Need professional skill</td>
</tr>
<tr>
<td>Investment of the facilities could be high</td>
</tr>
<tr>
<td>Staff</td>
</tr>
<tr>
<td>Difficulty in collecting data and information to visualize</td>
</tr>
<tr>
<td>Time consuming to set up the visualization model</td>
</tr>
<tr>
<td>High expense of software and hardware</td>
</tr>
<tr>
<td>residents nearby</td>
</tr>
<tr>
<td>Accuracy of the presentation</td>
</tr>
<tr>
<td>Explanation and edition right subject to developers</td>
</tr>
<tr>
<td>Complexity of implementation and interaction</td>
</tr>
</tbody>
</table>

Table 7: Public perception of strengths and limitations of 3D visualization techniques
6) Response to Question 6: helpful or not in presentation of biodiversity and landscape information

Table 8
Data summary of the public attitudes towards 3D visualizations

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Very helpful</th>
<th>Helpful</th>
<th>Fairly helpful</th>
<th>Unhelpful</th>
<th>Very unhelpful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>36%</td>
<td>6%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Staff</td>
<td>17%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Residents nearby</td>
<td>22%</td>
<td>1%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>75.00%</td>
<td>12%</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

7) Response to Question 7: Public acceptance of the use of 3D visualization

The response of this question was quite one side. There were 64 survey participants, only 3 chose the options of “NO”, 9 chose “have no ideas”; the rest all agreed that they would like to experience the merits of visualization techniques.

Graph 1: Acceptance of the use of 3D visualization

8) Response to Question 8: current communication ways and their strengths and weaknesses
Table 9: Summarized data of existing ways of presenting and communicating biodiversity and their strengths and limits

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Maps</th>
<th>Criteria weight</th>
<th>Experts’ evaluation (e.g. EIA.)</th>
<th>Real photographs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Low cost</td>
<td>1</td>
<td>Relative objectivity</td>
<td>1 Authority</td>
<td>1 More real</td>
</tr>
<tr>
<td>2 Light to carry around</td>
<td>2</td>
<td>Easily to distinguish levels of hierarchy</td>
<td>2 Professional</td>
<td>2 Low cost</td>
</tr>
<tr>
<td>3 Easy to make</td>
<td>3</td>
<td>Suitable for communication</td>
<td>3 Systematic</td>
<td>3 Easy to operate</td>
</tr>
<tr>
<td>4 Have already popularized</td>
<td>4</td>
<td>Well accepted by the public</td>
<td>4</td>
<td>4 Well accepted by the public</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limitation</th>
<th>Maps</th>
<th>Criteria weight</th>
<th>Experts’ evaluation (e.g. EIA.)</th>
<th>Real photographs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Carry small quantity of information</td>
<td>1</td>
<td>The setting of criteria can not avoid subjective factors</td>
<td>1 May bring in personal subjective judgement</td>
<td>1 Can not be updated</td>
</tr>
<tr>
<td>2 Not visual attracting and direct viewing</td>
<td>2</td>
<td>Need professional skills and experiences</td>
<td>2 Experts opinion can not represent all stakeholders’ benefits</td>
<td>2 Can carry small quantity of information</td>
</tr>
<tr>
<td>3 Can not keep updating</td>
<td>3</td>
<td>Time and money consuming</td>
<td>3 Can be affect by other factors, not objective enough</td>
<td>3 Not objective enough, affected by factors such as: the skill of photographers, angles, the personal judgment of the photographers,</td>
</tr>
<tr>
<td>4 Require expensive facilities</td>
<td>4</td>
<td>Time and money consuming</td>
<td>4</td>
<td>4 Can be affected by the environment, such as the humidity level</td>
</tr>
<tr>
<td>5 Applicable scope is not broad enough</td>
<td>5</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
9) Response to Question 9: should 3D visualizations used in Conservation Development Strategy Plan?

