Visualisation Protocol for Urban Forestry

LTOA London Tree Officers Association

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This document has been produced by the London Tree Officers Association's Visualisations in Urban Forestry Working Party.

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LTOA

The London Tree Officers Association provides an information network for the exchange of views, experiences and ideas on trees and the management of London's Urban Forest. The Association dates back to 1982 and aims to enhance the management of the capital's trees and woodlands. It involves local authority Tree Officers in all 33 London Boroughs, an associate membership of a wide range of tree professionals and those who manage and care for trees. The LTOA is funded by London Boroughs and associate member subscriptions and is hosted by the London Borough of Camden. For more information, documents, advice and guidelines on tree care take a look at the LTOA website at www.ltoa.org.uk

CALP

The Collaborative for Advanced Landscape Planning is an interdisciplinary research team at the Faculty of Forestry, University of British Columbia (UBC) in Vancouver, Canada, that develops tools and processes to address sustainability, climate change and urban forestry solutions, through participatory planning, visualisation media, spatial modeling, and environmental design. To know more visit https://calp.forestry.ubc.ca

Arbocity

Arbocity is a non-profit association that gathers together professionals, researchers and academics from the fields of Forestry and Urban Forestry to communicate the benefits of the urban forest and the importance of its care and management. Arbocity supports local governments, private sector and citizens bringing to them and developing technological solutions, new management and ecosystem evaluation methodologies, and citizen science and environmental education initiatives.
To know more visit www.arbocity.com

Contents

1 Executive summary

HOW THIS PROTOCOL MAY BENEFIT TREE OFFICERS

1.1. This Visualisation Protocol for Urban Forestry has been developed in association with public realm and planning tree officers/managers and urban forestry researchers. It aims to provide tree officers with a basic understanding of the planning and production process for using visualisations. Tree officers often face the challenge of reviewing planning proposals with visualisations which are of variable quality or with unverifiable implications for the health and future viability of the trees shown. Research has documented frequent concerns from tree officers over the lack of standards or redress in using such visualisations. This Protocol will help them to review, request, commission or produce visualisations and to ensure that they are accurate, representative, easy to understand, interesting and legitimate. This document provides general guidance but is not intended as a step by step manual on how to produce visualisations with specific software packages.

1.2. The Protocol has been specifically created for visualisations in which urban trees in particular and urban greening in general, play a prime role. Although mainly aimed at tree officers, the guidance may also be of value to other professionals involved in the creation of visualisations or who receive such materials within the field of urban forestry, urban planning or landscape architecture.

CONTENTS OF THE PROTOCOL

1.3. The Protocol provides both a theoretical base and practical applications of visualisation, relating to situations where tree officers interact with artists renderings or other visual simulations. It builds on accepted principles that can be used to foster visualisation efforts which are fair, credible and effective. The document is divided in the following sections:

Section 2 includes definitions of visualisation and the applications and benefits of their use in urban forestry. It explores the different types of visualisations we can find and explains the reasons why this Protocol is necessary.

Section 3 identifies the principles for visualisation that constitute a code of ethics which all professional visualisations should attempt to comply with.

Section 4 provides an overview of the process and required data and materials for each phase in planning and commissioning/producing a visualisation effort, what to consider when presenting and circulating a visualisation and how to review/evaluate visualisations.

Section 5 describes the different situations in which tree officers could be involved in the use of visualisations and includes a collection of practical case study examples of different types of visualisations in an urban forestry context.

The bibliography lists useful references including other guidelines and regulations, books and academic papers which complement the Protocol.

An appraisal form is provided as an Annex to assist tree officers in reviewing and evaluating visualisations they receive, commission or prepare.

2 Introduction

WHAT ARE VISUALISATIONS AND WHY MIGHT WE NEED THEM?

Definition of visualisation

Benefits and applications of visualisations in urban forestry:

- To identify possible spatial conflicts with site designs
- As a general communication tool
- To educate, engage and influence public attitudes
- To increase and improve community involvement
- In internal agency design, decision-making and capacity-building among staff
- To provide a way to verify or assess a project

2.1. Visualisations are "visual pictures or images of proposed projects or future conditions, shown in the context of actual sites" (Sheppard, 1989: p.6). Landscape visualisations represent the visual landscape in three-dimensional (3D) perspective views, with varying degrees of realism. They are images of real places which can be manipulated in several ways to show important features or to simulate future conditions used with different management options. These visualisations can be static or dynamic, interactive and be displayed in various ways. This Protocol does not focus on plans or maps, except as supporting materials.

2.2. Visualisations are a tool that provides multiple benefits for the field of urban forestry management and planning. There are several situations or objectives in which visualisations can be helpful:

- **To identify possible spatial conflicts for a proposed design or planting scheme.** Visualisations offer the possibility to simulate future conditions and explore different alternative scenarios that can be navigated and visualised from different points of view. This allows tree officers to identify possible conflicts between trees and other infrastructure (e.g. balconies or windows from new buildings too close to street trees; street furniture or drainage potentially affecting trees).
- **As a general communication tool**. Visualisations can be used to communicate messages clearly, effectively and fast. Using visualisations in everyday work situations, urban tree managers and planners can translate complex technical proposals and management plans into images that can be easily understood by colleagues from different departments, politicians and lay-people: for example, in keeping people informed about new planting schemes or restoration projects. It can be hard for the public, and even trained professionals, to envision accurately what a site will look like with changes in vegetation and how the trees in question may affect other values (e.g. property values, visibility, perceived safety, shading, etc.).

- **To educate, engage and shift public attitudes toward urban trees**. By translating into images ordinarily invisible processes such as tree root development or abstract concepts like tree condition or specific benefits of urban trees, key concepts can be more easily conveyed to increase people's understanding of urban trees. They can make visible today the long term impact of a change for local residents. This new awareness can change the way people see trees or understand tree management practices and help motivate better stewardship by residents on private and public land.
- **To increase and improve community involvement on projects and build support for new greenspace policies.** Visualisations can facilitate participatory planning to obtain early public feedback and are often seized upon by lay people who aren't interested in wading though technical reports or plans. They can sometimes be used to clarify or resolve difficult arguments about the impact of a tree intervention on people's cherished local landscapes, e.g. by showing what tree replacement and replanting would look like over time. They can also support campaigns for new tree protection bylaws or green infrastructure improvements.
- **In internal agency design, decision-making and capacity-building among staff**. Visualisations can help urban forestry managers and planners improve their own planting schemes and train staff. They can also help tree officers integrate into multidisciplinary teams and promote their arguments, by using similar or better technical capabilities than those used by engineers, urban planners, architects and landscape architects. By simulating alternatives future scenarios (Sheppard & Salter, 2004), visualisations assist urban forestry practitioners to plan better spatial relations between trees and other infrastructure, and to experiment with different species and planting design, before the trees are planted. Tree officers could also request or require appropriate landscape visualisations in order to assess proposals from developers or other third parties.
- **To provide a way to verify or assess a project** once the development has been completed, by comparing the actual result with the visualisation of proposed conditions. The visualisation can be seen as a benchmark or even a 'contract' with consequences, for example to uphold performance or help secure compensation (Chenoweth, 1991)

TYPES AND TECHNIQUES OF VISUALISATION

- **Types of visualisations and examples**
- **Realism vs. accuracy**
- **Techniques for the creation of visualisations**

Types of visualisations

2.3. There are three broad types of landscape visualisations:

- **Conceptual or abstract visualisations** where the landscape is represented by outlines, volumes or wireframe meshes. These visualisations are useful for internal planning as they are quicker to produce, but can be easy for non-experts to misinterpret. Examples of these are CAD wireframe representations (also called 'wirelines [Landscape Institute, 2017]), elevations, or diagrammatic images (Figure 1a).

- **Experiential landscape visualisations** represent the landscape in perspective and can be semi-realistic or highly realistic when bringing colours, texture, detail and atmosphere/illumination into the scene (Figure 1b). These visualisations are used when aesthetic judgements are required and when many details of the project are defined, as they are more time-consuming to produce and often require accurate data sets describing specific types of objects (e.g. tree species and sizes, model of street lamps) and their location.
- **Augmented visualisations** are a combination of both types: symbols or colour-coding are used to add additional information layered on top of an experiential landscape visualisation (Figure 2).

Figure 1. Different levels of realism for a 3D visualisation.
a) *an abstract rendering where buildings are texture-less blocks*

b) *a semi-realistic visualisation where textures, street furniture and other details have been added. Credit: Ana Macias*

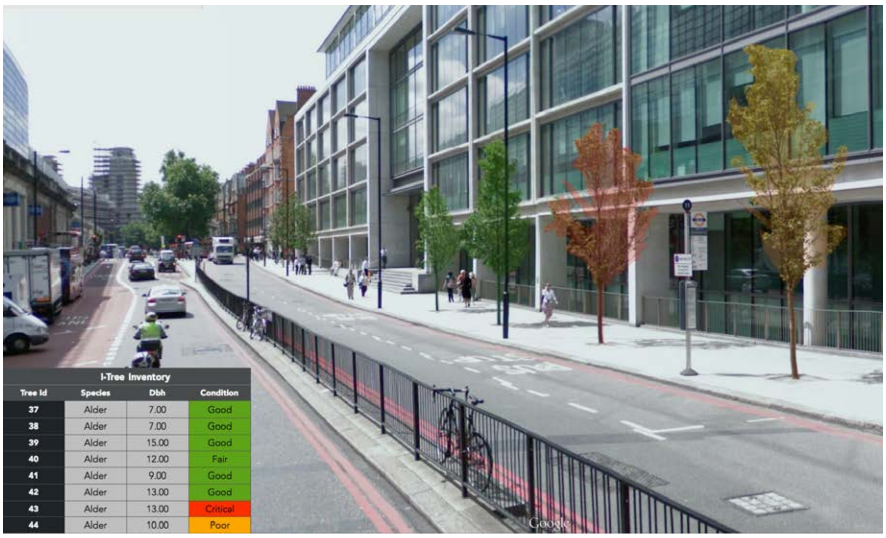


Figure 2. Augmented visualisation.
Trees have been colour-coded (green, yellow or red) to visualize their health condition. Credit: Ana Macias

Box 1 Realism vs. accuracy

- **Realism or photorealism** refers to the apparent similarity of a visualisation image to a photograph or view of a place, with colours, details and textures as you might expect them to look to the naked eye. Does it *look* real? There may however be distortions or not even any such place or photograph in reality (Figure 3).
- **Accuracy** is the similarity between a visualisation image and the actual view of a real place as it is currently or would look after the projected plan has been implemented (as determined by the design data and plans). A visualisation may be accurate but not realistic (e.g., a wireframe showing the accurate scale of an object).

