1.0 OVERVIEW

1.1 The purpose of this document is to clearly convey the set of principles that guide the production of an Accurate Visual Representation (AVR). The information contained in the document will allow a third party to verify the accuracy of the AVRs produced in terms of height, scale and placement. The principles followed are in accordance with best practice including, where appropriate, references to the methods described in the London View Management Framework (LVMF) and the Second Edition of the Guidelines for Landscape & Visual Impact Assessment Second Edition 2002 produced by The Landscape Institute and Institute of Environmental.

1.2 There are two common ways of conveying an AVR:

- The first, and generally favoured, is a computer generated photomontage, where a fully rendered image is superimposed over a background photograph. This gives an realistic visual representation of the proposed design in its entirety;
- The other is also a photomontage, but consists of a line (or number of lines) that fall on the inside extremities of the proposed design from a particular viewpoint. In effect it represents the design’s building envelope.

1.3 Management & Assessment. The methodology is therefore in accordance with, and often exceeds, current best practice and provides the best level of accuracy achievable with today’s latest technologies.

1.4 The full methodology is set out below.

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[1] Accurate Visual Representation (AVR) is an industry term that describes a static or moving image showing the location of a proposed development, the degree to which it will be visible, its detailed form and/or the materials to be used. AVRs accurately combine computer generated images of the proposed development with a digital representation of the existing view (usually in the form of a digital photograph). The resulting image(s) is seen as being an accurate representation of what an observer would expect to see if viewed from the same location.

[2] London View Management Framework (LVMF) is a report written in combination with London Plan (the Mayor’s Spatial Development Strategy published in 2007). It sets out guidance for the process called Qualitative Visual Assessment (QVA). Strategically important or ‘designated’ views are identified and assessed to control the visual effects of a new development or planning proposal.

[3] Guidelines for Landscape & Visual Impact Assessment Second Edition 2002 which landscape and visual assessments are essential components, is an environmental management tool which has been in use on an...
2.0 SELECTION OF VIEWPOINTS

2.1 Each viewpoint[^4] is usually selected by either the architect or local planning office and should conform to relevant planning policies. This information usually consists of a photograph from the viewpoint and an Ordnance Survey[^5] map showing the approximate location of each selected viewpoint.

2.2 m3fx conducts a site reconnaissance. Using the information supplied by designer and/or planning officer the viewpoint(s) are visited and recreated on site. A photograph is then taken making sure all requested context is included. Each photograph will be taken to reflect as closely as possible the view as seen by the human eye. In each case a suitable lens will be used to minimize distortion and to provide an impartial and objective view that avoids any potential misleading impressions. A semi-permanent marker is then applied at the point that each photograph was taken. Where possible, an additional photograph is taken of the marker in place with the proposed site in the background. These photographs are then sent to the designer and/or planning officer for approval.

2.3 Once approved, the specific location, direction, reconnaissance viewpoint photograph and photograph showing the marker in position are sent to both photographer and surveyor.

[^4]: A viewpoint is the point at which a view is established and dictates where the camera should be set up ready for the photography.

[^5]: Ordnance Survey is an executive agency of the United Kingdom government. It is the national mapping agency for Great Britain, and one of the world’s largest producers of maps.

N.B. The image used above is for illustrative purposes only and is not relevant to this specific project.
3.0 PHOTOGRAPHY

3.1 Digital photography is used as a preference to analog to provide a fast and analytical approach. The recorded image file also contains all relevant information relating to camera and lens types used, time and date and other important EXIF metadata (shutter speed, focal length, ISO speed, etc.).

3.2 An Ordnance Survey map, the reconnaissance viewpoint photograph and viewpoint marker photograph are supplied to the photographer in advance of their visit to site. Additional information like preferred weather conditions and position of sun at any given viewpoint, are supplied. The photographer will then set up their camera adopting the following procedures:

N.B. The procedures that follow are repeated for each of the chosen viewpoints.

- The camera is mounted on a tripod at eye level (approx. 1.6m) and aligned in the vertical and horizontal axis. This levelling of the camera establishes a 2-point perspective which means the lens axis is pointed at the horizon and the top and bottom edge of the sensor is parallel the horizon;
- The camera lens’ point of no-parallax is positioned accurately above the marked survey point. A plumb line may be used for this;
- An accurate measurement of the height from the point of no-parallax to the marked survey point is recorded;
- The time and date of when each photograph is recorded. This should tally with the EXIF metadata stored with the digitally recorded image file;
- Photographs are captured at an ‘infinity focusing’ distance using a small aperture in order to render all parts of the scene from foreground to distance as ‘in focus’;
- The photographer captures the full tonal range of the scene;
- All photographs are captured in RAW format as it allows all of the tonal, colour and resolution data recorded by the sensor to be preserved for use at the post production stage;
- Photographs of the tripod and camera in position are then taken which provides additional information to accompany each viewpoint in the final document;
- Various additional photographs may be taken to create HDR (high dynamic range) images for environment and reflection maps used in the CGI stage.