Table 10:

<table>
<thead>
<tr>
<th>Attitudes</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Fairly agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Stakeholders' percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>30%</td>
<td>14%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>47%</td>
</tr>
<tr>
<td>Staff</td>
<td>16%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>22%</td>
</tr>
<tr>
<td>Residents nearby</td>
<td>20%</td>
<td>11%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>31%</td>
</tr>
<tr>
<td>Attitudes' percentage</td>
<td>66%</td>
<td>31%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Graph 2: Public attitudes of the 3D visualization used in Conservation Development Strategy Plan

10) Response to Question 10: suggestion for how to integrate 3D visualization into UEA

a. to establish a interactive model of 3D campus in the UEA website
b. to invest more money and invite more experts on the campus visualization
c. Use 3D simulation images in Conservation Strategy Development plan
d. Use 3D screenshot images in posters, leaflets
e. Make a architecture model of the UEA campus
Analysis and discussion:

1) Representation of plants and vegetation VS realism ranking

Regarding the result of Question 1, the visualization images of Strategy 2 (landscape between River Yare and the UEA buildings) ranked the last among the three groups. Some respondents explained the reasons for their choices that the area of the ground vegetations in the visualization images of Strategy 2 was the largest and the features of the landscape seem to be least real. They expected better representation of plants and habitats. Many studies such as the survey carried out by Bishop and Rohrmann (2003) have similar results as the outcome of Question 1. This indicates that the problem in the realism of vegetation is universal to many researchers. This is supported by the findings of Appleton and Lovett (2003) that foreground vegetation and the appearance of the ground surface have a significant effect on the rating for realism. The grass land nearby the lake in the visualization images of Strategy 2 is the most criticized for its colour and texture. Most of the respondents of the survey suggested these images could be improved to be realistic representation of the plants and habitats like photographs. This problem could be solved by the simple technique of vegetation modelling that taking photos of landscape in the real world and applied the photographic textures to places you need. By doing this, immediate photo-realism could be gained by adding no matter individual tree images or land cover vegetations. Although the problem of “sheer number of plants and the complex photo-texture-mapped geometry” worried by Paar (p.833, 2006), these techniques would be improved as the rapid development of visualization software and hardware in computers (Muhar, 2001). To sum up, the degree of realism in the visualization of vegetation is one of the most important factors which might have affected the general quality of biodiversity and landscape simulation.
2) Visual biodiversity

In Question of the special requirements of biodiversity visualization, some respondents stressed the need of visualization technique to accurately represent the biodiversity information such as the species, amount of plants. This is a very interesting issue related with ‘visual biodiversity’ of vegetation species in landscape simulations which was raised by Paar (2006). It is a relative new issue compared with the research of simulating landscape varieties.

Respondents were inclined to receive biodiversity and landscape information in a more directive way, such as get information of the fauna and flora species densities by clicking certain places in an interactive map, information flora and fauna species densities. The efficiency of representing quantity of individual plant models and the accuracy of plant species might be the most crucial in this issue. Topics raised in these issues are the major causes for concerns the public (Paar, 2006). At the same time, available plants models for natural landscape provided by the visualization software are far from enough to support the sufficient representations of plants and habitats. In this project, this problem was solved by using some of the similar tree components represent those that were not available in the component library in VNS software.

Graph 3: Effectiveness of 3Dsimulations in presenting landscape strategies
3) Effects in presenting future scenarios

In our survey, the vast majority (76.56%) of respondents agreed that 3D simulation images and other 3D visualization techniques could help explain future strategies by presenting the future scenarios effectively. 18.75% of the respondents thought the presentation of landscape in these images was not good enough because of the operation skill was not good enough. It is interesting that there were 14.06% of respondents, all of who were residents nearby, thought that these images cannot present the key information of landscape strategies. Some of them explained their choice that these images were not real enough and the key information was not highlighted in these images. From these results, it is found that the public especially laypersons who lack of previous knowledge in 3D visualization would expect the simulation to be like real photo. This related with the degree of realism which would be discussed in the part 5. What is more, the understandings of management policies among people could be different. So that the potential landscape changes shown in these images were not that some respondents expected to be according to their interpretation. In general, these results matched Hypothesis Two that most of respondents were affirmative to the effects of 3D visualization techniques in presenting future landscape changes.

4) How real is enough?