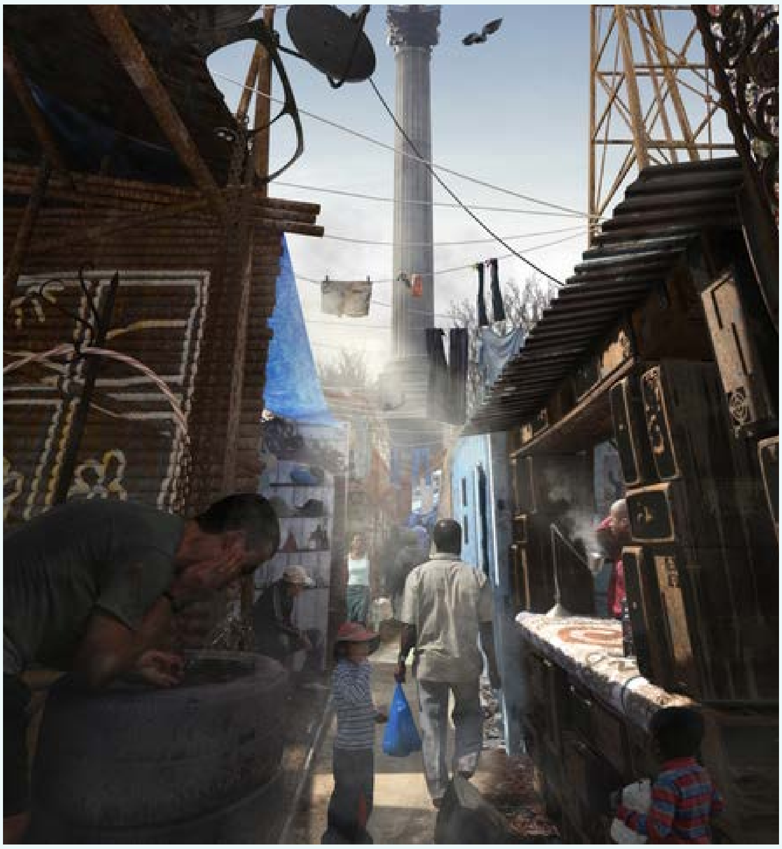


Figure 3. Example of a realistic visualisation of a future London that mostly does not exist.

Imaginary future landscape (shanty town) based on Trafalgar Square. Credit: copyright Robert Graves and Didier Madoc-Jones, London Futures, postcardsfromthefuture.co.uk

Techniques

2.4. Visualisations can be produced using non-digital and digital techniques. Non-digital techniques include among others hand drawings or sketches, artists renderings, hand drawings over photographs or computer print-outs (Figure 4), collages, and physical scale-models. In recent years computer generated visualisations have reached very high levels of realism, becoming comparable to photographs of actual scenes as visualisation software has improved. These tools have also become more accessible to professionals and other users. Two main groups of techniques are in wide use: photo editing (or photo-montage) techniques and 3D modelling techniques (see Landscape Institute, 2017, for further discussion of visualisation types).

2.5. **Photo editing** consists of the use of digital alteration techniques to obtain realistic 2D images that alter an original photograph to show the expected appearance of a specific project or development. It involves digital drawing or montage techniques on digital photographs of the landscape to simulate possible interventions. The points of view are limited to available photographs of the case study area and it is not typically possible to create animations (Figure 5).

Figure 4. Artist's rendering. *Hand sketch of proposed planting for the Kimberley, BC adaptation plan. Credit: E. Pond, S. Muir-Owen, and C. Miller, CALP.*

Figure 5. Photo editing of a 2D digital photograph. *Example of a photograph from Google Street View edited in Photoshop to show a street in Vancouver (Canada) with the potential impact of loss of street trees.Credit: Weicong Fu, CALP/FAFU.*

2.6. **3D modelling techniques** are computer-generated landscape visualisations based on geodata that allow the generation of 3D perspective views from a potentially limitless number of different viewpoints and which can range in terms of realism from abstract to photo-realistic (Ervin & Hasbrouck, 2001; Sheppard & Salter, 2004; Macias, 2016). When using 3D modelling techniques, not only static images can be generated, but animated or video sequences as well, to give an impression of walking or flying through or above a scene (Figure 6).

2.7. Sometimes images created by 3D modelling techniques can be merged with digital photographs using photo-montage techniques, creating what are called **hybrid 2D-3D or augmented visualisations** (Figure 7).

Figure 6. Three-dimensional model.
Example of visualisation of a 3D model of Buckingham Palace Road (London, UK). Credit: Ana Macias

Figure 7. Hybrid visualisation examples.
Over a photograph of Paseo del Prado Avenue (Madrid, Spain) a new design modelled separately in 3D with SketchUp has been merged using Photoshop. The resulting augmented visualisations show the new proposed plan for the area in two different seasons: spring and autumn. Credit: Ana Macias

2.8. When users can freely explore 3D modelled landscapes in real time, instead of through specific pre-selected images or videos, we talk about **interactive visualisations or virtual reality** (Figure 8). These can be viewed dynamically through digital globes such as Google Earth or videogame engines such as Unity. Sometimes we can not only move around the model but also change it in real time by altering certain parameters (e.g. density of trees planted or distance between trees).

2.9. **Augmented reality** refers to viewing and exploring real places or landscapes in real time with superimposed 3D modelled features, accurately positioned through a headset viewing device or on a mobile device screen (Soria and Roth, 2018). Such emerging devices and software can also allow the user to tag or insert features in the real scene, as with Pokemon-Go, but may require access to sophisticated databases for scientific use with urban planning implications.

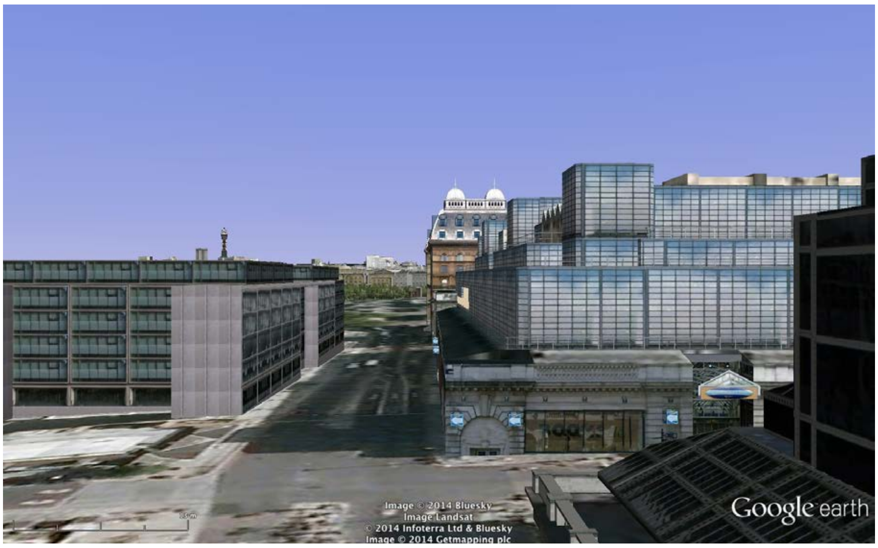


Figure 8. Interactive visualisation using a virtual globe. *Image of Buckingham Palace Road, London, from a Google Earth fly-through with 3D buildings. Data source: copyright (2014) Google Earth*

WHY THIS PROTOCOL?

- **Visualisations are a powerful tool but there are risks when used without guidance.**
- **Wider use of credible visualisations can improve decision-making.**
- **There is a lack of training for urban forestry professionals in visualisation use and production.**
- **There is a need for standards and best practice guidance for using visualisation in urban forestry (Code of Ethics for visualisation).**

2.10. Visualisations can be a powerful tool to assist urban foresters in various ways, but if used without careful thought, they can potentially be misleading or perceived to be misleading. There needs to be a simple but systematic process to plan, produce, present and review visualisations, to minimize the risk of poor practice and resulting problems.

2.11. A set of standards for visualisations would limit the inappropriate use of visualisations by project proponents or opponents who often present a project under conditions that would support their position. In a London research study, visualisation problems identified by tree officers include altering illumination of the scene, selectively including or eliminating vegetation or other elements of the scene and selecting unrepresentative viewpoints (Macias, 2016). Compared with other elements of the visualisations, trees are often represented with a lower level of accuracy in placement (locating them in positions where trees cannot be planted, e.g. over basements) and in size or shape, representing them by random non-realistic models that could be any species or with species that do not correspond with those specified in the proposal (Macias, 2016).

2.12. This lack of standards for visualisations and the use of poor quality visualisations can affect the credibility of local government, as people may identify the local authority as responsible for the images and the fact that the project execution does not provide the expected results.

2.13. Even when visualisations are not part of the compulsory list of documents to include for planning applications but are included voluntarily, they should be subject to the same expectations of precision and reliability that are placed on the rest of the documentation (including other graphic information such as CAD plans).

2.14. Recent software development has resulted in tools that are more intuitive and capable of producing highly realistic visualisations. Visualisation software is now accessible by a wider population of both professional and non-professionals, leading to a greater democratization of the technology and the information but, at the same time leading to very powerful tools being used potentially incorrectly by untrained people. Additionally, highly realistic visualisations can lead to the false idea that a high level of realism or sophistication implies high accuracy, making people more vulnerable to biased visualisations (Groulx, 2010; Landscape Institute, 2017).

2.15. Tree officers and other urban forestry professionals seldom receive training in visualisation production and ethical use, particularly if they do not have design training such as landscape architecture or architecture. This may place them at a disadvantage when dealing with or evaluating visualisation graphic materials.

2.16. Trees and other types of vegetation play an important role in people's perception of the aesthetic value of a project or development (Galindo *et al.*, 2000; Isaacs, 2000). For that reason, it is especially important to ensure that trees and other vegetation are accurately represented in visualisations.

2.17. This protocol provides basic principles drawn from the research literature on visualisation and a set of guidelines for defensible use of visualisations in urban forestry applications. It aims to give tree officers the basic theoretical foundation to be able to understand how visualisations work and to be able to confidently review, commission, or even produce these types of materials. Through a limited literature search, we have identified other relevant requirements or guides for visualisation for use by practitioners, as developed by professional associations, government bodies, and researchers [see selected examples in Table 1 below and the Bibliography for more information]. Most of these documents provide general guidance on visualisation or are specific to other kinds of development projects; this review suggests that the Protocol developed here is the only one focused specifically on urban trees and urban vegetation. A few of these documents have been formally adopted by regulatory agencies. in particular, this Protocol is designed to be consistent with and generally complement the guidance, principles and recommended techniques provided by the UK Landscape Institute in its *Guidelines for landscape and visual impact assessment* and other technical advisory documents (Landscape Institute 2013, 2017 and 2018).

