Showing Underground Stations in a GIS-based Guide System

The Vienna 3D City Model

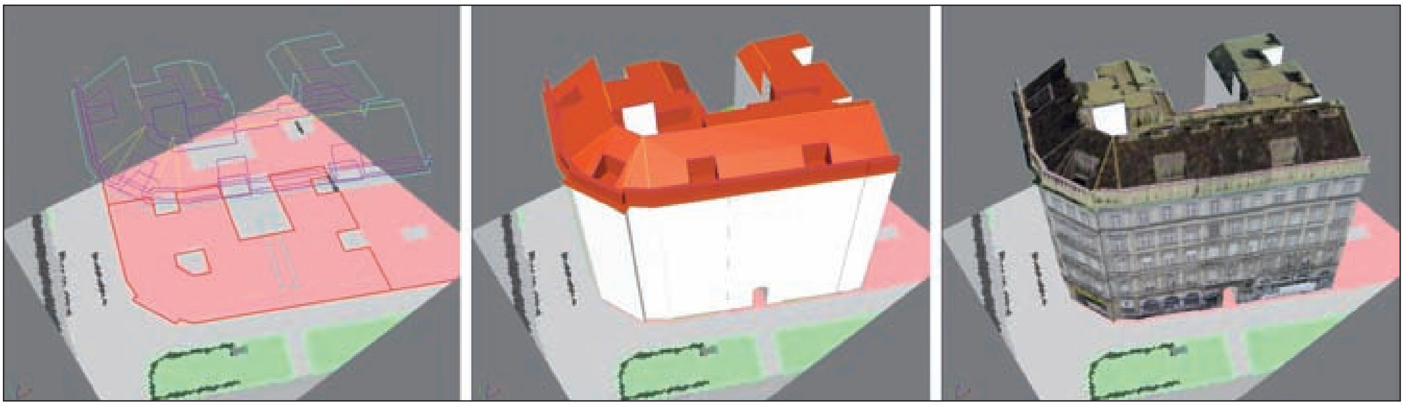

Figure 1: Left: Building represented by structure lines from the 3D database, middle: automatic surface model derivative, right: photo texture applied.

In the Vienna metropolis, 3D geo-information is required for noise protection and city planning tasks but also for managing the underground line systems; this geo-information should ideally be available as part of the communal GIS. For this reason, the City of Vienna decided in 2003 to expand the existing geo-data into a database managed 3D city model that will be regularly updated and made available to users under ArcGIS.

By Gerald Forkert and Lionel Dorffner

The city of Vienna uses ArcSDE to manage the elements of the digital map 'MZK'('Digitale MehrZweckKarte' – 'digital multi-purpose map), the digital terrain model, and the supply line cadastre. Within the city of Vienna, this 2.5D geo-data is mainly used by GIS 'Power Users', like city planners, noise protectors, water supply or fire brigade. At present, about 100 workstations are equipped with ArcGIS.

The geo-information technicians of the city of Vienna were recently looking for a 3D solution for buildings and subterranean structures compatible with the existing system. This solution was found in the form of the CityGRID system (www.citygrid.at), which was implemented at the city of Vienna from the year 2003 in several stages. The advantage of this system lies in line-oriented 3D modelling where the geo-data is topologically processed and saved in a 3D database as a result. This principle facilitates the continuous updating of the modelled objects.

Noise Protection

In the first phase of city modelling the roof scenery of the above-ground city model was established by completing the existing geo-data with the help of photogrammetric aerial restitution. This task was managed by only two employees of the surveying department. This effort is rather small compared to the generation of the digital map 'MZK' which tasks 30 employees. In other words: an accurate terrain model and a well organized digital map like the 'MZK' provide already 90 per cent of the city model. In the meantime, an almost complete model of 500,000 buildings represented by simplified flat roof models and 25,000 buildings represented by detailed roof shape models is available. On request, a scenery of roof shape models can be textured quickly by hand-held photographs.

