

CONSTRUCTION OF THIRD DIMENSION SKETCH-UP OF KALYAN-DOMBIVLI, MUMBAI DISTRICT, INDIA USING GIS TECHNIQUE



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Abstract.

Three D-modeling has been the privilege of architects and engineers. But, the usage of 3-D modeling is no longer limited to design and engineering details. It is being used by urban planners in decision making and visual representation. The usage of 3-D model is primarily for the purpose of visual analysis like shadow analysis, line-of sight, building density, etc. The rapid urbanization process is brining such indicators a new importance, where the city is not only expanding horizontally but vertically too. The free availability of software like Sketch-up and Google Earth has brought the idea and art of making 3-D model to urban planners and non-technical person in particular. It helps in refining the spatial analysis process in ArcGIS. The idea of this research was to expose the process of 3-D model making in the Sketch-up environment, be able to place it on Google Earth and ArcGIS. To explore this interoperability was the main aim and to demonstrate analysis in this direction. This interoperability gets hindered in certain places due to lack of plug-ins and data format. At present, the attribute loss from Sketch-up to ArcGIS makes the model created limited in its usage for spatial analysis. A way around these obstacles is the future of its better integration in the GIS environment.

Keywords: Urban heat island, Sketch-up, ArcGIS, Three D modelling

1 Introduction

The increasing rate of urbanization, is leading to focus more and more on the built environment. The city is not only expanding horizontally but in many cases vertically too. This vertical growth requires the urban planner's to be able to visualize the 3rd dimension. It

shows the invisible face, improving the scope of demand and allocation process particularly in reference to the built form. In context to urban planners, we need detailed 3-D models as architects but in a more practical and visually simple format. The 2-dimensional view of an object shows the x and y axis which is primarily a planar view. In case of 3-dimensional, the z-axis is also visible. It shows the third dimension which is closer to reality. The advantage of a 3-D over 2-d is that it can show the volume of the building or conflict between two objects or buildings [6]. The figure below as taken from [6] shows the fundamental difference between a 2-dimensional representation and a 3-dimensional visual.

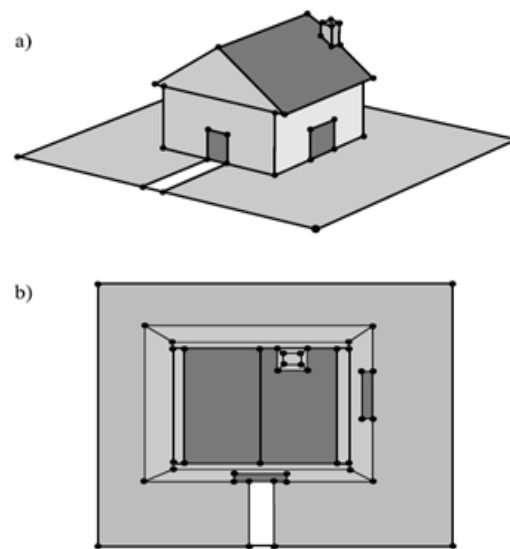


Fig. 1. a) the 3-D view b) the 2-D view (Groger, 2005)

The purpose and methodology of creating 3-D models are many. The earliest ways of constructing 3-D has been with the help of photogrammetric images and DEM created from satellite images. To current times where Google earth and Sketch-Up are providing easy to use interface. Nonetheless, 3D- urban modelling can be summarized into following categories [12].

1. The degree of reality it represents
2. Functionality: like 2D GIS models which are useful for spatial analytical process.
3. The type of data input
4. The uses to which it can be put: planning and design, infrastructure and facility services and better visualization of big cities for various purposes.

1.1 3D GIS and Urban Planning: Recent Trends

One of the integral aspects of urban planning is physical arrangements of different elements in urban space. This needs visualization in a manner that not only expresses the design scheme but improves that space in an effective manner. Elements included within this virtual environment could be sunshine/shadow condition, heat environment, views-cape and accessibility among others.