Table 1.
Listing of existing guidance and regulations related to the use of visualisations

Document name	Sections/chapters related to visualisations	Concepts included	Mention visualising vegetation/trees?
Guidelines for Landscape and Visual Impact Assessment (2011, Second Edition) – Landscape Institute	Part 8 section 4 Appendices 7, 8 and 9	Accuracy of visualisations, representative view-points needed, the use of growth tables for 4D simulations for trees and to avoid artist impressions not accurately constructed.	Yes (only when citing time evolution and the use of growth tables)
Guidelines for Landscape and Visual Impact Assessment (2013, Third Edition) – Landscape Institute	Chapter 9	Accuracy of visualisations, levels of detail and illustrative techniques in accordance with projects size, objectives and budget; representative viewpoints and atmospheric conditions needed; photomontages vs. 3D digital models	Not specifically
Visual representation of development proposals (2017) – Landscape Institute	All	Types of visualisation; principles and guidance to choose appropriate visualisation techniques where the effort is proportionate to the purpose, scale and sensitivity of the project.	Not specifically
Photography and photomontage in landscape and visual impact assessment (draft 2018) - Landscape Institute	All	Photography techniques and requirements; photomontage production; accompanying information; techniques for matching photography and 3D modelling	Not specifically
London View Management Framework Supplementary Planning Guidance (2012) – Greater London Authority	Appendix C	Definition of Accurate Visual Representation, requiring a well-defined and verifiable procedure to represent fairly the visual properties of proposed building and context; data that should accompany visualisations to ensure veracity (Method Statement).	Not specifically
Visual Representation of Wind Farms (Version 2.2, 2017) – Scottish Natural Heritage	Chapter 4 Annexes A and B	Visualisations accuracy and data used to construct them; presentation and viewing instructions; limitation of visualisations disclosure and information accompanying them	Not specifically
Visual Simulation Manual (1980) - Bureau of Land Management (BLM)	All	Visualisation types and techniques	Not specifically
Communications tower requirements in Pima County's land use code – Pima County	Section H3 c and h	Cell Towers requiring pre-post photo visualisations and follow-up photos	Not specifically

Table 1. (continued)

Document name	Sections/chapters related to visualisations	Concepts included	Mention visualising vegetation/trees?
Visualizations guidelines for VIA on energy projects - California Energy Commission		Image size of colour photo visualisations, to enable viewing at appropriate scale of visualized landscape on the retina, image labelling, etc.	Not specifically
Organizational rules for the evaluation reviewing and acting upon applications to construct energy facilities - New Hampshire Site Evaluation Committee	Section 301.05(7) and (8)	Representative view-points, high resolution for photographs and images, list of data that should accompany images	Not specifically
Guide to Evaluating Visual Impact Assessments for Renewable Energy Projects (2014) – Sullivan and Meyer	Chapter 5 Appendix B	Interpreting and evaluating visual impact simulations, principles and guidance on evaluating the quality of visual impact simulations, guidelines for producing and presenting simulations, limitations and common problems with production and presentation of simulations.	Not specifically
The Renewable Energy Landscape (2016) – Apostol *et al.*	Chapter 9	Guidelines and case studies, for visualising various kinds of energy development, with a review of sources of error and inaccuracy often encountered.	Not specifically
Visual Simulations Best Practice Guide (2010) – New Zealand Institute of Landscape Architects	All	Principles, viewpoint selection, photomontage process stages, presentation of visual simulations	Not specifically
Visual Impact Assessment Guidebook (2001) – Ministry of Forests (British Columbia)	Chapter 7 Appendix 6	View point selection, guidance on choosing the appropriate visual simulation technique	Forestry Applications
Visual Simulation: A User's Guide for Architects, Engineers and Planners (1989) - Sheppard	All	Principles, findings on bias in visualisation and visualisation appraisal methods.	Consideration of tree screening and tree growth over time
Landscape Visualization: An Extension Guide for First Nations and Rural Communities (2004) - CALP	All	Principles, techniques and guidance on practitioner roles for reviewing, commissioning and producing visualisation	Forestry applications
Local Climate Change Visioning and Landscape Visualizations: Guidance Manual (2010) - CALP	All	Methods of factoring in climate change into visualising futures and engaging communities with visuals.	Not specifically
Visualizing Climate Change: A Guide to Visual Communication of Climate Change and Developing Local Solutions (2012) - Sheppard	All	Methods of factoring in climate change into visualising futures	Not specifically

3 Principles for visualisation

3.1. The over-riding principle in using landscape visualisations is that "images should provide the viewer with a fair representation of what…. (is)… likely to be seen if the proposed development is implemented. Images should not be misleading." (Landscape Institute, 2018, p. 1). The Code of Ethics for Landscape Visualization (Sheppard, 2001) provides the most comprehensive guidance on practical principles for implementing fair visualisation and securing unbiased responses to them and forms the basis for the following criteria for visualisation evaluation (drawing also on Appleyard, 1977; Sheppard *et al*., 2004; Sheppard & Cizek, 2009; Sheppard, 2012 and Landscape Institute, 2017):

a) Accuracy Visualisations should simulate the actual and expected appearance of the site after the development project has been completed, without distortion and at an appropriate level of abstraction/realism for the intended purpose.

b) Representativeness Visualisations should represent the typical or important range of views, conditions and time frames which would be experienced with the proposed project (see p. 19, Step 4).

c) Clarity The details, components and overall content of the visualisation should be clearly communicated and comprehensible. The interpreter should be able to obtain enough information from the image to make a clear and reliable judgment of the project shown in the visualisation.

d) Interest Visualisations should engage and hold the interest of the audience, without seeking to distract or impress.

e) Legitimacy Visualisations should be defensible throughout by making the simulation process and assumptions transparent to the viewer and by clearly describing the expected level of accuracy and uncertainty.

f) Access to visual information Visualisations which are consistent with the above principles should be made readily accessible to the public and other interested parties.

g) Framing and presentation Important contextual and other relevant information should be presented along with the visualisation imagery and in a clear, neutral fashion. Dependent on how visualisations are going to be presented, the labelling, accompanying documents or explanations provided by the presenter should be clear, informative and unambiguous.

h) Appropriateness for purpose and users Visualisations should be cost effective and well suited to the audience, with the level of sophistication proportional to the sensitivity of the context and scale of the anticipated landscape changes.

4 Guidelines for planning, preparing and using visualisations

THE TYPICAL VISUALISATION PROCESS

4.1. The Protocol lays out initial guidance for tree officers and other practitioners or staff who are considering using visualisations in various possible roles or stages of a project:

- for **advance planning** on how to use visualisations for a project;
- for actually **producing** visualisations themselves **or commissioning the visualisation effort** (e.g. tree officers with training, landscape architects, draftsman, GIS specialists, consultants etc.);
- for **presenting** visualisations to various audiences;
- for **reviewing** visualisations produced by others.

4.2. In any of these situations, tree offices do not have to be a graphics expert in order to plan or help plan a visualisation exercise. In fact, visualisations should not be left up to the visualisation expert alone: good visualisations come from good planning, collaboration and review. The technical content of what is shown needs to reflect the urban forestry practitioner's experience.

4.3. The typical visualisation process is represented in the flowchart of Figure 9 (adapted from Appleyard, 1977 and Sheppard, 1989):

- Option 1 refers to the steps taken when a visualisation needs to be produced. First, the visualisation effort must be carefully scoped and planned to determine the type and sophistication of visualisations needed, according to the purpose, audience, context, scale of project and the data and resources available, among other factors (Landscape Institute, 2017). Whether the tree officer is going to produce the visualisations themselves or is going to commission the production of the visualisation, the resulting visualisations would need to be reviewed by fellow practitioners or stakeholder representatives to determine if they need any modification. When, as a result of the review process, the visualisations are found to need major modifications, it is advisable to revisit the planning phase and initial assumptions. Once the revisions are made and the review is favourable, the visualisations can be presented or disseminated to the public.
- The second option refers to the situation when a tree officer is the receptor of a visualisation. In that case the received materials are reviewed following the guidelines provided in following sections of the Protocol and the evaluation report is completed. It may be necessary for the tree officer to request additional information (see Sections 4.7 and 4.19 below for types of data that may be required) in order to conduct a reasonable review, or even to request modified or additional visualisations if preliminary review suggests the current visualisations are inadequate.

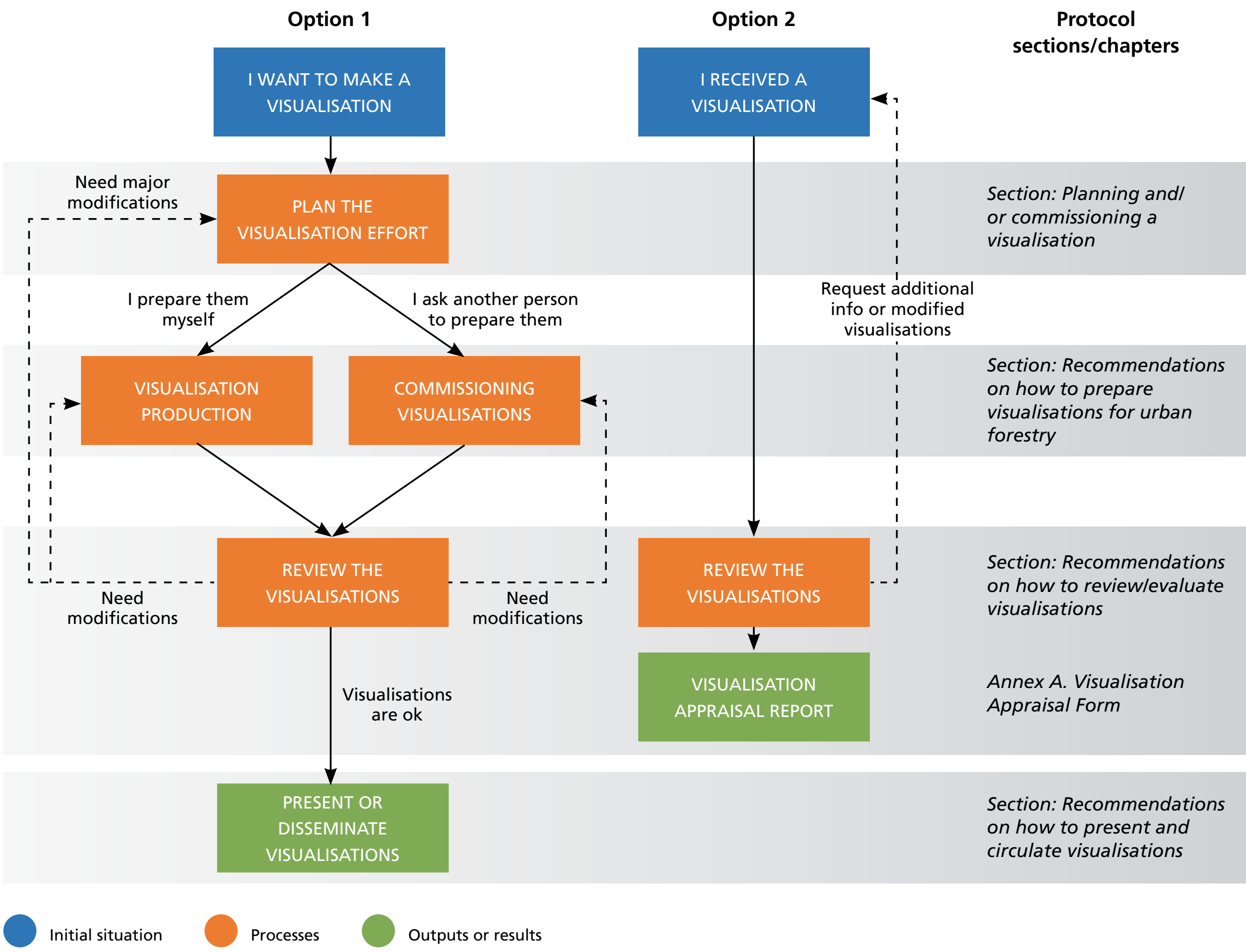


Figure 9. Typical processes for preparing or reviewing visualisation.