3.3 As a guideline, the camera system used should be able to create an uninterpolated A3 print at 300dpi which, when captured using a 40deg HFOV lens, is able to match the nominal visual acuity of human eyesight.
3.4 To ensure minimum optical lens distortion and in accordance with the recommendations in the Guidelines for Landscape and Visual Impact Assessment 2002 the photographs will be taken using a Normal Lens\[16\] type. An approximate guide to the typical angles of view for a 36x24mm sensor digital SLR\[17\] are given below:

<table>
<thead>
<tr>
<th>Lens</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>14mm</td>
<td>104 degrees</td>
</tr>
<tr>
<td>24mm</td>
<td>74 degrees</td>
</tr>
<tr>
<td>35mm</td>
<td>53 degrees</td>
</tr>
<tr>
<td>50mm</td>
<td>39 degrees</td>
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<tr>
<td>80mm</td>
<td>25 degrees</td>
</tr>
<tr>
<td>135mm</td>
<td>20 degrees</td>
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</tbody>
</table>

3.5 RAW camera images are converted into ‘lossless RGB’\[18\] files where the tonality and colour balance are matched to the lighting conditions at the time of capture with the aid of reference colour targets. All non-perspective optical distortion is removed from the image using data specific to the lens and camera used. The lens’ optical axis is then identified in relation to the camera’s sensor. This will include any intentional offset of the lens axis as a result of a ‘shift lens’\[19\] being used.

\[12\] RAW format contains the image data as captured by the camera sensor. They therefore contain more information (e.g. wide dynamic range) which means effective adjustments can be made at post production before committing to a more versatile file format.

\[13\] HDR (high dynamic range) are images that contain a particularly high range of light intensities between the lightest and darkest areas of the image. These files assist visualisers to accurately represent the wide range of intensity levels found in the real-world.

\[14\] CGI (computer generated imagery) covers the field of computer graphics or, more specifically, 3D computer graphics.

\[15\] HFOV (Horizontal Field of View) is the angular coverage of a camera lens in the horizontal direction.

\[16\] A normal lens is defined as one where the focal length is nearest the diagonal dimension of the sensor or film.

\[17\] SLR (single lens reflex) is a camera that typically uses a mechanical mirror system and a pentaprism to direct the light from the lens to an optical viewfinder on the back of the camera.

\[18\] Lossless RGB is a digital file’s class of data compression that allows the exact original data to be reconstructed from the compressed date.

\[19\] A ‘shift lens’ or ‘perspective control lens’ allows the photographer to control the framing of the image. When the camera is leveled in line with the horizon, to ensure 2-point perspective, a shift lens enables the relative position of the lens axis to the sensor to be adjusted so that framing and compositional changes can be made while still maintaining a 2-point perspective. In architectural photography this enables the horizon line to move towards the lower part of the sensor and reveal taller objects above it which would otherwise be cropped out if a conventional lens were used.

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\[8\] Digital photography is captured without chemical processing. Instead, a digital sensor plate is used to capture the image digitally so that it can be displayed and stored instantaneously.

\[7\] EXIF (exchangeable image file format) metadata is a tag attached to every digital photographic image that includes specific information like date and time, camera settings and copyright.

\[9\] No-parallax point (or entrance pupil) is the specific point in a camera’s lens and is located at the vertex of the camera’s angle of view and therefore its center of perspective. This point varies from lens to lens.

\[10\] Plumb line is a weight, usually with a pointed tip at the bottom, that is suspended on the end of a piece of string. It is used to establish a point on the ground directly below the point it is suspended from.

\[11\] Infinity focusing is the focusing position of the lens which renders very distant objects sharp. When used in conjunction with a small aperture all parts of the scene will appear ‘in focus’.

\[12\] Aperture is the opening in the camera which determines amount of light rays that come into contact with the camera’s film or image sensor plate.
4.0 SURVEYING

4.1 The latest surveying technology is used to calculate the camera position(s) and several chosen fixed control points that appear on the reconnaissance photo. Specifically for the viewpoint markers, the latest technology obtains National Grid coordinates in real time (Real Time Kinematic [20]) to a tolerance of +/- 20mm using both American GPS [21] and Russian GLONASS [22] satellite networks. An internet connection is established over a GPRS [23] network which receives any necessary corrections from a reference station (see image 4). The fixed control points are surveyed using conventional survey techniques. These techniques utilize electronic theodolites (see image 5) and reflector-less laser technology. These techniques operate to an accuracy of +/- 5mm.

