











### 4.3.3 Single / stand-alone file and Limited Databases Support

Unity uses only a single file (or single file directory) to store all the codes, functions, GUI properties as well as the datasets (2D and 3D) of a project, thus consumes huge memories (RAM and ROM) of the computer system. Other disadvantage – it is a stand-alone system which hardly able to integrate with other software such as database.

### 4.3.4 Less Users, Documents and Supports for 3D Mapping

Unity is designed for game development where most of the manuals, tutorials and sample projects are associated with the gaming specifications and developments. The game engine can be considered as very specialized tool for 3D visualization of spatial objects. It has various limitations and other drawbacks, thus very limited users, documents and supports.

## 4.4 3D Game Engine for 3D GIS Visualization

This section describes the potential of 3D Unity visualization and game engine for 3D GIS visualization. There are several visualization packages meant for GIS, however most of those packages have very limited functionality for 3D GIS modelling and visualization, e.g. ArcScene, Bentley Map, MapInfo Discover 3D, AutoCAD Map 3D as reported during the workshop (TU Delft, 2011) as well as by Abdul Rahman (2016). The development of 3D visualization from those packages is still in progress and working toward solutions for ‘real’ 3D GIS visualization requirements.

3D spatial database component is quite essential in any spatial information system. We anticipate those two projects could be extended for a bigger scope in 3D spatial database component, i.e. providing answers for spatial and non-spatial queries of 3D object. We also recommend a transformation of 3D objects (CityGML) into GIS-based layers where more spatial or/and spatio analysis could be carried out on the layers.

All these layers from two different projects (solar energy estimation and underground utility) would be useful for future GIS-based smart city – planning and management. Later, new 3D layers or objects could be added or integrated to provide multi-functional applications within a single smart city model, in this case - 3D Unity.

## 5. CONCLUSIONS

We have described the 3D modelling for estimating potential solar energy on buildings surfaces and underground utility mapping using Unity 3D game engine platform for Istanbul. These applications provide precise measurements (e.g. solar energy estimation and location of underground utilities), analysis and better visualization especially for city planners.

Some advantages and limitations of the game engine also highlighted. The Unity 3D game engine itself is the most high quality game engine available in the market, easy to use and shorter rendering duration are mostly suite for game developers and companies. We strongly believe this 3D game engine could be extended for better visualization, format interoperability, database and other spatial related functions or applications in the near future.

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