PLANNING AND/OR COMMISSIONING A VISUALISATION

- **Study area selection**
- **Scoping the visualisation effort**
- **Data collection**
- **Planning the visualisation process**
- **Organizing review of the visualisations before presentation**
- **Planning for presenting the visualisations and follow-up**

4.4. The methodology to plan, produce and present visualisations involves six steps (see Figure 10), described in detail in the following sections.

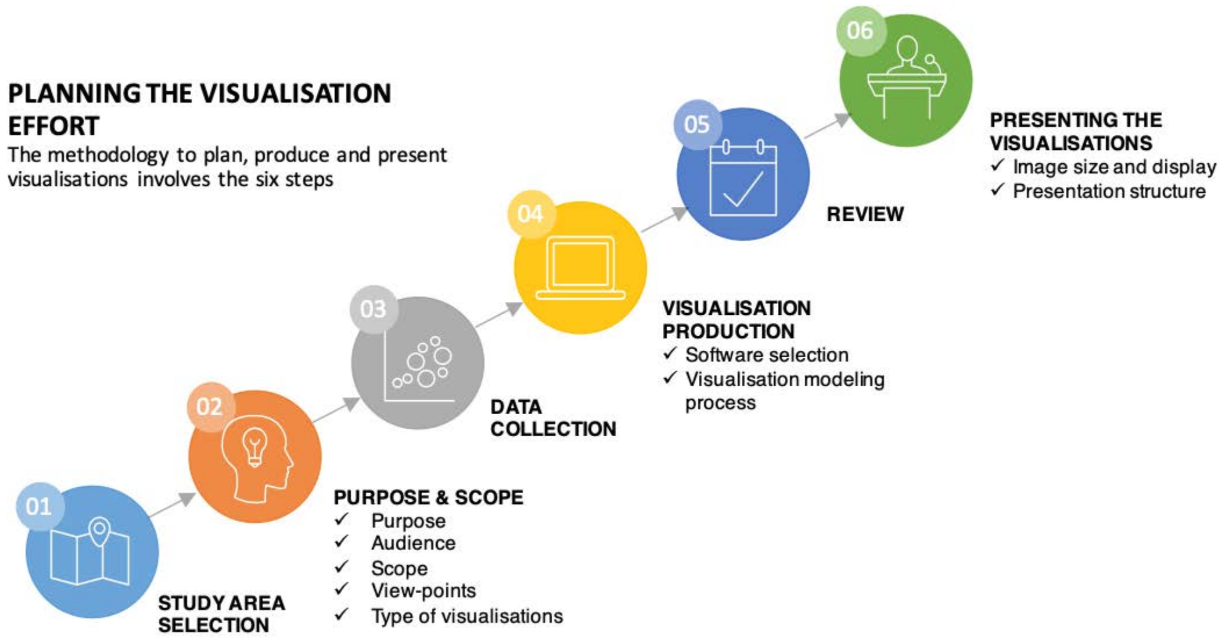


Figure 10. Graphical representation of the visualisation production methodology.

Step 1. Selecting study area for visualisations

4.5. The study area for the visualisations would be generally determined by the location, the defined site boundaries and expanse of the proposed project. Background landscapes and offsite viewpoints may be important context to include. Sometimes, visualisations will not be site specific and only a generic location will be modelled for typical and recurring situations.

Step 2. Scoping the visualisation effort

4.6. To scope the required visualisations for urban forestry applications and their level of sophistication, there are a number of key considerations:

- **Purpose** of the visualisations: what information do the visualisations need to provide and what questions do they need to answer (e.g. explain a new management scheme to people not familiar with urban forestry, to evaluate aesthetic impact of a new development, or as an in-house comparison of different planting designs)
- **Audience** of the visualisations (e.g. general public, landowners, or other tree officers for internal analysis) and their sensitivity to landscape change.
- **Context** and sensitivity of local area, including relevant planning policy, landscape character, special designations etc. (see Landscape Institute, 2017, p.5).
- **Content** of the visualisations themselves: what will be shown in the visualisations, the nature of expected changes and their scale. It is important to broadly identify the following parameters that will be directly related to the size and type of project:
  - **View-point** selection: how many, ground vs oblique, viewing distance, etc.
  - **Viewing conditions** (e.g. seasons, lighting, weather).
  - **Timescale** (age of trees) **and long term projections** (growth curves, survival rate, climate change projections)
  - **Alternative plans or management treatments** for use in planning

- **Types of visualisation** media, including the setting in which they are going to be presented or format in which they are going to be distributed (e.g. images, animations - see Section 2 above and Landscape Institute, 2017, Section 5; for a review of available and emerging visual media, see also Sheppard, 2012).
- Available **resources**: budget, software availability, preparer skills (e.g. GIS experience, 3D modelling).

Step 3. Collecting data

4.7. Relevant available and up-to-date information should be gathered. The data necessary to produce the visualisations will depend on the type of visualisations and techniques chosen for the study, but may include:

- Detailed plans, Geo-referenced CAD maps and/or GIS data/files of topography, land use, circulation routes, etc.,
- Aerial photos of the study area.
- CAD and/or GIS/BIM files with building elevations and floor plans, landscape plans and vegetation mapping.
- Location and inventory data about existing trees (within or around the project area) to be shown in the visualisations.
- Information about existing and proposed tree species: growth rate or at least typical dimensions at maturity for simulations of future conditions. It is important to obtain regional climate change projections and any local guidance on their potential influence on growth rates, tree survival, etc., for visualisation of any longer term interventions.
- LIDAR modelling, if available, which can provide information about 3D volumes of surrounding buildings, crown width and canopy cover, etc.
- Historic or recent onsite photographs of study area. Google Street View can be a useful additional tool if used with caution: always cross checking against site photographs and considering date/season of on-line images, image distortions etc.

4.8. The visualisation preparer should always act in accordance with the license agreement when using images or models from a third party, making sure the author/source of the images is clearly stated and that the purpose for the visualisations is within the terms of use (e.g. not to use Google Maps images in order to directly make a profit or without the necessary credit given).

Step 4. The visualisation production process

4.9. Once the scope of required images has been identified the next step is to choose software packages and determine the visualisation modelling process. For more detailed guidance on visualisation production with photo-montages and digital 3D models, see Landscape Institute (2018, Section 4).

4.10. Those preparing landscape visualisation should consider the following steps (adapted from Sheppard, 2001 and Landscape Institute, 2017):

- Demonstrate an appropriate level of qualifications and experience of the preparer(s) given the medium being used.
- Choose an appropriate level of realism.

- Document supporting data available for or used in the visualisation process.
- Conduct an on-site visual reconnaissance to determine important issues and views and take photographs.
- Seek statutory authority and community/stakeholder input on viewpoints and landscape issues to address in the visualisations.
- Provide the viewer with a reasonable choice of representative viewpoints, view directions, view angles, viewing conditions and timeframes appropriate to the area being visualized. Important viewpoints may include popular landmarks or scenic viewpoints, gateways to neighbourhoods, well-travelled routes, locations of sensitive viewers (e.g. nearby home-owners), and 'worst case' views of proposed development that would be seen by many people (for further guidance, see Landscape Institute, 2013).
- Use more than one visual medium or presentation mode (to accommodate different visual learners among the audience) and consider how the affected public/stakeholders may access the visualisations.
- Prepare important non-visual information for use with visual presentation (e.g. titles, labels, supporting maps, etc.)
- Avoid the use or the appearance of sales techniques or gimmicks.
- Avoid seeking a particular response from the audience, where the goal is to reduce bias in project decision-making. However, where visualisations are being used with an educational purpose or to raise awareness and change attitudes, it is appropriate to seek a learning effect on the audience.
- Provide background information describing how the visualisation process is conducted and key assumptions/decisions taken. See Landscape Institute (2018) for methods to prepare verifiable visualisations. Estimate and disclose the expected degree of error and uncertainty where possible. It is very important to acknowledge that with climate change we cannot be sure of outcomes in the medium to long run. Similarly, assumptions on long term tree management, pests and other variables affecting vegetation health and appearance should be noted.

Step 5. Organizing review of the visualisations before presentation

4.11. The visualisations need to be evaluated by at least one other person different from the modeller/preparer and ideally by another tree officer, local stakeholder representative and/or project manager (discussed further below). Different people see different things. Reduce the risk of surprises and mistakes by scheduling a review and revision phase.

Step 6. Planning for presenting the visualisations and follow-up (see below)

4.12. How the visualisations will be disseminated and presented (and by whom) should be considered ahead of time. For example, providing context and data used to create the visualisation reduces the risk of perceived bias and increases the defensibility of the visualisations (Sheppard *et al.*, 2004).

4.13. It is desirable and instructive to:

- Record responses to visualisations as feedback for future efforts.
- Conduct post-construction evaluations to verify or document accuracy of visualisations or changes in project design/construction/use. If simulations are prepared by the firm doing the design, post-construction photography that matches the simulations should be part of the contract.

RECOMMENDATIONS ON HOW TO PREPARE VISUALISATIONS FOR URBAN FORESTRY

- **Data assembly**
- **Tree models: problem with urban trees, tree growth simulation**
- **Cost, time**
- **Software recommendations**

4.14. Visualisation preparation should start with assembling data collected in a GIS or other database. Site visits are mandatory for the visualisation preparer to take site photographs, refine viewpoint locations and take note of all relevant details. It may be necessary to carry out site surveying for more challenging sites or sophisticated visualisation efforts requiring precise data or verification (see Landscape Institute, 2018).

4.15. It is important to be careful with digital tree models in visualisations, both for photomontages and 3D models. The visualisation preparer must have some knowledge of arboriculture or have their models reviewed by an expert for the different species and ages represented, to check that the modelled trees from standard digital collections look reasonably realistic given local site conditions; e.g. trees growing in clumps versus those that are freestanding with fuller crowns. Street trees tend to have higher crown height (compared with trees in parks and open spaces) and pollarded trees are very rarely included in standard tree model libraries, requiring them to be custom built.