Survey Question 5 was designed to explore the degree of realism. There were 73.44% of survey participants who expected these 3D visualization images or animation to be of high quality, among which 28.13% thought these simulation outcomes, should be as real as possible at any cost. Regarding the predicted outcome of Hypothesis Three, it is not surprising to find that most of those respondents who insisted visualization should be improved to be perfect spared no efforts were residents nearby. At the same time, most of the staffs chose the two options “general real screenshot images to provide key information” and “high quality visualization to provide enough details”, which means more attentions were paid to cost and benefits. It was unexpected that although there were many residents nearby held the opinion “as real as possible”, the rest of them who insisted of no need for 3D
visualizations were all residents. It is very interesting that public opinions have polarized on this issue. It may be explained that some of residents were lack of knowledge and previous experiences in 3D visualization programs.

The respondent who insisted of no need for 3D visualization explained that when 2D was enough to show key information, it was not necessary to add third dimension information. He stated that most of the projects could be present well enough by maps, graphics, and photos together with texture description. But many researchers and laypersons including me believed that 3D presentations add more aesthetical elements (e.g. the shaded side of buildings) into presentation which would make the landscape in future scenario more verisimilitude.

**Graph 4: public perception of the realism in 3D Visualizations**

The degree of realism involves with many issues, such as the necessarily of the hyper-realism, the abstraction, and the level of detail presented.

Is it necessary to represent the landscape changes completely the same as the real world? In these days, as the rapid development of the computer and software techniques, 3D software programs and specialized landscape tools such as 3D Nature’s Visual Nature Studio (VNS) allow a high degree of 3D visual realism of existed or potential landscapes (Sheppard, 2001). But it is still impossible and unnecessary to make the visualizations as real as the real world. The visualization software still had many defects. The difficulty of data collection, high cost and requirement of operation should be taken into
consideration. What is more, photo realism or even physical realism is unnecessary for public communication purposes (Ervin, 2001).

Researchers had expressed concerns of overkill through over-stimulation or information overloads (Orford et al., 1999; Lange, 1999) and the necessity of abstraction. Regarding many of the 2D visualization ways, such as sketches, maps, diagrams, they are of some degree of abstractions. They are effective in presenting and communicating landscape strategy as well. Planners should have some criteria to decide what information should be selected, discarded, highlighted in representation.

Some respondents were distracted from the low-detailed elements inconsistent from the rest of the image, and this had affected their judgements of this image. This indicates that the general realism should be consistent with rest of the visualization while the highlighted part could be presented in more details. This was supported by the finding of survey carried out by Appleton and Lovett (2003) explored a level of realism for visualizations for rural landscapes that is sufficient for environmental decision making. A reasonable solution to this issue was addressed by Daniel (1992) by suggesting that images quality could be improved by additional efforts without an increase in image validity. Simulation images of UEA landscape strategy might perhaps be of lower representation quality contain less data, but still sufficiently realistic to generate reliable response form the public. To sum up, planners need to make trade-offs between the degree of realism and the cost together with other issues.

5) Concerns of reliability and validity

Respondents were asked to give their expectations of 3D visualization techniques used in biodiversity and landscape information communication. The most common answers are as “visualize the future landscape changes effectively”, and “present key information accurately”. Most of these respondents cared about the accuracy of presentation.
The concern of reliability and validity of landscape simulation prove to be unavoidable (Lange, 2001). Nowadays, landscape simulations might be of high image quality to “photo-realistic”, but their accuracy may be not that satisfactory (Daniel, 1992). Actually the accuracies of these visualization techniques were rarely measured. Many secondary details would affect the perception of the general realism of the simulation outcomes. For instance, the accuracy of landscape simulation images in this project, were doubted because of the vegetation species, the colour of grass land used, and the appearance of buildings. What is more, the understandings of the visualized strategies were different. For example, Strategy 2 describing the future management of landscape of rear (north) elevation of ziggurats stated as: “landscaping should match the vigour and scale of the buildings.” My interpretation was that the suburban features of rear elevation of ziggurats should be removed, and the new planting should be big enough and planted in line to make a magnificent and arranged view. But several respondents expressed different opinions. They preferred landscape to be placed randomly to merge into the natural landscape in UEA. In a word, the validity and reliability of the simulation outcomes are important issues which are influenced by many factors.