In their paper [2], the writer explores globally the recent developments and experiments of 3-D visualization integral to GIS environment. The current trends of 3-D modelling and research work can be summarised under the following category:

1. Different proprietary software systems involving 2D GIS, 3D CAD, and multimedia methods.
2. Different levels of spatial abstraction from high to low geometric content.

3. Different types of data capture from detailed manual-based construction and rendering to fully automatic methods based on LIDAR, and
4. Different methods for delivering visualization capability from the desktop to the web.

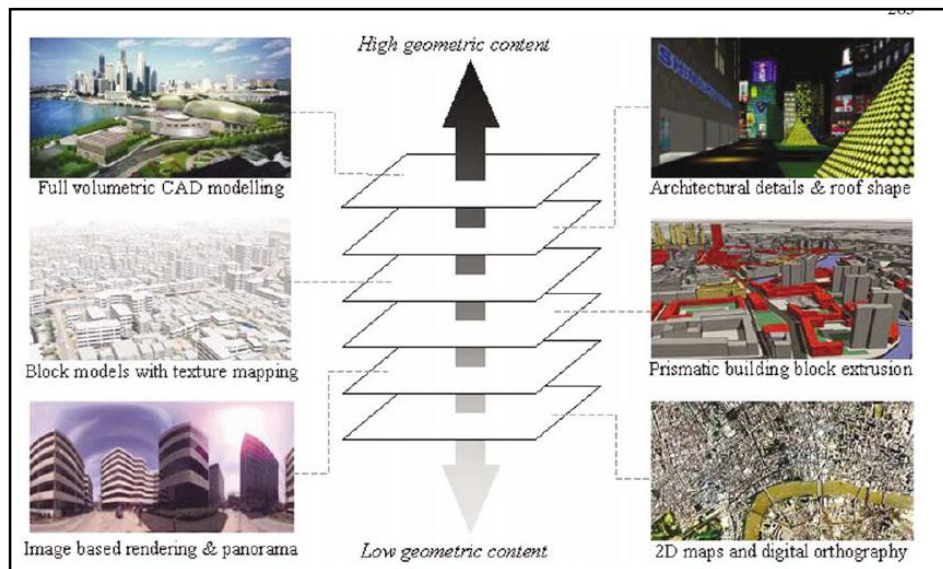


Fig. 2. Different levels of Spatial Abstractions (Betty et al, 2000)

The 3-D geo-visualisation process has a particular advantage, since it can be easily interpretable;

it's highly interactive and distributable. But only visual impact assessment is not sufficient, what is also required is a decision making framework [11], [10]. GIS is used as a principal tool for developing planning proposals with 3D visualization and providing the rendering of these designs [11].

In the last few years across universities, urban planning and architecture departments in their research studies have made local attempts to integrate the 3-D visualization process for decision making. In their study [1] for planning a new building in the university area they used three ways of visual representation for decision making with the stakeholders. This namely included 2-d plan view, a simple 3d view and a photorealistic 3d world view. The test showed that the world view was informative and provided volumetric support. It is a good example of using 3-D for decision making.

There is a strong need for a three-dimensional geographic information system to manage 3D geometry and topology, to integrate 3-D geometry semantic information, analyze both spatial and topological relationships and be able to visualize in a suitable form [7]. The recent emphasis on 3-D GIS has been taken a step forward by some of the researchers proposing a new indicator for measuring urban morphology i.e. urban volume. In their paper [7] they construct 3-D model of Amsterdam city and use it for analysis in the GIS environment.

Some of the recent literatures have indicated and applied various methods of using 3-D models for analysis purposes (Xia) which can be categorised as following:

1. Physical quality analysis of urban space: heat environment, sunlight condition.
2. Visual quality analysis of urban space: aesthetics of surrounding environment.
3. Structure analysis of urban space: building density, functional distribution of urban elements.