4.16. Tree growth cannot simply be simulated by scaling up a tree image, because crown shape changes with age and also because leaf size would be incorrectly scaled up at the same time. Growth curves would ideally be used for simulating growth but they are not common for urban trees given the varied conditions and management regimes. It would be important at least to use a range of typical heights and crown spread measurements, stating assumptions alongside the simulations. Root conditions and potential spread may need to be visualized in some cases (see Box 2). Additionally, climate change projections and responses in planting and management plans need to be considered (see Box 3 for influence on shade provision by urban trees). It would be advisable to secure review and input from local tree experts or other tree officers on such issues.

Box 2 Visualising the underground: tree roots and infrastructure

It can be very important in some urban situations to explain how root-balls, sub-surface drainage, structured soils, root cells, or interactions with other underground utility structures are currently configured. Use of specialized digital 3D solid modelling with options such as transparency or cut-away views may be very helpful, or may be duplicated in photo-editing software by skilled artists/designers.

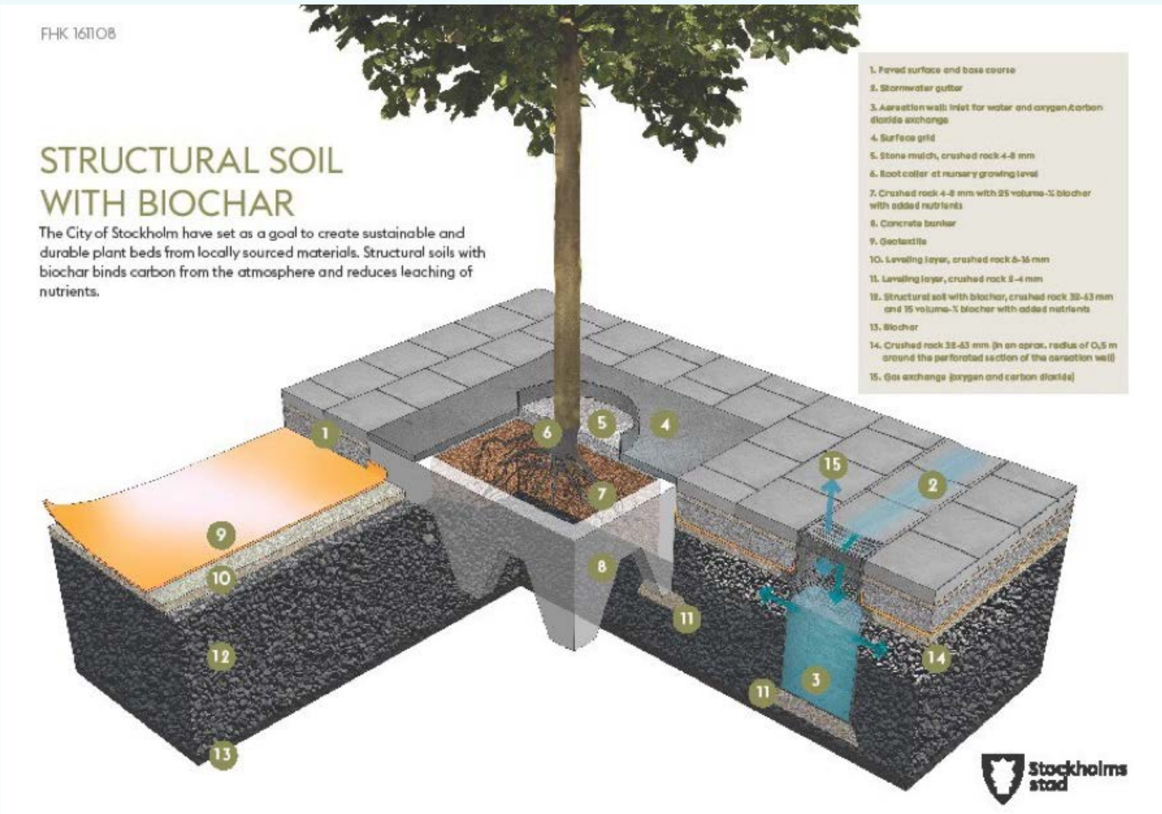


Figure 11. Visualisation of underground structural soil, drainage system and tree roots.
The image shows the different layers of a structural soil using biochar for street trees in Stockholm. The image was produced in Photoshop by a graphic designer using as a base a 3D model (in AutoCAD) made by a technical consultant. Credit: Stockholm Stad and Hildegun Nilsson Varhelyi

Box 3 Modelling and visualising shade

Visualisations of shade cast by urban trees have a range of potential roles including communicating the cooling benefits of trees and providing quantitative evidence of their shading potential, which itself can be useful in countering complaints about trees (Macias, 2016). By incorporating tree growth simulation into future scenarios, it is possible to study changes in shade footprint over time, helping in selecting appropriate tree species for a site.

Additionally, shade visualisation can be used as an internal modelling tool to assist urban planners and managers in identifying preferential planting locations for street trees and to study the effect of future buildings on existing trees' access to light.

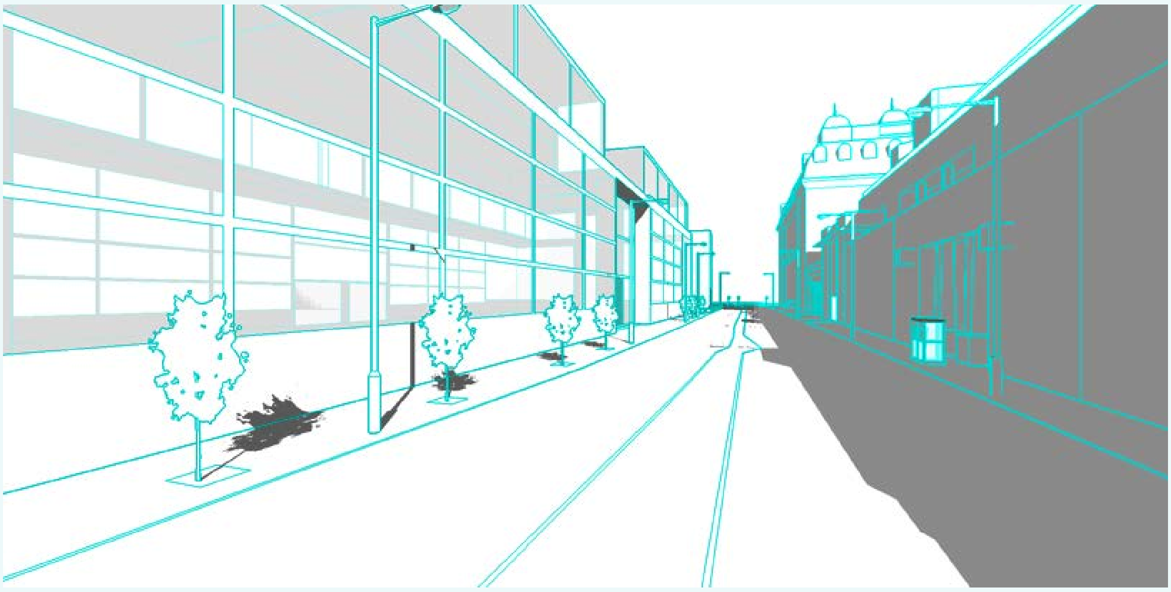


Figure 12. Visualising shade provided by street trees.
Using Buckingham Palace Road, London as a case study, visualisations were used to study the influence of tree size, planting location and planting design in shade provision over time. The study demonstrated how street orientation and height of surrounding buildings reduced the number of hours the trees received direct solar radiation, and the area of shade cast by trees on pedestrian areas at critical times of day (Macias & Doick, 2017). Credit: Ana Macias

4.17. Cost and time are the usual limiting factors. When money or time is limited, it is better to use the tools and software one is most familiar with (see Box 4 for software recommendations). Depending on the chosen visualisation technique, even a small job could require an estimated 2-3 days for a draftsman or designer using Photoshop or SketchUp, including initial meeting and review/revision. Much more time can be required in the case of a visualisation of a big development or planting scheme and/or the use of more sophisticated software.

Box 4 Software for visualisations

There are many kinds of visualisations tools with some of them more easy to use than others. Examples of commonly used visualisation software, with the caveat that the software itself can change quite rapidly, including:

- **For 2D simulations:** *Adobe Photoshop* a common photo-editing software tool, and *Gimp*, a freeware tool with comparable features.
  Tutorials online: https://www.gimp.org/tutorials/
- **For 3D simulations:** *Trimble SketchUp*, is an easy 3D modelling software to use and very intuitive. There is a free version for non-commercial purposes, though more limited than the pro version. SketchUp also has the advantage of a large free model library that includes trees, buildings and street furniture, among other objects.
  Tutorials online: https://help.sketchup.com/en

RECOMMENDATIONS ON HOW TO PRESENT AND CIRCULATE VISUALISATIONS

- **Image size and display**
- **Contextual information: what to include, how to include it**
- **Supporting tools**
- **Role of the presenter**

4.18. Visualisations should be presented at a large size and at a viewing angle close to the original field of view as seen in the field. It is important to try to match actual size seen in the landscape from the viewpoint used (see Landscape Institute, 2018, p. 8-9). Usually that means using big screens or posters, with people fairly close up to the image. If budget allows, several screens or immersive displays with curved screens and viewing angles of 180-degree or more can be used.

4.19. It is important to avoid distortion from wide angle settings/fish-eye lenses and from telephoto lenses with narrow cropping; any use of such techniques should be clearly indicated. Stretching or squeezing any image should be avoided (see Landscape Institute, 2018).

4.20. The visualisations should be presented alongside relevant information to provide a context for the images and legitimize the simulation process. Contextual information should include:

- The data on which the visualisations were based and data sources, assumptions made and inevitable inaccuracies due to lack of data.
- Map with viewpoints and rationale for selection of those viewpoints.
- Site photos of existing conditions from the same viewpoints.
- Viewing conditions in which project appearance may differ from that shown.
- Evidence showing how simulations were prepared and how accuracy was assured.

Relevant information should typically be presented in accompanying but separate sheets or images, to avoid compromising or distracting from the visualisation images themselves.

4.21. Titles, labels and accompanying information should be designed carefully to avoid obscuring the simulation, distracting from it or biasing people's responses to it.

4.22. Mapping and modelling tools (e.g. GIS, Google Earth, iTree Design) can be used during the visualisations presentation as useful supporting tools that help explain and quantify a planting scheme or other proposal.

4.23. The role of the presenter(s) is key; they must be credible and well informed, and may need to be a neutral third party. Another option is to have stakeholder representatives involved in the visualisation creation or in the planning process to support the presentation. It can be useful to have the actual preparer in attendance to speak to the methods used and answer questions.

RECOMMENDATIONS ON HOW TO REVIEW/EVALUATE VISUALISATIONS

- **When to review? Who needs to review visualisations?**
- **Criteria for the evaluation of visualisations: visualisation review checklist**
- **Recommendations on testing and future use of the Visualisation Protocol**

4.24. Ideally visualisations should be evaluated in draft form, before they are presented to the public, and again, after the project/plan is executed, to check how well the simulations and/or project execution performed. This last review is rarely performed in practice currently but should be part of design or visualisation contracts.