6) Interactivity

Regarding Question 5, some students and teaching staffs mentioned that 3D simulation would be better present the landscape change if it is interactive and multimedia. There are many computer animations with great advantages to allow people to move about, and observe the 3D objectives from different perspectives. So the observers are not limited to certain predetermined viewpoint. It was easy to understand that most of the supporters for interactive 3D visualization were from the students group. It could be explained that young people were more curious than the other age groups in this survey and could accept new technologies in shorter time. Actually, the 3D visualization techniques have already used in the on-line games which are quite favoured by young people. Some teaching staffs had also talked of interactive simulations. However, only a small number of respondents
supported the use of interactive visualisations. That might because that except of some students and staffs, most of the laypersons did not acknowledged many real-time visualization programs. In this project, an interactive animation model had been set up. However only those screen shot images from particular viewpoints were shown to the survey participants because of limiting conditions. Consider allow respondents to rotate angles to see Sainsbury Centre for Visual Arts, or navigate into the landscapes between the Ziggurats and River Yare. It would make it easier for people to gain a more detailed and multiple perspectives experience of the current or proposed landscape. Evidences were shown that animation significantly reduces the cognitive load on the user by providing constancy (George et al, 1993). Based on this evidence, it is predictable that interactive animation would be a very effective method for the public communication.

7) Strengths and weakness of 3D visualization

When asked the perceived merits and limitations of 3D visualization technique in Question 5, respondents gave various answers.

First of all, one of the most common advantages mentioned by the survey respondents is greater information density than 2Ds. it is not difficult to interpret that an additional dimension consists some more information than the only 2D ones, such as the relations between objectives. At the same time, high information density means saving more computer space. Secondly, 3D visualization allows the presentation of the real world to be more natural. This could because of the similarity of 3D graphics with the real world (Teyseyre and Campo, 2009). In this way, the representation of the objects would be more realistic. Thirdly, residents living nearby just mentioned two very important advantages for communication: more direct viewing and easy to interpret. Unlike the other presenting ways such as maps, engineering graphics, 3D simulation images or animation do not require professional knowledge to read and understand. However, this result was conflicting with one of the opinion held by some researchers (Bowman et al, 2001; Teyseyre and Campo, 2009). They suggested that it is often more difficult for users to understand 3D space and perform actions. As for public communication, the
presentations of the project were often given and operated by specialist. Even the interaction was done by laypersons, this operation just involving clicking several button and moving around to navigate. This is could be very simple if explained it clearly. In addition, it would be possible for a 3D visualization model to update frequently, which was raised by some student with relevant experience. This was really important in many occasions; for instance, consider setting up an E-Campus model for potential students and applicants to visit. New buildings and landscape feature could be added into the campus model up to date.

On the other hand, limitations of the current visualization technique were raised by survey participants, such as more complexity of implementation and interaction, the difficulty in learning (time consuming and relevant knowledge required), and relative high cost of facilities. The first problem lies in the adaptation to new software. Some respondents stated that the interaction with the presentation and the use of relevant software require considerable efforts to get use to these technologies. Another problem of 3D communications that lack of validity and reliability in presentation had been discussed in the previous part. This problem could be addressed by balancing several factors, such as the cost and time and the degree of validity, the use of powerful visualization software and purchase of more data. The problem of relative high cost of facilities and difficulty in learning the software could be addressed by the rapid development of computer graphic software. Actually different software would have various strengths and weaknesses. Appleton et al. (2002) analyzed current methods of GIS-based landscape simulations by comparing their advantages and disadvantages. As their concluded that there was not a perfect visualization solution, the current technologies require people to choose from different software based on detailed considerations.

8) public perception of 3D visualization techniques’ effectiveness

Regarding Question 6, the majority of respondents (87.50%) thought that these 3D simulation techniques have great effects in aiding landscape and biodiversity communication, 75% of which found them to be “very useful”. On
the other hand, there was still 12.50% of survey participants found it only "fairly helpful". Those who held the opinion that the 3D visualization techniques were just fairly helpful explained their choices that it would be unnecessary to use 3D visualizations when 2Ds could represent enough information. However, conventional planning instruments such as texts or maps have proved to be not very useful in the effective visual communication of a future landscape and biodiversity change. 3D visualizations have been attributed with a great potential to assist the effective visual communication of landscape and biodiversity strategies.