There have also been experiments with the interoperability between ArcGIS, Google Sketch-Up (GS) and Google Earth (GE) in academic exercises both by architects and planners. In his article [8], speaks about how GIS and 3D modelling software can be used to produce highly detailed three dimensional models that can be easily imported into ArcScene

as 3D marker symbols. In his article interoperable three dimensional GIS describes an exercises in which the urban planning and architecture department at Florida Atlantic University (FAU) came together to create an interactive three dimensional GIS model for three time periods. They used GIS for creating 3D models and analyse how the city changed over the years. In an another study of High Springs Town Center redevelopment project, the 3D simulation process facilitated data analysis and design alternatives with the help of stakeholder participation with live simulation process on ground.

1.2 Land surface Temperature

Land surface temperatures are reflective of the thermal environment. The earth surface bereft of green cover and vegetation would contribute in the creation of local heat island. In his work [9], LANDSAT 7 ETM + use to construct land surface Temperature Maps for two times different time periods and winter and summer seasons. This land surface temperature was overlaid with landuse maps. It showed cool temperatures in areas which were covered with agriculture field, close to water bodies and planned areas where streets are lined with trees.

2 Methodology

The aim of this exercise is to explore the interoperability between ArcGIS, Sketch-Up and Google earth. With the traditional design tools, one had to find the problems, analyse the space with manual sketch and then visualize the design result through the 2D map or picture. The analysis part got a boost with increased usage of ArcGIS by planners for spatial analysis. The area of improvement lay in being able to include the 3-dimension in analysis and visual representation.

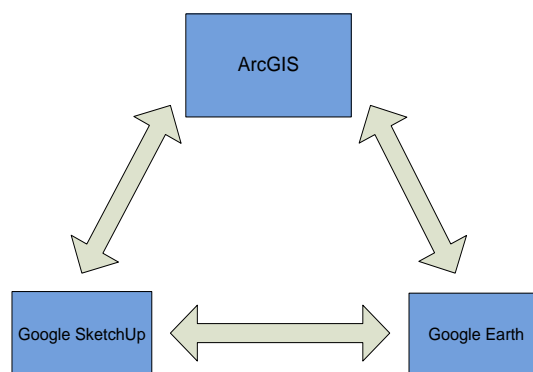


Fig. 3. Framework for Research of Possible Interoperability

Thus, there is a need to explore the possibility of data exchange between ArcGIS, Google Sketch-Up and Google earth. In this case ArcGIS is used, since it the most common tool used by urban planners for spatial analysis. Google Sketch-Up is being used for 3-D model building which is easy to learn and has ArcGIS supportive file format. The other area of exploration is Google earth. The emergence of Google earth for 3-dimensional viewing and its easy accessibility makes it an important interface for urban planners to use and explore. It can be used more and more for ground-truthing and space time visualisation of a plan.

2.1 Work Flow between SketchUp and Google Earth

A model in Sketch-Up can be built for an actual location on earth. It requires Google earth on the desktop along with the Sketch-Up software. Once the model is designed, it can be easily placed back on Google earth. The fig below is a schematic representation of this

data movement and supportive file type. It gives a good view of how a model can be designed in Sketch-Up and placed on Google Earth.