Reviews can be informal and in-house as part of the visualisation production process (see Figure 9, Option 1), conducted by other tree officers or staff from related disciplines. Conversely, reviews can be an official or semi-official review of a project referred to tree officers or other local government units (Figure 9, Option 2). In either case, various **triggers for review** can be identified as indicating possible questions, issues or problems requiring further information, scrutiny or decisions on project approval (see examples in Box 5).

4.25. Criteria for evaluating visualisations would be helpful for those who receive and interpret other people's visualisations or for preparers who wish to carry out quality control of their own visualisations (see criteria in Box 6 in checklist format). A more formal Visualisation Appraisal Form is provided in Annex A for testing/use in review documentation.

Box 5 List of possible "triggers for review"

- Images presented without any disclosure information on data sources, modelling assumptions, viewpoint selection, etc.
- Images provided only with sunny, blue-sky summer conditions or other unrepresentative conditions
- Accompanying images of vegetation, other natural elements, 'happy' people, families, or other "positive" imagery that are not shown in the plans or would not typically be expected with the project
- Mature-appearing proposed trees on new construction sites with no future date provided
- Only viewpoints favourable to the project, unrepresentative of typical views, or unattainable are used
- Distracting titles and labels obscuring the visualisations

RECOMMENDATIONS ON TESTING AND FUTURE USE OF THE VISUALISATION PROTOCOL

4.26. It is recommended that the Visualisation Protocol be applied in practice in selected London boroughs and tested over a trial period, leading to a revised and if necessary improved Protocol for wider usage. It may also be appropriate to consider at that time any supporting policies or requirements to ensure delivery of fair and accurate visualisations for decision-making on urban forestry and related projects or issues.

4.27. It may also be beneficial to establish a training program available to tree officers and allied professionals who are involved in preparing, commissioning, or reviewing visualisations of urban forestry applications. Such a program could include workshops, webinars, or courses with professional recognition and credit.

Box 6 Checklist of criteria for evaluating visualisations

1) Viewpoints and time frame (representativeness)

- [ ] A range of important and representative viewpoints and seasonal or weather conditions are represented, as agreed with authorities and stakeholders.
- [ ] Visualisation images provide enough field of view to show the project at its correct scale seen in perspective within its site context.
- [ ] Both current and expected future conditions of the project/site are included in the visualisation images.
- [ ] Several time frames showing tree growth are shown (recommended). Where mature trees are shown but small trees will actually be planted, expected time projections (age of trees) for visualisations are clearly stated.

2) Trees and other elements (accuracy)

- [ ] Contains all elements included in the project such as built infrastructure and landscaping which are represented and located accurately, according to the specifications stated in the project plan.
- [ ] Existing trees not affected by the project, adjacent buildings and other significant elements are included in the visualisations.
- [ ] Where elements of a visualisation are removed for illustrative purposes or because they are going to be removed as part of the plan, it is key that they are clearly identified, additional visualisations are produced to show the views without the elements removed and that the reason for removal is clearly stated.
- [ ] Tree models represent tree species accurately or at least are similar in size, shape and foliage/texture.
- [ ] Accuracy of dimensions are estimated to be at least sub-metre accuracy (Landscape Institute, 2018, p.27)

3) Image quality and presentation (visual clarity)

- [ ] Visualisations are clear: the size of image is not too big or too small (relative to the actual angle of view obtained on site), the quality of the image reproductions is high (not blurred, grainy or dark), and style or additional elements (e.g. labels or frames) are not distracting.

4) Assumptions and additional information (legitimacy)

- [ ] Descriptions of data sources, assumptions, uncertainties and margins of error are included.
- [ ] The assumptions made about tree species, tree management and future climate conditions are clearly stated, referenced and their uncertainty disclosed.
- [ ] The inventory data, growth curves or any other data used to produce the imagery are described with their accuracy stated, and even provided if considered necessary.
- [ ] Map is included showing location of viewpoints and rationale for their selection.
- [ ] All relevant information accompanying the visualisations are provided as context in a clear and neutral way.

5) Accessibility

- [ ] Visualisations and relevant documents are accessible to all involved stakeholders.

5 Illustrative case study examples

5.1. This section provides illustrative examples of visualisations for typical situations encountered within urban forestry. These are intended to help practitioners recognize good quality visualisation efforts, understand how to categorise different kinds of visualisation projects and select appropriate levels of sophistication.

5.2. It is important to recognize that there are various ways that a tree officer might use or apply visualisations which will determine the scope of their visualisation effort. In some situations, tree officers will review visualisations prepared by others and, in other cases, they may prepare visualisations themselves or commission them.

TYPICAL CASES FOR THE USE OF VISUALISATIONS

5.3. The purpose of the visualisation, the intended audience, the size and nature of the project, sensitivity of the context, as well as the resources available, will influence the type and sophistication of visualisation effort needed (see Section 4.7 above and Landscape Institute, 2017). In particular, the scale of the project is a key influence:

- For small-scale tree planting or tree care e.g. at street-scale or small parks, a simple sketch or conceptual visualisations (developed by the tree officers themselves or in-house staff) may be enough to effectively communicate a specific issue or proposal to residents or colleagues from other departments. With more sensitive settings or small projects, more detailed visualisations by experts may be needed,
- With medium-sized neighbourhood schemes or development projects, tree officers could take a proactive role, requesting detailed visualisations from developers or other agencies, or commissioning them from in-house graphics /design professionals or from external consultants.
- For large-scale development projects or city-wide schemes, visualisations may be quite sophisticated; tree officers will likely be receiving and reviewing such visualisations, as a referral on a development application or as part of a long term planning process.

5.4. Some typical use cases likely to be encountered by urban foresters are identified in Table 2. This matrix is intended to provide further guidance to tree officers in determining what type and sophistication level of the visualisation effort may be appropriate or proportionate for a given project scale, taking into account their role. The use-cases shown in Table 2 include the following types of visualisation efforts, from the simplest to the most elaborate:

1. ‘Quickie’ draft or conceptual visualisation(s) for internal analysis or design purposes. This simple type of visualisation may be done with user-friendly media such as sketching, photomontage or even simple 3D software.
2. Generic but realistic visualisations of typical situations (e.g. typical street tree plantings) for wider dissemination, educational use and public engagement.
3. Specific detailed visualisations of plans or management activities for particular sites or small scale projects, for use in public presentations, council decision-making, etc.

4. Detailed visualisations of broader neighbourhood-level or medium sized projects or planning studies where trees play a major role, for use in public presentations, council decision-making, court cases, etc.

5. Sophisticated visualisation packages for large scale development schemes prepared by developers or government teams involved in greenspace planning, extensive public consultation, public enquiries etc.

5.5. Table 2 presents common situations where these types of visualisation efforts (from 1-5) may occur, but many other combinations of scale, type of visualisation, and role of practitioners are possible. The matrix also suggests where the evaluation checklist (Box 6 or Visualisation Appraisal Form in Annex A) should be used by tree officers, and highlights situations illustrated in the actual case examples described in the next section.

Table 2. Matrix of different use cases and examples of corresponding visualisation types

		COMMON USE CASES AT VARIOUS PROJECT SCALES			
		SMALL SCALE		MEDIUM SCALE	LARGE SCALE
TREE OFFICER ROLE	OTHER PRACTITIONERS ROLE	GENERIC LOCATION (e.g. typical planting scheme)	SPECIFIC SITE (e.g. small planting scheme for street or local park)	NEIGHBOUR-HOOD LEVEL (e.g. medium sized development project)	COMMUNITY-WIDE (e.g. large redevelopment scheme or city-wide green infrastructure program)
Review visualisations (use checklist)	Developer or designer provides visualisations and responds to tree officer comments		3 **Specific realistic visualisation**	4 **Specific realistic visualisation**	5 **Various realistic and multi-media visualisation package** CASE 9
Request or commission visualisations (provide/use checklist)	Developer, designer, or staff prepares visualisations for tree officer review	2 **Generic visualisation of typical situation** CASE 8b	3 **Specific realistic visualisation** CASES 3 – 6	4 **Specific realistic visualisation** CASE 7 – 8a	
Prepare visualisations (checklist optional)	Colleagues/ staff review visualisations		1 **"Quickie" conceptual visualisation** (e.g. hand-sketch, simple photo-edit, or SketchUp) CASES 1 – 2		

Green shaded cells with blue numbers signify corresponding visualisation cases illustrated below.

5.6. The visualisation efforts in Table 2 all address types of landscape visualisation, i.e. seen in perspective views. Box 7 illustrates another type of simple plan-view visualisation that can usefully accompany and support true landscape visualisations.

Box 7 Augmented visualisation of aerial or plan-views

Datasets collected by remote sensing can be used to successfully pinpoint the location of individual trees affected by disease and other conditions. Hyperspectral imagery, which combines hundreds of narrow bands of reflectance, can be used to identify declining health such as ash dieback *(Chalara)* through changes in affected canopies (Figure 13). Airborne laser scanning surveys (LiDAR) have also been applied to identify disease, such as *Phytophthora ramorum* in Welsh larch forests, through structural changes to trees affected by the pathogen.

Remote sensing techniques have applications in forest health assessment in commercial, urban and rural environments when the most appropriate sensor (e.g. aerial imagery, LiDAR, hyperspectral imagery) and platform (e.g. UAV, aircraft and satellite) are selected.

Figure 13. High resolution aerial imagery for Bromley, London (2Excel geospatial) with simple augmented information about crown decline.
Individual trees identified with healthy tree in green polygon and crown decline indicated in red polygon. Credit: Chloe Barnes

CASE STUDY EXAMPLES

5.7. The following 9 cases illustrate examples of various kinds of visualisation efforts, media, and project scales that have been applied to urban forestry. They are intended to help preparers of visualisations who are considering appropriate methods to use, and as general benchmarks for reviewing visualisations.

Case 1 Augmented visualisation – colour-coding trees for health condition

Location: Buckingham Palace Road, London
Visualisation technique: Augmented hybrid of conceptual and experiential media
Software used: Microsoft PowerPoint and Gimp

Augmented visualisation can be used to visualize tree condition and to explain to the general public why tree removal might be required. Street trees in Buckingham Palace Road (London, UK) are color-coded according to their health condition (good/fair, poor or critical), using inventory data from the Victoria BIC i-Tree inventory (Rogers and Jarratt, 2012). The recognizable "traffic light" trio of colours was chosen for its familiarity.

By placing coloured dots on top of an aerial photograph (Figure 14) and by colouring street trees from a street level photograph (Figure 15) it is easy to observe at a glance something not obvious to untrained people, such as the health condition of the trees in their street.