However, it is interesting to find that not many people know heard about the Conservation Development Strategy Plan. This reflects that the public engagement in UEA was not good enough and need more effective techniques such as 3D simulation images and animations to improve its efficiency.

From the outcome of this question, we could see that 3D visualization techniques have been accepted by most survey participants. The result of Question 7 proved that 3D visualization techniques have great favourability rating. Hypothesis Six of Question 7 that most of the respondents were expected to accept the benefits of 3D visualization techniques was confirmed then.

9) Use it in Conservation Development Plan for UEA?

Almost all of people (96.88%) responded to Question 7 approved to the use of 3D simulation techniques in Conservation Development Plan which is the most important document on landscape and biodiversity management. One of the typical reasons was that the 3D simulation images similar with those used in this survey looks more natural and could easily help the public to imagine. Except for these people, 3.12% of respondents who were all students just fairly agreed to use the 3D simulation in this document. They suggested that it would be not suitable to use the 3D visualization images in the paper documents if these images were not photo-realistic. A 3D simulation model was suggested to set up in the UEA website to allow people to navigate into
the virtual campus. This revealed the potential of 3D visualization techniques integrated in the environmental management system in organizations such as universities and colleges. The virtualized and visualized gallery and 3D Interactive Map of University of Warwick campus is proved to be good examples of the techniques application. It is in active development which meant it could keep updating.

10) Techniques used in UEA campus landscape management

Regarding Hypothesis Five, survey participants were expected to have chance to take part in the communication activities and be familiar with the communication ways in UEA. However the end result was unsatisfactory. Only a half of them who were mostly students and staffs in UEA had ever been involved in the landscape and biodiversity communication activities, such as answering the questionnaire survey and other research activities related with different management. And most of the residents nearby in this survey were reported have no change of involvement. The reason to explain this is the limited communication and integration internal and external. Even the integration of student courses and societies in aiding conservation efforts on site is limited to some extend. One of the most common involvement activities in UEA was the small group visit to the UEA site.

According to the theory of seven stage of communication (Bier, 2001a), the communication level in UEA is of low sufficiency. Several options of the communication ways used in UEA landscape and biodiversity management were given to allow respondents to choose from. These options which were summarize from the interview results were outlined as follows: Maps, Criteria weighting, experts’ evaluation (e.g. report of EIA), real photographs, texture description. Compared with 3D simulation techniques, these communication ways all have their advantages and disadvantages. Taken maps and real photographs for example, low cost and well acceptance of the public were its main merits while deficiencies of small information density, not directive viewing, not easy to keep updating. More scientific and systematic methods such as criteria weighting and experts’ evaluation were perceived to be relative objective which would help the presenter be more persuasive. But
similar as maps and real photographs, the critical defect of these methods was not intuitionistic or readable enough for laypersons. Directive viewing is really crucial in public communication especially when presenting to laypersons that lack of relevant knowledge. Last but not the least, keeping updated is very necessary for the landscape and biodiversity management in an organization. Based on the discussion above, there is great potential to integrate 3D visualization techniques into the environmental management system.

11) How to integrate the 3D visualization techniques into the landscape and biodiversity management

There are many forms of 3D simulations to aid the presentation and communication, such as the interactive map on-line, 3D simulated images used in relevant posters, documents, and animation of UEA campus. As for the interactive map on line, there were many successful cases such as the interactive e-map of the campus of University of Warwick. The interactive map is quite similar as Google Earth, Bing Map, which allow users to navigate into the campus environment. 3D simulated images, for instance, those images used in this project, are quite versatile. They could be used in presentation meetings, the posters, leaflets, and documents such as the Conservation Development Plan for UEA.

There are a lot left to do in order to improve the public engagement in landscape and biodiversity management, 3D visualization techniques would be a great method to achieve this.

Conclusion:

3D visualization of biodiversity and landscape has received much attention in recent years. Thanks to the breakthrough of computer graphic techniques, simulating biodiversity have been increasingly applied in many areas. In this survey, the public opinions differ from each other on the visualization of biodiversity and landscape.
From the responses of the surveyed, it can be seen that the representation of vegetation would affect the public perception of the realism of overall compositions. This is supported by some findings in researches that the appearance of the ground surface would influence the ranking of realism most (Appleton, 2003). What is more, the simplified visualization of buildings – blocks were challenged by some respondents, which have also affected the overall perception of the 3D simulation outcome. It could be explained that the landscape the poorest component would have “dragging the wheel” of the perception of overall quality of simulation outcomes.