4.2 An Ordnance Survey map, the reconnaissance viewpoint photograph and a plan indicating the viewpoint positions are supplied to the surveyors in advance of their visit to site. The surveyors will then set up their equipment adopting the following simplified procedures:

N.B. The procedures that follow are repeated for each of the chosen viewpoints.

- When approximate camera viewpoints have been established it is usually the surveying team’s responsibility to accurately mark its position on the ground surface with a semi-permanent marker. This forms the basis of accuracy. The surveyor and photographer will then set up their equipment directly above this point (Section 3.2). The exact position of this marker is then surveyed using the techniques described above;

N.B. There are occasions when the photographer will be on site before the surveying team. In such situations the photographer will establish the semi-permanent marker instead.

- Using the reconnaissance photo supplied, between 15 and 20 clearly defined fixed control points are chosen that are visible within the reconnaissance photo (see image 7). The chosen points must be fixed and permanent and should cover a wide and even spread of points within the photo, i.e. left, right and at near, mid and far distances;

N.B. If the site is in a greenfield area or the site lacks sufficient fixed control points graduated surveying poles are placed and surveyed. The photographer is then required to take two identically located photos, one with the poles and one without.

- All the recorded survey information is then translated into a CAD program which represents the information as vertical 3-dimensional lines. In addition, the marked up and annotated reconnaissance photo is supplied. Lastly, a list of every surveyed point with their coordinates and location descriptions is created ready for ‘camera matching’ (Section 6.0).

[20] Real Time Kinematic (RTK) is a satellite navigation technique used in land survey and in hydrographic survey based on the use of carrier phase measurements of the GPS, GLONASS and/or Galileo signals where a single reference station provides real time corrections, providing up to a centimeter-level accuracy.
[21] GPS (Global Positioning System) is a space-based global navigation satellite system that provides a reliable location in all weather conditions.
[22] GLONASS (Global Navigation Satellite System) is a radio-based satellite navigation system developed by the Soviet Union and now operated by the Russian government and the Russian Space Forces.
[23] GPRS (General Packet Radio Service) is a mobile data service used to receive data from a reference station.
5.0 3D COMPUTER GENERATED MODEL

5.1 To produce an AVR (Accurate Visual Representation) of the scheme, it is essential to have an accurate 3D model. The 3D model created is a direct reproduction of the designer’s proposal. The process is performed in a specialized software that develops a mathematical representation of all 3D surfaces. Autodesk 3ds Max® an industry standard software application and is m3fx’s chosen 3D modelling software (see image 6).

5.2 The site plan and/or site survey forms the basis on which the 3D model is created. All plans are then overlaid allowing accurate reproduction of the proposed scheme. Once the model has been created the height is cross checked against the designer’s section(s). These heights are usually given in metres AOD (Above Ordnance Datum)\(^{[24]}\).

5.3 Additional to the proposed scheme, a 3D context model is created. This includes, but is not limited to, artificial and natural landscaping and the surrounding buildings. This is later used for shadow casting and reflections (Section 7.4).

\(^{[24]}\) AOD (Above Ordnance Datum) is a vertical level used in Great Britain by an ordnance survey as the basis for deriving altitudes on maps. The datum is treated as being sea level.
6.0 CAMERA MATCHING

6.1 The next stage in the process is camera matching. This process is designed to ensure that the 3D computer generated model sits accurately relative to the photograph. This part of the process is technical and quantitative in nature and is therefore objectively verifiable. In layman’s terms, the virtual camera’s position, direction, angle of view and focal point within the 3D computer space accurately recreates the equivalent real world parameters on the day of the photographic shoot. As all these positions are relative to the proposed 3D model of the scheme, a rendered image can be created and accurately superimposed over the digital photograph.

6.2 To accurately position the virtual camera in the scene, the following data is required:

- The 3D model of the proposed scheme (see image 8);
- 3D co-ordinates from the surveyor of the viewpoint marker point(s) relative to the site plan and AOD (Above Ordnance Datum) (see image 8);
- 3D co-ordinates from the surveyor of several key fixed points of buildings visible within the photograph relative to the site plan and AOD (Above Ordnance Datum) (see image 7);
- Photographic information of the camera’s focal length and film gate;
- The height of the camera’s no-parallax point above the viewpoint marker.
- The digitally corrected background photographic image (see image 9).

N.B. The image used above is for illustrative purposes only and is not relevant to this specific project.
6.3 The steps below cover the majority of procedures adopted in the process:

N.B. The procedures that follow are repeated for each of the chosen viewpoints.