Noise protection departments are among the principle users of 3D city models, as the current model of the entire city is always required for simulating noise propagation over a wide area. Noise protection departments are responsible for documenting existing noise pollution in the form of noise maps and for simulating the effect of any building and protection measures. Topography and buildings affect noise propagation. A 3D city model is therefore essential for calculating noise pollution in a city.

For an average noise protection department project, an existing 3D city model saves more than 90 per cent of the time needed for preparing the geometrical input for the expert system used to calculate noise. For

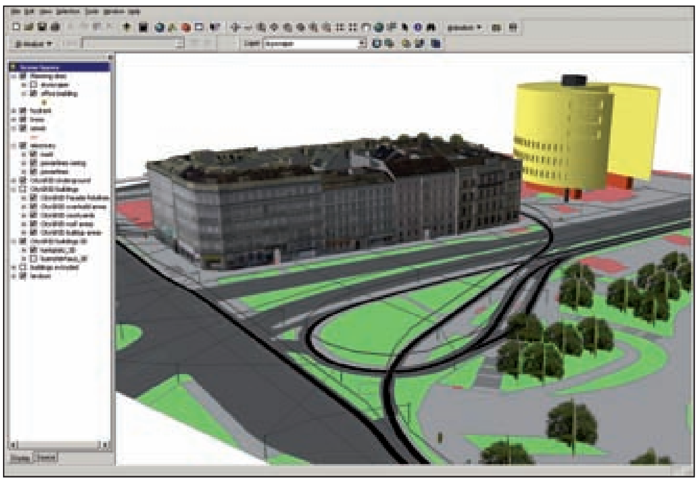

Figure 2: simulation of designed building using 3D visualisation module.

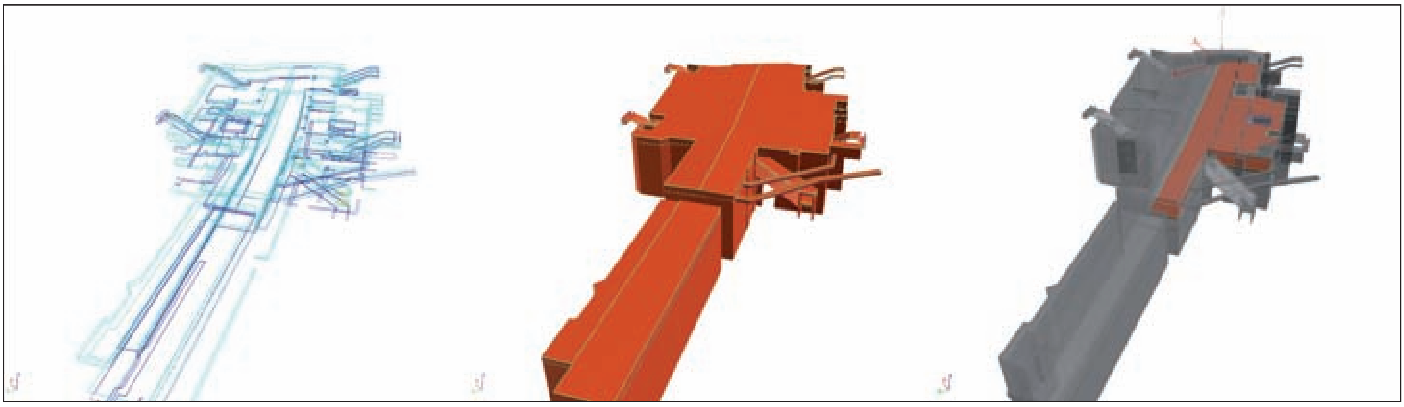

Figure 3: Left: Structure Lines defining underground buildings, middle: automatic surface model derivative, right: modelling of interior structure.

using 3D data as input to noise protection systems the city model must be available in the form of a block model. A simplified roof can be included as a prism on top of the building if attributive information on the average height of the eaves and ridge height is available. In addition road and green areas (stored in the MZK) provide information about areas with different acoustical absorption.