The feasible study survey provides relevant information about the perceptions of 3D visualization among different stakeholders. 3D visualization was proved to have a positive image in simulating future landscape. In general, most of the respondents in the survey were willing to accept the additional benefits of 3D visualizations in biodiversity and landscape management. It is interesting to find that expectations and perceptions are slightly different according to ages. Students who were younger than the other groups were interested in the application of 3D visualization techniques while many old participants were the contrast. What is more, other factors such as education background and relevant experience might also influence people’s attitude towards this new technique.

Not many surveys provide direct survey data on the public expectation and requirements of visualization biodiversity and landscape. Evidences showed the need of visualization technique to accurately represent the biodiversity information such as the species, the amount of plants. An interactive simulation model with accurate information, such as the fauna and flora species and density was recommended by many respondents.

The findings of the survey reveal that the attitudes of the degree of realism in the 3D simulation application vary with many factors, such as relevant professional experience, ages and education backgrounds. The public opinions have polarized on this issue. Possible explanation could be a lack of knowledge and previous experiences in 3D visualization programs among the laypersons. The majority of respondents believed that it was impossible and
unnecessary to pursue the photo-realism. Abstraction of secondary information are needed, at the same time the influence of details of low level realism to the overall realism of simulation outcomes should be taken into consideration. In short, planners need to make trade-offs between the degree of realism and the other factors, such as costs and data availability.

The concern of reliability and validity of landscape simulation were expressed by most of the respondents. They suggested that landscape simulations might be of high image quality to “photo-realistic”, but their accuracy may be not that satisfactory. There are many factors that might affect the reliability and validity of the visualization outcome, such as different understandings of the visualized strategies, the low realistic representation of secondary information.

There are evidences in this survey showing the preference of interactive animation. Many respondents, especially young people (e.g. students, young residents who lived nearby UEA) believed that the interactive animation would be a very effective method for the public communication.

There are many merits of the application of 3D visualization in biodiversity and landscape, including greater information density, more natural presentations, more direct viewings and easy interpretation, and easy updating. Barriers to the implementation of 3D visualization tools are the high costs of facilities, time consuming to learn and operate, more complexity of implementation and interaction. However, these problems could be solved as the rapid developments of computer techniques.

There is increasing awareness of the 3D simulations’ effects in communicating biodiversity and landscape information. Most of the respondents thought these techniques to be “helpful” or “very helpful” when in the application of biodiversity and landscape. The preference of 3D visualization techniques could also be seen in the result of Question 9 although Conservation Strategy Plan was little known.

Existing ways in communicating biodiversity and landscape were evaluated in this survey, including maps, experts’ evaluation, criteria weighting and
photographs. Compared with 3D visualizations, these methods were perceived to be low information density, require professional knowledge and experiences, not directive viewing and not easy to maintain and update. These shortcomings are very fatal flaws in public communication. In order to improve the level of communication in UEA, many methods were recommended by these respondents, such as the interactive maps, 3D visualization model which allow users to navigate and explore, and 3D simulated images which could be used in the presentation meetings, posters and leaflets.

Limitations and improvement

The visualization images generated in this project were not good enough as I anticipated because of limited time. Buildings were just blocks and lack of necessary features. Taken the building of Ziggurat for example, the shapes of pyramids were not simulated in the visualization images because of the limited time. Trees and brushes components used in the visualization models were not exactly the types in the real world. Related species of these plants were chosen to take the place of the original species components which were not found in component library in VNS. If time permits, features such as the outlines of buildings, and adding new vegetations components by creating image components myself.

In this survey carried out in project, the participants were divided into three groups, including students, staffs, and residents nearby. Further survey would be designed to explore distinguishes of public perceptions between different factors, such as ages, education background.
Appendix 1 Map The following map gives many details on the type of habitats found at UEA and the important species which can be found at these habitats and the locations of these habitats. (UEA Environmental Working Group, 2008)
Appendix 2: Expert interview questions

Questions for experts’ interview

Question 1: what do you think of the existing situation of landscape and biodiversity management in UEA?