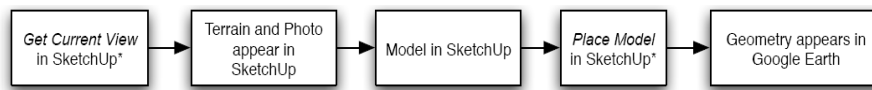


Fig. 4 Interoperability Process between Sketch-Up and Google Earth



Fig. 5 Supported File Format between Sketch-Up and Google Earth

2.2 The Process of making 3-D model in SketchUp and placing it on Google Earth

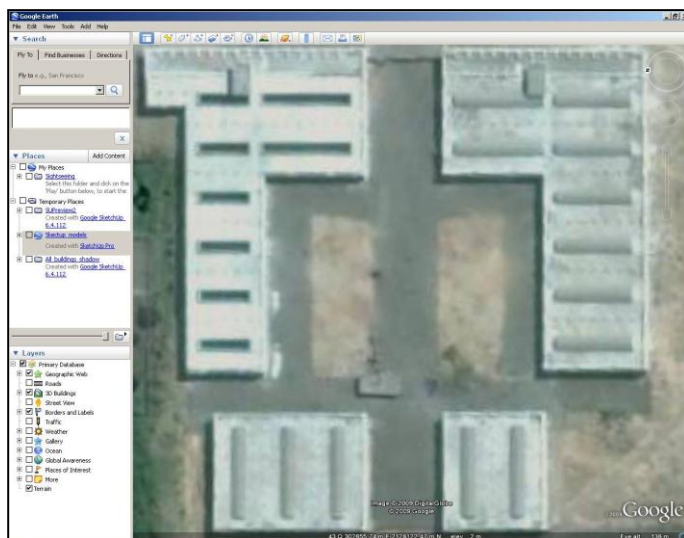


Fig. 6 Select and zoom to area for 3-D model creation

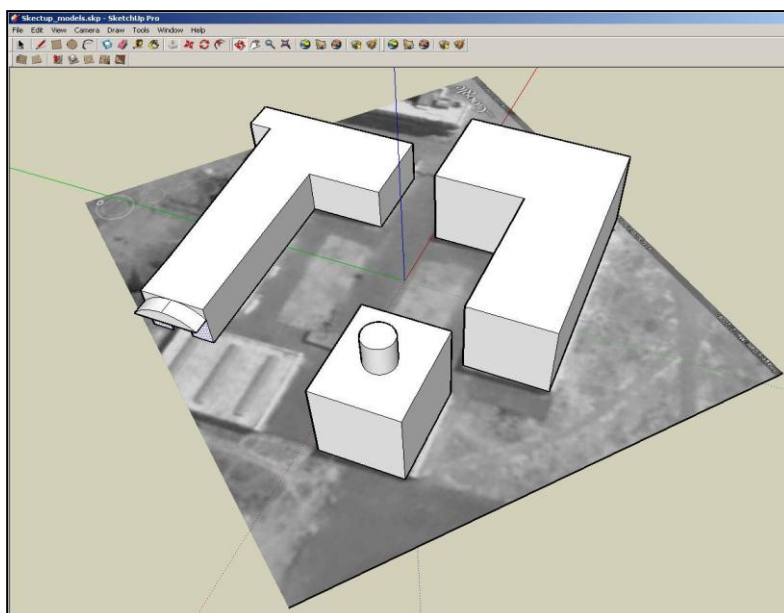


Fig. 7 Get the scene to Sketch-Up and create model

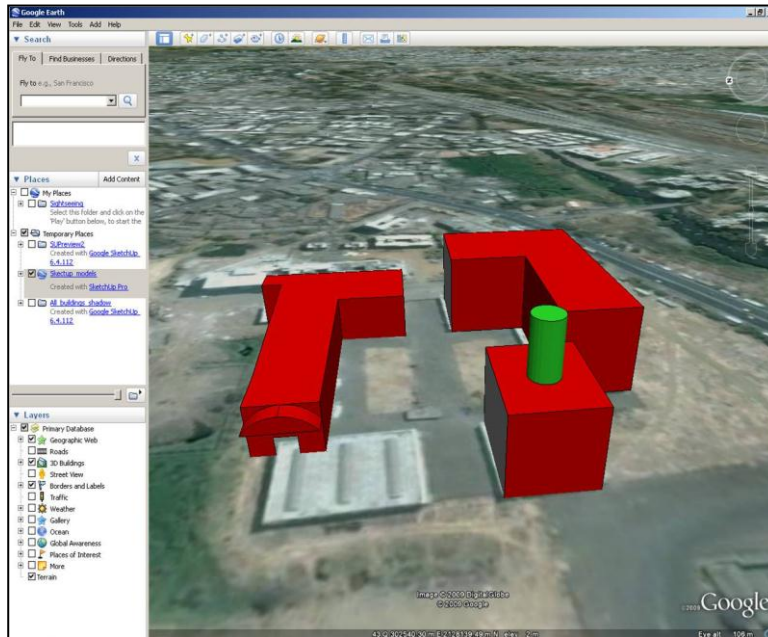


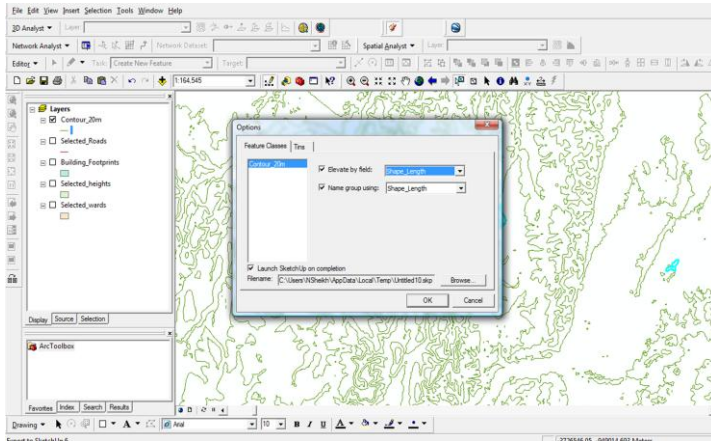
Fig. 8 Export the model and place it on Google Earth

2.3 Operability with ArcGIS

Sketch-Up Pro allows importing of GIS data and quickly and accurately. One can add new levels of complexity, map photographs or simply create 3D models at whatever level of details. These 3D models can be exported back to ArcGIS project as ESRI multi-patch data or use them as 3D symbol's.

2.4 Multi-patch in Sketch-Up

A 3D geometry used to represent the outer surface, or shell, of features that occupy a discrete area or volume in three dimensional spaces. It comprises 3D rings and triangles that are used in combination to model a three dimensional shell. It can be used to represent simple objects like spheres, cubes or complex objects such as buildings and trees [16].



2.5 Work Flow between Sketch-Up and ArcGIS

The import and export of data between SketchUp and ArcGIS offers a range of possibility for spatial analysis in particular. The 2-D data like building foot prints, contour lines and location of amenities etc can be exported to SketchUp for detailed modelling. At present this smooth process of data movement is hindered with SketchUp plug-in **not** available with the new versions of Esri ArcGIS.