- The completed 3D model is opened within the 3D software;
- The digitally corrected photographic image is opened within the 3D software and added as a background within the software’s viewport[27];
- The correct ‘aspect ratio’[28] is inputted within the 3D software’s global parameters;
- All 3D co-ordinates from the surveyor are imported into the 3D software relative to the proposed 3D model;
- A virtual camera is placed exactly where the viewpoint marker point exists;
- The virtual camera is raised in the vertical axis to match the height from the viewpoint marker to the real-world camera’s no-parallax point;
- The photographic information (focal length and film gate) are inputted into the virtual camera’s parameters;
- The virtual camera’s target is moved towards the position of the site plan within the 3D space;
- Fine adjustments are made so that all the key fixed points match their equivalent points on the background photographic image;
- The whole process is checked by another senior architectural visualiser.

[25] The focal length, simply put, is the distance from the lens to the film/sensor. When the rays of light converge it focuses the image and when they diverge they defocus.

[26] The film gate traditionally is the rectangular opening in the front of a motion picture camera, however in digital photography it relates to the longer length on the digital film/sensor.

[27] The viewport is a 2-dimensional rectangular/square region found in CAD software that displays a 3-dimensional scene. Typically it will show what the virtual camera sees.

[28] The aspect ratio describes the ratio of an image’s longer dimension to its shorter dimension. Typically they are expressed as two numbers separated by a colon.
7.0 RENDERING

7.1 Rendering is the process of generating a 2-dimensional digital image from a computer generated 3D model. In layman’s terms, the 3D model is first assigned textures, lighting and shading information. The computer then uses these parameters to generate the rendered digital image. These parameters attempt to mimic the conditions which were present during the moment of the photography shoot. The processes involved in rendering are both complex and subjective and therefore differ from one company to the next. It is important to add that in no way do these differing approaches alter the appearance of volumes relative to the background photographic image and therefore do not have an effect on the image’s verifiability. For these reasons the main descriptions of the stages of rendering are kept generic.

7.2 Texturing or texture mapping is the first significant part of the rendering process. In essence it adds surface texture and detail through the use of colour and raster images onto the 3D surfaces. This provides a realistic and accurate image of how the final building materials will look when the construction is completed. The raster images typically originate from photographic images of real life objects. They are then digitally adjusted to remove any distortion and are mapped onto the 3D surface. During the rendering stage these texture maps, combined with lighting parameters, have a significant influence on the look and feel of every 3D surface and therefore in turn the final output 2-dimensional digital image.

7.3 Lighting is the second significant part of the rendering process. Virtual lights are placed within the 3D space to simulate real-world light sources. Importantly, the software simulates the ‘directional’ lighting produced by the sun. The simulated light rays mimic the sun’s rays which, at the distance earth is from it's sun, are almost parallel to one another. Additionally the 3D software allows the visualiser to input date, time of day and location information. These all play a part in the position and direction the rays hit the 3D model during rendering. As well as the lighting of individual 3D surfaces, the rendering also calculates the effect other objects play in obstructing the light’s rays therefore producing shadows. These shadows are characteristically shown as hard edged shadows. Today’s 3D visualisation software can also calculate the radiosity (global illumination) which simulate the bouncing of light off surfaces onto others. As with directional lighting, shadows are produced, but are characteristically shown as soft edged shadows.

7.4 Building and other objects outside the proposed scheme have an influence on the rendered image. The main two influences are shadow casting and reflections. The context model (Section 5.3) is utilized so that both these influences have an impact on the final rendered image. High Dynamic Range images are also used to represent the sky.

N.B. The image used above is for illustrative purposes only and is not relevant to this specific project.
8.0 POST PRODUCTION

8.1 Once the computer has produced the rendered raster image there are several final steps all of which are completed in raster editing software. Adobe Photoshop® is our chosen raster editing software. The combination of these steps are grouped as post production. It is important to add that, although the look and feel of the image may be adjusted, the main volumes, represented two-dimensionally as areas, are not changed in terms of relative height, scale and placement.

8.2 Here are the main steps in the process of post production:

• The digitally corrected photographic image is opened (see image 9);

• The rendered raster image is superimposed over the photographic image on a separate layer (see image 11);

• Masks are created in the areas where the line of sight to the superimposed rendered image should not be seen. Typically this occurs when the areas of the rendered image need to be behind specific foreground buildings or objects that exist in the photographic image (see image 12);

• Endless aesthetic effects can be applied to the rendered image to enhance the realism of the final image and/or make adjustments as a result of proposed material changes. However, the visualiser always attempts to keep faithful to the proposed design within its chosen site;

• Finally the digital image is saved in the appropriate format ready to be included within this document (see image 13).
Appendix 7.1 Photomontages

Viewpoint 15 Existing