_____________________________________________________________________

Question 2: Which of the ways listed in the following options you know are effective in presenting landscape strategies?

G) Maps
H) Authorized evaluation
I) Photographs
J) 3D visual simulation
K) criteria weighting
L) others

If others, please specify_____________________________________________________________________

Question 3: “what is your recommendation for better communication in biodiversity and landscape information?”

_____________________________________________________________________

Question 4: is there any special requirement of techniques when communicating biodiversity and landscape information?

_____________________________________________________________________

Question 5: According to your experience of 3D simulations, what are the strengths and limitations of 3D visualization techniques used in landscape and biodiversity?

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________
### Appendix 3

**Table 11: High significant Features of UEA conservation policies to improve landscape on campus** (summarized from the Conservation Development Plan for UEA, 2006)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Existing problems</th>
<th>Maintenance</th>
<th>Alteration/ Refurbishment</th>
<th>Perspective Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front (south) Elevation</td>
<td>Keep the open landscape running right up to south face of ziggurats</td>
<td>Window have been replaced with the following characteristics:</td>
<td>Roof terraces Every effort should be made to find a practical, affordable, and visually acceptable way of making the roof terraces usable by the students.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• same configuration of opening and fixed lights</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• dark colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• thicker sections corresponding to the original timber windows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ziggurats</td>
<td>Window have been replaced with the following characteristics:</td>
<td>A signage plan should be implemented using the original lettering style (Universe Bold).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear (north) Elevation</td>
<td>Windowless and hard</td>
<td>Hard landscaping should be upgraded to enhance the environmental quality.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tall metal ventilation pipes</td>
<td>reported to be hard</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uncontrolled climbers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- high level walkway and</td>
<td>Norfolk terrace forms dead ends cause significant visual impacts</td>
<td>The narrow ‘slots’ between the stairs or walkways and accommodation should be opened up, but treated in such a way as to conform to safety standards and DDA requirements.</td>
<td>The connection between walkway at the west and of Norfolk Terrace and ground level or Teaching Wall walkway should be improved</td>
<td></td>
</tr>
<tr>
<td>bridges</td>
<td>Steep and dramatic stairs; no lobbies on the walking entrance; small canopies require repairing; separate from the open landscape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal circulation – access stairs</td>
<td>Steep and dramatic stairs; no lobbies on the walking entrance; small canopies require repairing; separate from the open landscape</td>
<td>The connection between walkway at the west and of Norfolk Terrace and ground level or Teaching Wall walkway should be improved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakfast room</td>
<td>conspicuous to view from outside</td>
<td>refitted to high standard in a continuous pattern; install Extractor fans in an inconspicuous way</td>
<td>Improve the internal insulation of the external walls or floors/ceilings</td>
<td></td>
</tr>
<tr>
<td>study bedrooms, double bedrooms, and single tutor’s flat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
<td>Actions</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Front (south) Elevation</td>
<td>Solar heat gain assessment, and rectification strategy; several ad hoc concrete block extensions</td>
<td>Remove the ad hoc concrete extension; A strategy for organising the proliferation of rooftop plant and services has been established; Replace windows to improve their thermos performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear (north) Elevation</td>
<td>The biology plant room, stair and WC towers have been refurnished.</td>
<td>Extend the floor place to the Arts Spur; utilise the ‘knock-out’ panels in the original construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Elevation</td>
<td>Exploit positively the architecture feature of the colonnade, e.g. lighting, signage, landscaping and acknowledgement of the original architecture.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high-level walkway and bridges</td>
<td>Improve the surface to meet DDA requirement for surface treatment and visibility.</td>
<td>Reinstall the bridge to Norfolk Terrace; improve the connection to ground level from the raised plaza at the west end of the walkway system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Elevation</td>
<td>Never intended as a finished elevation</td>
<td>Extension to provide more floor place to the teaching buildings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library interior</td>
<td>The poorly sealed external Envelope; overheating; original shelving layout not comply with disabled access requirements.</td>
<td>Retain or reinstall original finishes; utilise existing services ducts or trucking for service runs, e.g. replace electrical sockets and switches, replace the light fittings, replace radiators</td>
<td>Exploit the improvement chance of the internal insulation of the external walls or floors/ceilings.</td>
<td></td>
</tr>
<tr>
<td>Lecture theatres Exterior</td>
<td>Economical building lacks architectural excitement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler House, Chimney flues are anticipated</td>
<td></td>
<td>Replace buildings and</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

