Overview of 3D city models for architects

What is a 3D city model?

The term "3D model" is an overarching term covering everything from simple extruded map polygons models all the way to custom-made millimeter-accuracy 3D scans. The 3D models vary greatly in terms of their accuracy, level of detail, recency and usability, as well as in terms of their costs, delivery time and its file format.

It is necessary for architects to understand the spatial context of a development. Architects usually take advantage of existing 3D city models or commission or even create their own 3D model of the surrounding area. RIBA plan of work has been updated in 2020. it is a task of Stage 1 to source Site information and Site Survey and 3D models of the as-built environment are often already used in stage 0 for the initial Site Appraisal.

Although architects are rarely involved in Stage 0, the project might inherit the 3D models sourced for the Site appraisal task and use this information in subsequent stages. Depending on the nature and location of the site, the site appraisal 3D model might be already a premium 3D model that can be used in subsequent stages. To avoid the use of low-quality site models, Stage 1 instructs project managers to "Source Site information including Site Survey".

5 types of city models

To make a direct comparison, the "Overview of 3D City Models for Architects" video offers an overlay of the same area of London represented in 5 different types of 3D city models.

Extruded Buildings footprint Polygons 3D map.

This is easy to obtain and possibly the simplest form of a 3D city model. It's excellent for background models and wide-area city visualisations on a budget.

Airborne Lidar model.

A much more accurate and detailed model, however it's quite a messy and unseparated Digital Surface model dataset.

Aerial photogrammetry.

Made with clean geometry with a high level of detail, up to 15 cm accurate. This does come at a cost.

Textured photogrammetry model.

Textures applied onto clean geometry, an accurate city model with high visual fidelity. Might be cost-prohibitive and currently only available for London.

Non-GIS Game-ready model.

Not made for architecture or urban planning but very affordable with a surprising level of detail on landmark buildings.

Extruded Polygons 3D Map

This kind of 3D model is easy and cheap to obtain. It is made of separated, lightweight geometry, ideal for large-area city models visualised on a budget. Excellent for background models and wide-area city visualisations where accuracy and level of detail are not that important.

The free model created from the OpenStreetMap dataset offers some third dimension to a map, but that is pretty much it and its level of detail is almost nonexistent.

The Extruded Polygon 3D map models are often used as a background model to illustrate the wide-area context. Used as a background model supplementing the Photogrammetric model in Plan.City app and viewed from shallow angles, the line between 2 models is all but invisible.

Used in GIS applications, the Extruded Footprint Polygons 3D maps can offer an inexpensive way to visualise the city environment. Using for example Cesium, users can visualise the urban landscape but also quantify its features such as buildings use, density or heights.

However, it is not recommended to rely on these datasets for an immediate site context. They might be released but not further managed by non-profit organizations such as OpenStreetMap or by local authorities such as New York City through its OpenData portal.

There might be significant differences in these datasets. These are usually down to the different understanding of buildings levels, different underlying mapping data as well as differences in what constitutes a building or a feature that should be displayed as a 3D object.

Airborne Lidar model

The Airborne lidar model is created by a plane collecting laser scans. Inherently a much more accurate and detailed model, great not just for backgrounds but also to measure from and even run some basic studies and simulations. Free datasets are available, just like the one by the UK Environmental agency 1m grid Lidar surveys, used in this comparison.

This data usually needs to be further processed to be used in various applications. For example, there is a source code on Github for a little program to convert LIDAR scans into 3D-printable STL tiles for 3D printing.

When converted the Lidar does create quite messy geometry and the resultant Digital Surface model isn't separated. The most limiting feature of this dataset is how out of date it is. Notoriously

difficult to update, it is the destiny of lidar 3D models to stay as young as when they were captured.

Because Lidar 3D models are not usually separated into terrain and buildings, they are referred to as Digital Surface Models. That means that they can be used directly in applications such as Wind Load and Pedestrian Wind Comfort Modelling without much post-processing. A study conducted using Lidar model will generate more accurate results than using Extruded Footprint Polygons model. But because of the messy geometry of the Lidar model, the study might take longer to process.

Lidars' accurate height readings over a large area are often utilized to assign better height values and even correct roof shapes to Extruded polygons 3D maps. The results of these mapping processes are very much dependent on the quality of both the datasets and algorithms used in the process. The workflow design for this process is constantly changing and improving with continuous research.

Another way to use Lidar 3D models is to run simulations on this data to generate new 2D mapping data. A good example of this 2D mapping data generated from Lidar height maps is the OS Flood map.

Aerial photogrammetry model

An Aerial photogrammetry 3D city model has clean geometry, high detail and up to 15 cm accuracy. Every point and every line in these 3D city models is manually captured using stereophotogrammetry. Terrain height changes are captured along features. The model is separated into layers (Buildings, Trees, Terrain layers such as Roads or Greenspaces) and is easy to update and upgrade.