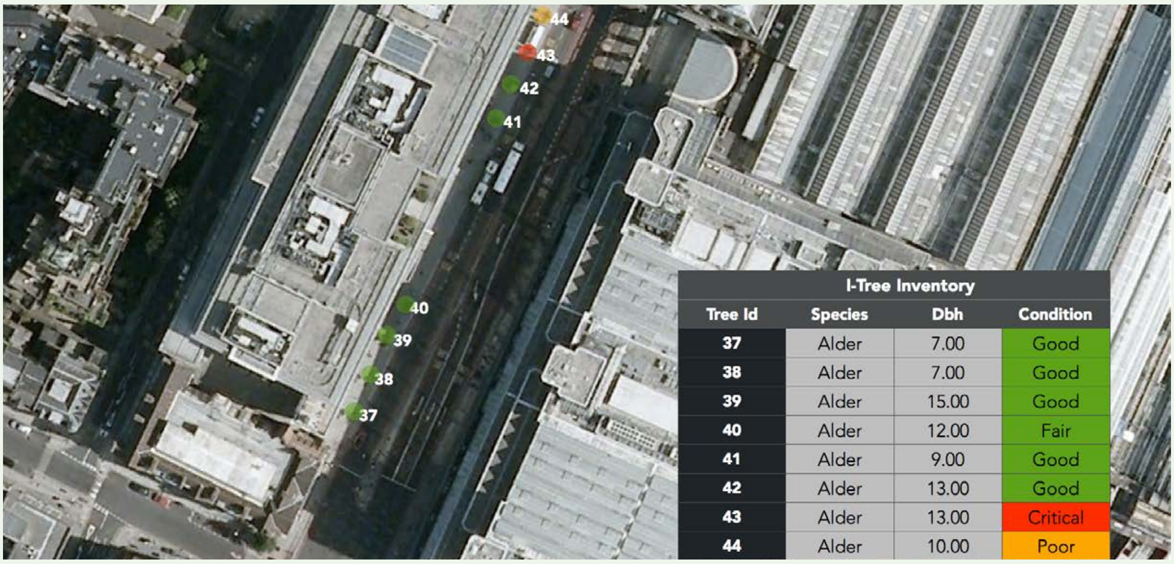


***Figure 14.** Credit: Macias 2016.*

***Figure 15.** Credit: Macias 2016.*

Case 2 Visualising time evolution in simple 3D

Location: Buckingham Palace Road, London
Visualisation technique: Conceptual 3D modelling of a series of temporal phases to show tree growth and evolution of a street tree line over time
Software used: Trimble SketchUp

Time evolution visualisation is key when explaining long term goals of urban tree management to non-experts. These images were created using SketchUp and using semi-abstract 2D tree models and 3D buildings from the SketchUp's 3D Warehouse free model library. By creating a series of still images of a tree line at different times we create a sequence that can be "animated" if presented sequentially. Higher realism can be achieved applying these same techniques and methods but would require choosing photorealistic tree models and using additional rendering software.

A series of five images of a street tree-line of alders is shown (Figure 16) from the time when one tree in critical condition (in yellow in Figure 16b) is replaced by a young alder sapling (16d), to the point after 25 years when the sapling has reached its maturity and a similar size to the other trees on the street. The size of the trees for the different images was calculated using the inventory data for the existing trees from the Victoria BID i-Tree study (Rogers & Jarratt, 2012) and the average size at maturity within lifespan for alders. Such visualised projections should ideally factor in or note typical mortality rates for trees in similar conditions, if such data is available.

Figure 16. *Credit: Before image Google Street View, rest of images Ana Macias*

a) *Before image of the tree line.*

b) *Critical tree shown in yellow and tree in poor condition (at the right of the image) with signs of decay.*

c) *Critical tree is felled.*

d) *Felled tree is replaced by a young sapling of the same species.*

e) *After 10 years, young alder is still of smaller height, while tree in poor condition has recovered.*

f) *At maturity, after 25 years, the tree line is uniform again, assuming no further mortality or decline over this period.*

Case 3 Adding street trees using photo editing

Location: Edgware Road, London
Visualisation technique: Photomontage in 2D
Software used: Adobe Photoshop

The images were commissioned by Andy Tipping (Tree Officer London Borough of Barnet) to explain to residents the new proposed planting scheme for Edgware Road in London. Shop owners were especially reticent due to being worried about trees obscuring their shop signs.

The visualisations were commissioned from an "in house" technician from the Borough's press office and it took a few hours of work to produce them. The images show how the columnar shape and crown height of the chosen species (dawn redwood) did not block the view of the shops and significantly improved the overall look and feel of the street.

Images (Figure 17) were shown by the involved tree officer during one week in the public library and presented in printed A3 laminated format for the public to examine. A fact sheet with the tree species characteristics was given out during the public consultation.

Figure 17. *Credit: Andy Tipping*

Before photograph

Photomontage

Real life image three years after the planting scheme was completed

Real life image five years after the planting scheme was was completed

Case 4 Removing trees using photo-editing

Location: Victoria Embankment, London
Visualisation technique: Photomontage in 2D
Software used: Adobe Photoshop

Images have been included in documents from the Trees and Design Action Group (TDAG) to communicate the impact and importance of implementing a tree management strategy to maintain healthy trees and avoid losses in aesthetics and other ecosystem services in both summer and winter. The photomontage shows the aesthetic impact of losing the street trees along the Embankment (Figure 18).

Erasing trees from photos is more difficult than inserting tree images, and needs to be carefully done, with use of supporting photos from nearby viewpoints if necessary, due to the difficulty of seeing what is currently hidden behind the existing trees in the foreground.

Figure 18. *Credit: TDAG/Capita Lovejoy*

Before image in spring.

Before image in winter.

Photomontage

Case 5 3D modelling of small city project in different viewing conditions

Location: West Croydon Bus Station, London
Visualisation technique: 3D rendering with different levels of realism
Estimated cost: approx: 3,000 pounds

Two types of 3D visualisations were used: a mix of in-house low level of realism renderings (Figure 19b) for progressing the design by getting a look at a design idea or compare options, including relationship to existing tree (London plane) and the tree planted as part of the scheme (Himalayan birch) seen in summer; then, for the public display boards, photorealistic renderings (Figure 20) were created to convey the scheme to the public, with winter conditions at night-time in this example. The finished project has been awarded the 2017 RIBA London building award + 2017 RIBA Project Architect of the year award & 2017 Brick award.

"It is important to keep the renders appropriate and 'true to the design'. There is a culture of producing unrealistic renderings which do not reflect what will be provided. We are conscious of this and therefor try to convey the true image of what will be delivered (…) to avoid confusion and annoyance from general public." (Martin Eriksson)

Figure 19.
***a)** Before photograph*

***b)** Semi-realistic visualisation used to explore different design options among team members.Credit: Martin Eriksson*

Figure 20.
Photorealistic 3D rendering of the West Croydon Bus Station in London. Credit: Martin Eriksson

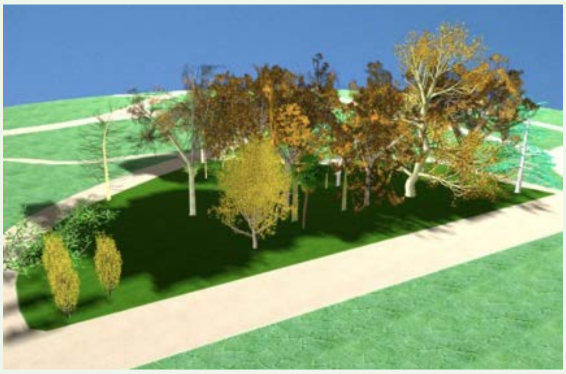
Case 6 Realistic 3D videos of a park over time with an interactive interface

Location: Campo del Moro, Royal Palace Gardens, Madrid (Spain)
Visualisation technique: 3D videos integrated into interactive presentation/interface
Software used: Trees created with Onyx Tree and Bionatics EASYnat; videos rendered in Autodesk 3ds Max; interactive interface created with Adobe Flash

Based on a complete inventory of Madrid's Royal Palace Gardens, a series of animations and visualisations were created to explain to the public the impact of the decisions derived from the inventory. Some the trees would have to be felled with an immediate aesthetic impact but, long term, the impact would be diminished. To illustrate that, a 3D animation of the different garden sections was rendered for the current time and for 5, 10 and 25 years projected into the future. In addition, an individual file and 3D representation for each individual tree was included for these same time intervals. Each animation, both of the garden sections and for each tree, can also be viewed for spring-summer, autumn and winter (Figures 21 and 22).

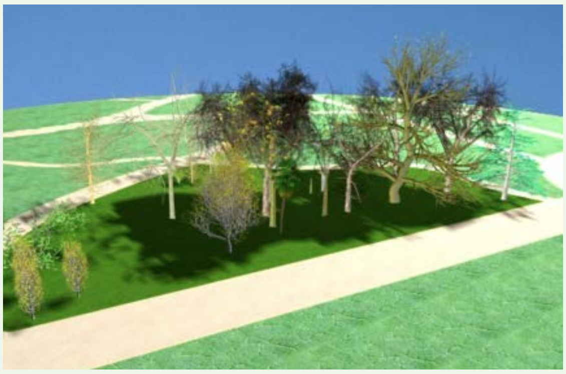
All the animations were compiled into an interactive interface created with Adobe Flash (Figure 22) to navigate to the different garden sections, select the individual trees from a plan view, and see additional information about the tree species, design and the history of the Royal Gardens.

Figure 21. *An example of a park section visualized with time evolution. Credit: Ana Macias*



Now in autumn

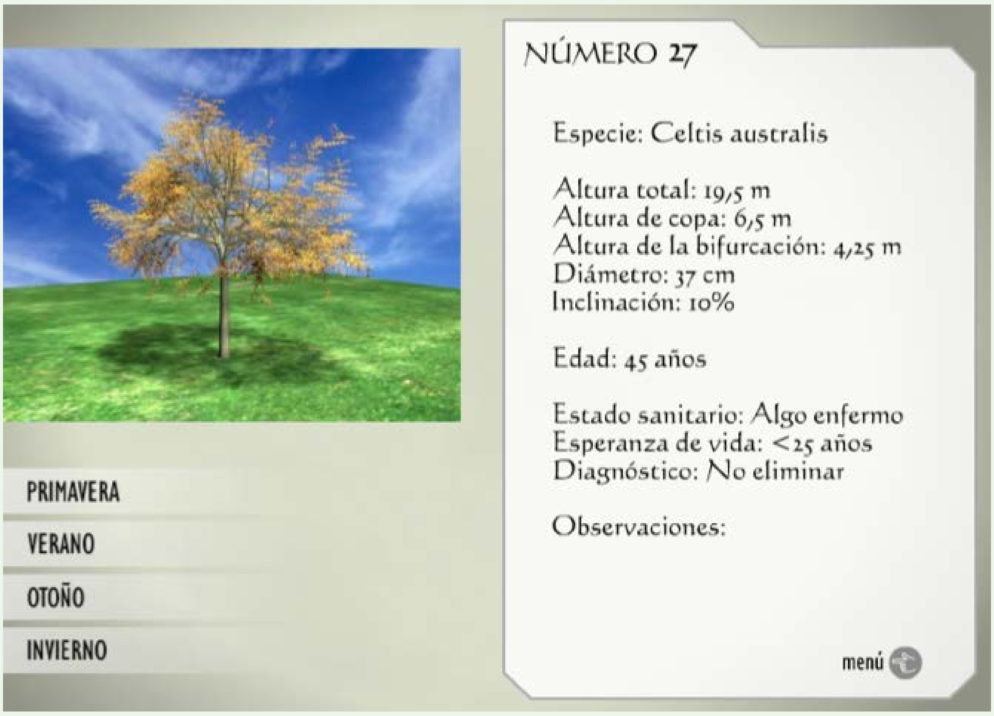
Now in spring-summer



Now in winter

In 25 years, in spring-summer

__Figure 22.__ Example of individual tree data and corresponding 3D image. Credit: Ana Macias



Case 7 Visualising suburban forest scenarios at neighbourhood scale

Location: Surrey BC, Canada
Visualisation technique: Photorealistic 3D visualisations
Software used: Rhino 6 for Windows, Lumien 8.3, Adobe Photoshop

These visualisations are part of a multi-criteria assessment of future forest scenarios in a suburban community in North America. The visualisations were created to examine possible futures of the urban forest in a dense suburban landscape in Surrey, BC, Canada (Figure 23). The community was designed to be sustainable, but after development it failed to establish a healthy urban forest canopy.