From ArcGIS to SketchUp: ArcGIS 9.2 or lower version to SketchUp 6.0 or lower version.

From SketchUp to ArcGIS: ArcGIS 9.1 or lower version with SketchUp 5.0 or 4.0 pro version.

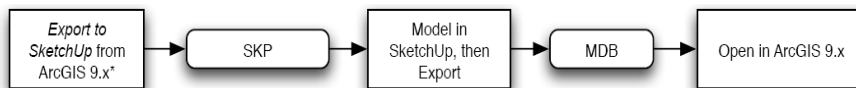


Fig. 9 Interoperability process between SketchUp and ArcGIS



Fig. 10 Supporting file between Sketch-Up and ArcGIS

Advantages

1. The advantage of doing the 3D modeling in Sketch-Up is primarily the simplicity of the software and the level of detailing which can be added for the purpose of spatial analysis. In ArcScene, one can only visualize a 3D building but the surrounding physical elements cannot be put together for a better understanding of real life situations.
2. One can import georeferenced vector data or orthorectified aerial imagery into SketchUp.

Disadvantages

1. The new version of SketchUp 7.0 pro does not have compatibility to transfer the multipatch .mdb file back to ArcGIS. In the earlier version, for SketchUp 5.0 it was possible to do the same with 9.2 or 9.1 ArcGIS. It can be brought back with the help of import 3D tool, but it loses its spatial location.
2. The only other option is to use a tool in ArcGIS. ArcGIS 9.2/9.3 has an import 3D tool located in the 3D Analysts toolbox. This will successfully import the model into a multipatch. However, the spatial xy location is 0,0. Therefore it is not much of importance because the multipatch shapefile loses its building co-ordinates.