Urban Planning

The higher highrise-buildings are, the more interesting they are to investors. When determining the height of buildings, city planners try to avoid negative impact on sensitive parts of the city. The aim is to find the optimum height for the project site at which the highrise will not be visible from critical points in the city. This optimisation is practically impossible using conventional methods, but the 3D city model can solve this task in just a few hours: the city model with correct roofs is converted into a GIS-compatible grid height model. This model can then be used in GIS to carry out the optimisation process using visibility analyses.

Integration of subterranean structures in the 3D city model started in the year 2005. At the moment 9 kilometres of the Viennese line network have been recorded to date. The subterranean models are saved in ArcSDE for 2D and 3D utilization.

Until the middle of 2007 the facilities of the 35 km of underground train will be incorporated with the help of the existing design drawings, which are mostly available in hard copy only. 3D modelling is carried out by the CityGRID system using digitized structure lines of subterranean facilities. Relevant elements in the interior of the underground train facilities can also be modelled.

Architectural Competitions

Different designs submitted in the course of an architectural competition should be evaluated using an objective basis. The 3D city model can provide a standard framework for all participants and ensure that results can be compared. The city model in the project neighbourhood should be a roof shape model, ideally with textured facades. Using 3D visualisation module, submitted designs can be simulated and assessed in different variants in an interactive 3D visualisation.

Supply Line Management

Additional underground supply lines must be planned especially carefully in city centres. The countless existing supply lines limit the available space, and traffic obstructions due to excavation should be kept to a minimum. Exact information on underground structures saves considerable time and money, especially when pipes must cross underground railway lines. So, 3D simulation and optimization may be realized already in an early state of the planning process. By that way planning errors can be avoided and constructional measures are minimized.

Actually, all elements of the supply line 'cadastre' are at least available in 2D. The underground train system managed in the subterranean city model is available in 3D. The city department of electronic data processing will take this occasion to improve the supply line cadastre to 3D also.

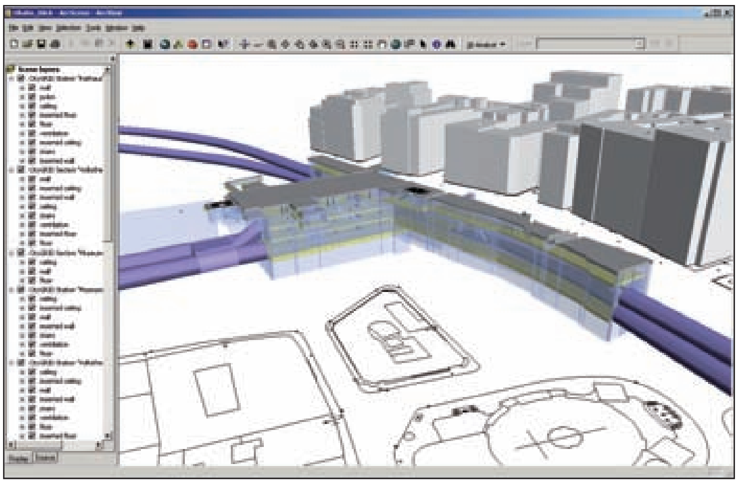

Figure 4: 3D presentation of an underground train system.

Transport Services

Underground railway stations are often complex structures, especially those that are hubs. In addition to the multi-level areas and stairways accessible to the public, stations also include service rooms, ventilation structures, connecting passages and the like. In general, all rooms have a fire alarm sensor, which, in the case of a fire, reports the code of the room where the fire is located to the central office. Actually locating the room on site in the station is often difficult using conventional 2D plans, even in the case of a false alarm where smoke does not obstruct the view. 3D representations of the station offer a crucial orientation aid and help emergency workers reach the position reported by the alarm faster.

Therefore the possibility of showing underground stations in a GIS-based guide system along with other safety-related constructions is not only nice to have, but is an essential component of an up-to-date emergency system. In this context the above-ground city model also provides valuable information on the station's surroundings.

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