The visualisations are intended to provide insight into the aesthetic acceptability and ecosystem services of various alternative scenarios (emphasizing rewilding, climate retrofit, or human health priorities), and to support qualitative and quantitative assessment of these scenarios (Barron, 2018).

The 3D visualisations were created based on scenario-specific planting plans, detailed species lists, and building outlines mapped in ArcGIS. The process took about a week of full-time work by a highly experienced designer. The images are intended to be presented to the public in a series of focus groups to assess which scenario aspects are most compelling to local residents.

Figure 23. *Credit: Sara Barron*

a) *"Climate Retrofit" scenario projected for 2050, seen from an oblique aerial view*

b) *Ground-level street-scene perspective of the "No Policy Change" scenario, as projected for 2050.*

Case 8 Visualisations to support city-wide urban forestry strategies

Location: Melbourne, Australia
Visualisation technique: Photomontage and conceptual 3D visualisations

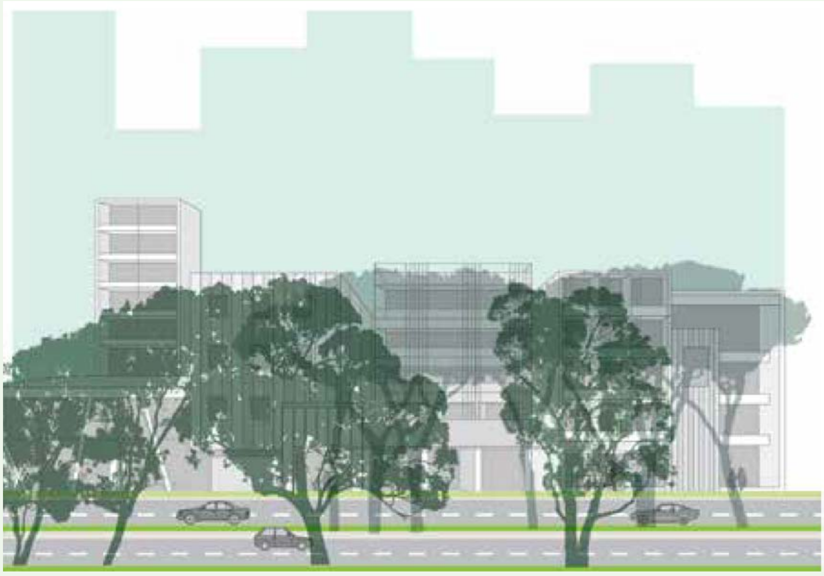
The City of Melbourne urban forestry strategy made extensive use of various kinds of visualisation (both for specific and generic sites and generic/typical conditions) to illustrate future conditions and forest management plan alternatives, engage the public, and help assess preferred strategies at city and precinct levels.

Case 8a) Figure 24. *Photo-editing and hybrid 2D/3D visualisations based on 3D modelling have been used to illustrate the potential impacts of tree loss and new development in different Melbourne neighbourhoods. Credit: City of Melbourne; Sources: Urban Forest Strategy 2012-2032.*


Fitzroy Gardens potential loss of avenues modelling at ground plane, showing existing conditions (left) and effect if elms were lost (right)


Royal Parade modelling of ground level view, showing existing conditions (left) and effect if elm avenues were lost (right)

Case 8b) Figure 25 *These generic conceptual visualisations represent different tree establishment strategies in typical neighbourhoods and transportation corridors in the Precinct of Fishermans Bend, Melbourne, illustrating the general effect of tree screening and greening on neighbourhood character. Credit: City of Melbourne; Sources: Fishermans Bend Urban Forest Precinct Plan 2015-2025.*



a) *Long-term planting plan: this strategy provides the long-term direction for planting in the precinct.*

b) *10-year planting plan: New and replacement planting is to occur across Fishermans bend*

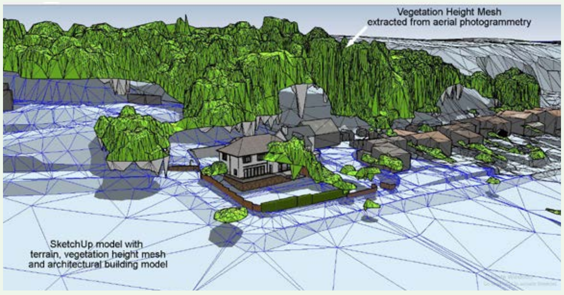
Case 9 Virtual 3D model of a large scale urban area with an interactive interface

Location: Island of Jersey
Visualisation technique: Interactive 3D city-wide model

Virtual 3D Jersey, created by the company RealSim and their mapping partners BKS-NI in 2012, is a three-dimensional model of Jersey's main town of St Helier that can be navigated in real time. The model was commissioned by the States of Jersey Planning department to aid the assessment of planning applications within an interactive geospatially accurate 3D environment viewer. The viewer would be game engine based thus harnessing the advantages such technology has in real-time 3D rendering, dynamic lighting, and ease of use over standard windows based engineering and architectural software applications.

The model data is derived from photogrammetric processing of stereo images from an aerial survey of the island. Photogrammetry is a well-established technique for locating the position and height of an object in 3D space from different photos. The model data was assembled into 500m x 500m SketchUp tiles for ease of access by architects. Each SketchUp model tile contains a digital terrain mesh, 3D buildings, and a vegetation height mesh (Figure 26a). This height mesh is used as a reference by RealSim to accurately place and size 3D trees in to their Unity based environment viewer (Figures 26b and 26c).

Figure 26. *RealSim Environment Viewer and SketchUp model used for refence to locate and determine size of the 3D tree models. Credit: RealSim and City of St Helier.*
Source: https://realsim.ie/product/interactive-model-of-st-helier/



a) *SketchUp model with terrain, vegetation height mesh and architectural building model*

b) *Jersey 3D Interactive Environment Viewer in wintertime lighting, shadows and foliage*

c) *Jersey 3D Interactive Environment Viewer in summertime lighting, shadows and foliage*

The model includes 3D buildings with detailed textures and other realistic, site-specific objects such as 3D trees, people, cars and other street furniture. The trees used in Jersey 3D come from the third-party modelling provider SpeedTree whose tree models are designed for real-time rendering with multiple levels of detail. RealSim have connected the shader which renders the leaves to their geographical simulated sun tool, so when the time of year is moved to the winter months, the deciduous trees lose their leaves. There is an 80% difference between the amount of light coming through a tree in full foliage and one without, so this is vital in helping planners assess the visual impact of a potential new building at all times of the year.

The model's uses are numerous. Though initially developed for planning assessment (Figure 27), the model is now being looked at as a platform to simulate and communicate other applications such as sophisticated 3D databases as interactive tools for multiple city and urban forestry purposes like flood level assessments, security, traffic, solar and wind energy potential, and emergency response planning. Other cities have been modelled in the same way, such as Galway, Dublin and Portlaoise in Ireland.

Figure 27. *Planning application registry website for the Island of Jersey allows to visualise 3D models of proposed developments. Credit: RealSim and Island of Jersey. Source:*
Source: https://www.gov.je/citizen/Planning/Pages/planning.aspx

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Annex A: Visualisation Appraisal Form

1	VIEW POINTS AND TIME FRAME (REPRESENTATIVENESS)	YES	NO	COMMENTS
a)	A range of important and representative viewpoints and seasonal or weather conditions are represented, as discussed with authorities and stakeholders.			
b)	Visualisation images provide enough field of view to show the project at its correct scale as seen in perspective within its site context.			
c)	Both current and expected conditions of the project/site are included in the visualisations.			
d)	Several time frames showing tree growth (recommended). Where mature trees shown but small trees will actually be planted, expected time projections (age of trees) for visualisations are clearly stated.			
2	**TREES AND OTHER ELEMENTS (ACCURACY)**			
a)	Contains all elements included in the project such as built infrastructure and landscaping which are represented and located accurately, according to the specifications stated in the project plan.			
b)	Existing trees not affected by the project, adjacent buildings and other significant elements are included in the visualisations.			
c)	If existing elements of the scene (e.g. foreground trees) that block/interfere with the view of the proposed development are removed from the visualisations, either for illustrative purposes to show the development, or because the removal is part of a possible future plan, the following criteria should be met: *i. the removed elements are clearly identified* *ii. additional visualisations are provided to show the altered views with and without the removed elements, and* *iii. the reason why those elements have been removed from the visualisations is stated.*			
d)	Tree models represent tree species accurately or at least are similar in size, shape and foliage/texture.			
e)	Accuracy of dimensions are estimated to be at least sub-metre accuracy (Landscape Institute, 2018, p.27)			
3	**IMAGE QUALITY AND PRESENTATION (VISUAL CLARITY)**			
a)	Visualisations are clear: the size of image is not too big or too small (relative to the actual angle of view obtained on site), the quality of the image reproductions is reasonable (not blurred, grainy or dark), and the style or additional elements (e.g. labels or frames) are not too distracting.			
4	**ASSUMPTIONS AND ADDITIONAL INFORMATION (LEGITIMACY)**			
a)	Descriptions of data sources, assumptions, uncertainties and margins of error are included.			
b)	The assumptions made about tree species, tree management and future climate conditions are clearly stated, referenced and their uncertainty disclosed.			
c)	The inventory data, growth curves or any other data used to produce the imagery are described with their accuracy stated, and even provided if considered necessary.			
d)	Map included showing location of viewpoints and rationale for their selection.			
e)	All relevant information accompanies the visualisation to provide necessary context and is provided in a clear and neutral way.			
5	**ACCESSIBILITY**			
a)	Visualisation and relevant documents are accessible to all involved stakeholders.			
6	**RECOMMENDATIONS**			
	Revise: Add:	Decision: ☐ Accept ☐ Reject		

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