The photogrammetry 3D models are the most commonly used premium dataset. 3D models of major UK cities are usually already created and sites outside of these city centers are very well covered by existing aerial surveys. As a result, photogrammetry 3D models can be sourced from existing libraries or produced to order in a very short amount of time for pretty much any site in the United Kingdom.

Building envelope constraints stemming from local planning regulations or from acquired rights such as rights to light can have a significant impact on the building design.

Visual Sky Component calculations assess the daylight impact of different massing options. This type of study is usually conducted by an architect or a planning consultant during the pre-planning phase and results in a generation of a maximum building envelope constraining the final architectural design.

Compliance with local planning regulations such as the London View Management Framework or 'St Paul's Heights' maximum heights grid represents further constraints on the maximum size of the proposed building.

Weston Williamson Architects used photogrammetry 3D models for Public consultation boards, as well as to generate 2D maps from geo-referenced 3D model data.

To comply with the City of London Wind Microclimate Guidelines requires wind modeling studies to be carried out. Exceeding the recommended values might result in amendments to the architectural design. More and more local authorities require these studies to be conducted for planning purposes.

Further studies might be required by local authorities during the planning process. Solar Glare Assessments might be required for developments near railways and Accurate Visual Representations renders will be very likely required in the planning process of tall and significant buildings to inform the effect of a proposal on the as-built environment.

Compliance with a wide variety of regulations often creates back and forth between the architect, planning consultant, and the investor. Using the same 3D model for all assessments from early on can help to identify and communicate possible issues and significantly reduce the time required to produce an architectural design compliant with all local planning restrictions.

Well thought-out access design and temporary site structures positioning are important considerations on every site. Working on a development in a busy city centre can increase the pressure and complexity of the operation multifold. BAM Construction used a photogrammetry 3D context model as part of a competitive tender process to design and communicate the size and appearance of the scaffolding, locations of the in/out site access, cranes positioning and even turning circles checks. For simple sites, even extruded building footprints may be sufficient. Premium 3D models are recommended for sites in urban areas, sites with complex terrain height changes or where the initial assessment identifies issues.

The last example of using 3D city models for designing more livable cities is an innovative project by Ioana Man. She explored how architecture can collaborate with biology to create a more sustainable built environment. She conducted microbes DNA sequencing and identification and used a photogrammetry 3D city model to take into account the existing urban density & land use. The use of accurate context model will also be pivotal in the effort to quantify and extrapolate her findings to other parts of London or other cities.

Textured photogrammetry model

The Textured photogrammetry model includes textures applied to clean geometry. It's an accurate city model with high visual fidelity.

Because the textures are applied onto a separated high detail photogrammetry model, users can turn textures on and off on buildings, terrain or on any other features. Pixel stretchings and imperfections, occurring mostly in urban cannoyons, can be rectified on focus buildings by upgrading a UV map from custom photographs.

Textured photogrammetry models are not necessarily required to conduct most architectural or planning studies. The cost of this premium dataset might be prohibitive for non-commercial projects and the model is currently only available for London.

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Textured photogrammetry models can also be 3D printed, as illustrated on a 500x500 meters city tile 3D printed in 15 x 15 cm by Hobs 3D.

Textured photogrammetry 3D models will also give architects a new way to visualise their designs in the existing environment. For example, it is now possible to visualise the reflection of the neighboring environment on the facade of a proposed development.

The greatest advantage of using the textured photogrammetry 3D models is in the ability of the investor to use the same 3D context model all the way to marketing and sales. Good example of this is this real-time simulation of views from a proposed restaurant created in Unreal Engine 4.

Non-GIS Game-ready model

An inexpensive game-ready model might offer a good alternative to accurate, GIS-based city models. The datasets are not made for architecture or urban planning but can be highly affordable with a surprising level of detail on landmark buildings.

If you opt to use a non-gis game model, be weary of different 3D city models used in games. 3D city models for videogames were historically only rarely used in architecture; mainly because until very recently they were only vaguely based on actual cities.

Recent game-ready models do offer an attractive and affordable option for many applications that require recognisability rather than high accuracy. High detail landmark buildings make this city model suitable for at least some applications such as CGIs or data visualisations on a budget.

If you opt to use a non-gis game model, be weary of different 3D city models used in games. You don't even have to be an architect or be restricted by a budget for a wrong choice of city model to invite ridicule and lessen a project value. A good example of this is the 3D London model used in MS Flight simulator a few years back. Even though the model was intended to be viewed from a plane and using procedural textures made sense for this purpose, using procedural textures across the city resulted in Buckingham palace looking like a council estate and the Queen Victorias memorial as a bungalow.

Just for the record, the London model in the MS Flight simulator has now been upgraded and looks great.

We would always recommend using premium 3D models for at least the immediate surroundings of the site; using out of date, simplified or inaccurate context models for applications where accuracy is important can result in loss of credibility when questioned or, even worse, in design mistakes caused by an inaccurate context model.

Watch Full Video Presentation

This material is available as an online RIBA CPD video and forms a part of the mix of learning material approved by the Royal Institute of British Architects.

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