46
<table>
<thead>
<tr>
<th>Stores, etc.</th>
<th>Sainsbury Centre</th>
<th>Exploit ways of reinstating the view to the Broad whilst protecting works of art.</th>
<th>the exception of the flues with higher quality buildings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sainsbury Centre</td>
<td>Refurbishment have been undertaken to replace servicing systems and improve the connection the Crescent Wing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music Centre</td>
<td>Need Refurbishment the next few years</td>
<td></td>
<td>High standard should be complied with in order to maintain the character and significance of the building.</td>
</tr>
<tr>
<td>Landscape</td>
<td>Landscape between the Yare and the UEA buildings</td>
<td>Not fully achieve the creation of a parkland landscape along the River Yare, overlooked by the new University buildings, and little has been done to the landscape for enhancement.</td>
<td>Develop the building quality of the east Suffolk Terrace</td>
</tr>
<tr>
<td>Landscape in developed area of campus</td>
<td>The main campus entrance is visually chaotic; the quality of the campus is degraded by car parking and service vehicles</td>
<td>Existing plantings and landscape features should be managed in accordance with a new landscape strategy.</td>
<td></td>
</tr>
<tr>
<td>South and west of the River Yare</td>
<td>Need road connection across the Yare</td>
<td>Remove the suburban features in between the Lasdun building; existing plantings and landscape features should be managed in accordance with a new landscape strategy.</td>
<td>Improve the visual quality of Campus entrance in accordance with a new landscape strategy.</td>
</tr>
</tbody>
</table>
Appendix 4: Survey questionnaire

Questionnaire of University of East Anglia (UEA) landscape strategy and communication by using visualisation techniques

Q 1: “In terms of realism, how would you score the overall composition of these images?” (High realistic—3; Medium realistic —2; Poorly realistic –1)

Strategy 1 (Boiler house with the high chimney) __________

Strategy 2 (Landscape between the Yare and the UEA buildings) __________

Strategy 3 (Landscape of rear elevation of Ziggurats) __________

Q 2: “Do you think these images can well present the landscape changes between the current situation and future strategies?”

A) Great presentation of information needed

B) Well presentation of key information

C) Generally good but miss some important information

D) Can not present the key information

E) Not good

Q 3: To what extend should the visualized image or animation used in presenting biodiversity and landscape management information be real?

A) As real as possible at any cost

B) High quality visualization to provide enough details

C) General real to provide key information

D) No need for 3D visualization
Part 2

Q 4: is there any special requirement of techniques when communicating biodiversity and landscape information?

Q 5: According to your experience of 3D simulations, what are the strengths and limitations of 3D visualization techniques used in landscape and biodiversity?

Q 6: To what extent do you think 3D visualization techniques are helpful to present and communicate biodiversity and landscape information?

A) Very helpful
B) Helpful
C) Fairly helpful
D) Unhelpful
E) Very unhelpful

Q 7: Do you accept additional benefits as a result of the use of 3D visualization?

A) YES
B) NO.

Please explain your choice

Part 3

Question 8: ‘what are the main ways in communicating biodiversity and landscape information in UEA right now? And what are the strengths and limits of these ways?

A) Maps
B) Criteria weighting
C) Experts’ evaluation (e.g. EIA.)
D) Real photographs

E) Others, please specify

Q 9: “Currently UEA’s Conservation Development Strategy do not use 3D visualization techniques. Do you think 3D images or 3D animation techniques should be used to visualize the future landscape strategy in the plan?

A) Strongly agree

B) Agree

C) Fairly agree

D) Disagree

E) Strongly disagree

Q 10: “what do you suggest ways to use 3D visualization techniques in UEA”

Thank you for your cooperation!
References:


Biodiversity and landscape working group in UEA (2009), Biodiversity Initiative Environmental Review Template


Cambridge Architectural Research Ltd (2006), Conservation Development Strategy for the University of East Anglia