- The data handling capacity is still low. The level of detailing has also to be kept low so that it can be easily transferred.

2.6 ArcGIS to Google Earth

From ArcGIS to Google Earth: the KMZ/KML extension or tool for taking the footprints to Google Earth, it maintains the geo-reference.

To Google Earth from ArcGIS: to get building foot prints from ArcGIS to Google Earth once can use ET 'Geo-wizards' extension. It is a freeware, and helps in transferring the CAD lines or polygons from ArcGIS.

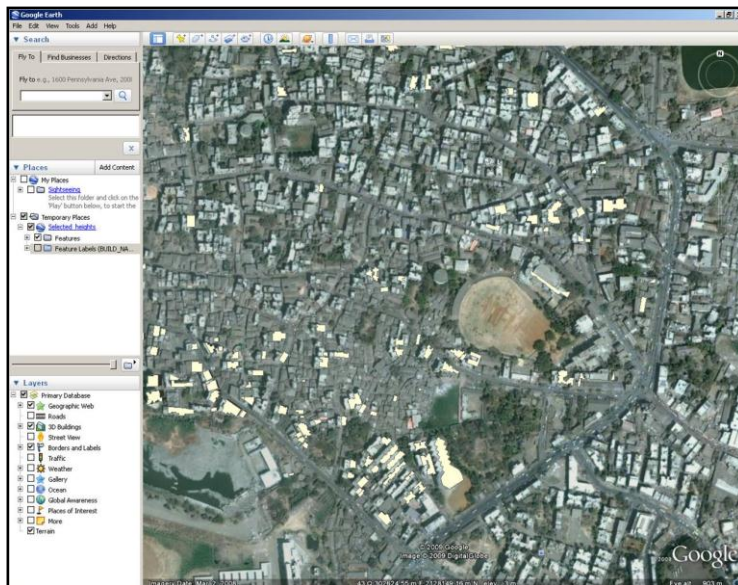


Fig. 11 Building Footprints of Kalyan exported as KML to Google Earth

3 Conclusion

The free availability of Google Sketchup and Google Earth and the quick learning time gives it the advantage over others. The limitation of the software's available plug-ins hinders a seamless flow of data and analysis within SketchUp, Google Earth and ArcGIS. The potentials of its usage are many, considering the simplicity of the user interface. One of the suggestive areas of improvements and standardisation is to develop a spatial database structure which would store the SketchUp model attribute. At present the multipatch data format limits its usage for analysis with other indicators in ArcGIS environment, it can only be used as a 3D marker. The other area of improvement is the possibility to store photo-texture parameters; this would be a boost to physical planning field.

The other software used was Google Earth, which has brought the 3-D earth on every desktop. The usage for creation of model in the Google earth interface would reduce the error of back and forth shifting of image leading to shift in its geo-reference.

The urban planning field till last decade was synonym to physical planning. It majorly dealt with landuse plan, infrastructure projects and city development. This invariably attracted more and more architects and civil engineers to the domain. The usage of ArcGIS as a spatial analyst tool has therefore been well established along with other CAD based software's. But, in this decade, the changing urban dynamics brought in people from other backgrounds like geography, economics, sociology and social work etc. Area of interest, for these planners lay in analysing the socio-economic aspect. At the same time, planning field

deals on a whole must talk about space. The availability of software's like Sketch-Up and Google earth makes the work of such '*non-technical*' planners easy. The simple interface and minimum time taken would attract more and more people to include the so called '*technical*' components. As mentioned earlier, 3-D models required by planners are not detail specific, they should be simple and visually understandable. For example, it can be easily included by a health geographer to visualise the built form and derive further constructive reasons for the occurrence of a particular disease. Indicators like Shadow analysis, urban heat island are used not only for architectural details, but also in environmental studies, health issues and poverty pockets.

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