On the convergence of 3D-GIS, CAD and 3D Simulation

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Urban information space

Due to improved tools for the design and acquisition of 3D models, to the wider acceptance of 3D technology, and 3D spatial databases the creation and management of urban information spaces representing entire cities in the virtual world is feasible nowadays. The urban information space is not limited to 3D building geometry but includes building semantics as well providing necessary information for urban planning, construction and management. However, sharing information between professionals from various disciplines and non-professional users such as citizens affected by planning proposals is a big challenge for the future. Currently, traditional disciplines such as architecture, civil engineering and GIS create classic information islands with different focus. Usually GIS is used to represent the current status of a whole city for administrative purposes. In contrast, planning and construction professionals focus on the future shape and status of a relatively small part city or just individual buildings in very high detail. In general, three categories of urban geo-information can be distinguished:

- GIS: two-dimensional maps, digital terrain model, 3D buildings with simple geometry of the entire city
- CAAD: detailed building models including interior
- BIM: building information model including information about structure and usage of individual buildings and their interior up to urban quartiers.

Due to the historic development of domain-specific applications, systems and formats, the different data sources are not interoperable per se. Döllner and Hagedorn (2007) have shown an integration of these data on visualization level using a servise-based 3D viewer based on the OGC Web Service Initiative 4 (OWS-4). However, new challenge such as disaster management, sustainable development, and energy-efficiency require do not only require an integration on visualization level, but an integration and convergence on data model level to enable intelligent data processing on city scale level.

Urban simulation

Integration and convergence on data model level is a key enabler to simulate an entire urban environment including building models from block data to architectural design, areal and underground infrastructure as well as airborne and terrestrial sensor observation data such as thermal sensors, image and laser data. The ability to simulate entire urban environments has implications for urban planning including the ability to simulate urban redevelopment projects, noise pollution, daylight simulation, wind modeling, emergency planning, and energy-management.

For example, urban quarters generally lack efficient energy management, which causes primary energy losses of up to 30% of the actual energy efficiency potential of the urban site[1]. A reduction of the CO_2 emissions of urban quarters of only 10 % respectively 150 Million

[1] Research projects on renewable energy management in buildings, "Solar optimized passive Buildings", UAS, 2001-2004

tons would mean an enormous impact on EU greenhouse gas avoidance efforts. The inefficient urban energy management is mainly caused by a missing integration platform, where data from the demand side, such as commercial, residential or public buildings (energetic performance, energy consumption, user behavior etc.) and from the supply side (district heating systems, district cogeneration, renewable energy systems, etc.) can be collected and implemented in an efficient urban site energy management system.

3D Geospatial Data Infrastruture

To achieve the integration a 3D geospatial data infrastructure has to be build in order to connect the existing information islands. The core component of this data infrastructure is a domain specific ontology that specifies the knowledge stored in the overall city information model. CityGML (Gröger et al. 2008) is a candidate for such an ontology. It was accepted as an OGC standard for the representation, storage and exchange of virtual 3D city and landscape models. CityGML is based on a rich, general purpose information model in addition to geometry and appearance information. For specific domain areas, CityGML also provides an extension mechanism to enrich the data with identifiable features under preservation of semantic interoperability. This extension mechanism is essential to make use of CityGML in other applications such as flood simulation (Schulte and Coors, 2008) and energy management. From BIM, the industrial foundation classes (IFC) developed by the International Alliance for Interoperability (IAI 2007) is a well defined data model for data interchange of building information models. The definition of a mapping of both CityGML and IFC is a future challenge that would result into a city information model at all levels from city wide models to high detailed building information model.

The second challenge towards a 3D geospatial data infrastructure is the definition of standard interfaces to access distributed data sources. These interfaces will enable individual access to the relevant information sources for a specific task. The OGC working group 3D Information Management (3DIM) is developing such interfaces to support a framework of data interoperability for the lifecycle of building and infrastructure investment: planning, design, construction, operation, and decommissioning. The following example on e-Participation will show the potential of such a 3D geospatial data infrastructure.

Using 3D urban models in e-Participation

The strategic goal for 2010 set for Europe is "to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion." (Lisbon European Council, 2000) This new style of society is defined as the 'Information Society', in which low-cost information and Information Communication Technologies (ICTs) are in general use. eGovernment has been defined as one of the most important goals in achieving the Information Society (European Commission, 2005a), which intends to provide the public with the services of government. As one of the most important section of eGovernment, ePlanning is about using ICTs to facilitate the urban planning process, with the support of government policy (Communities and Local Government, 2004). The aim of ePlanning is to enable easy access to information, guidance and services that support and assist planning applicants, and streamlined means of sharing and exchanging information among key players. As traditional planning process, socio-economic, environmental and natural resource issues need to be considered in ePlanning to ensure urban sustainable development and to enhance the quality of human life.

The public is the most essential stakeholder in urban planning and should be considered carefully in the urban planning process, since they consist of the most un-powered group (Vasconcelos et al., 2000). It is no doubt that efficient public participation can help government officials and other professionals to create better planning alternatives. In the context of eGovernment and ePlanning, one of main aims of the Information Society is to enhance the dialogue between the public and authorities, based on the sharing of information and the genuine participation of social groups at various levels (European Commission, 2004). In order to achieve this aim, an important concept, the 'eInclusion', is introduced by the umbrella strategy of i2010 launched by the European Commission, which 'ensures all people, especially the poor, the uneducated and the unskilled ones have access to this new society and benefit equally from ICTs for network strengthening, information sharing, creating knowledge resources and developing skills necessary for life/work in the new digital environment' (European Commission, 2005b).

Many local authorities have employed new ICT to provide different eGovernment services in Europe. The need for assistance in performing all these ePlanning and eParticipation activities has led to the rapid development of urban information systems, especially ePlanning systems.

ePlanning systems are based on a range of ideas and technologies that have been emerging over the last ten years. It offers considerable opportunity for early and rapid change to the future delivery of planning services, with an emphasis on electronic delivery. Main aims of ePlanning are to enable more people to get involved in planning; to increase openness, efficiency and effectiveness; and to arrange the delivery of planning services to meet citizens' needs.
Many authors argue that ePlanning systems offer the potential to improve the current situation in the consultative urban planning process, with the support of three main technologies, i.e. the Internet, Geographic Information System (GIS) and Virtual Reality (VR). There is a considerable amount of research to combine the three technologies for use in urban and environment systems (Batty et al., 1998; Golubovic Matic, 2006). The rapid development of these technologies provides new opportunities to make better use of resources.

Information, communication and co-operation are the basics of effective ePlanning and especially transparent public participation. New media offers a lot of possibilities to supplement the common participation instruments strengthened by demands of the EU to enhance e-democracy and e-participation. Using GIS and CAD data to generate 3D-urban-models, will utilize already existing planning data in a new way. 3D-visualistion of spatial data improves the understanding of spatial relations for non-professionals and therefore will lead to a better understanding of the consequences caused by planning alternatives. People might be able to evaluate and rate the planning much better as they were able to do by only having 2D maps and reports written by experts. Offering 3D-visualisation via internet, the range of residents achieved by participation measures might grow and also reach people who were not participating before (widen the group of approached people).
Using the internet enables the public to participate independently of time and space. Therefore, the information offered via websites has to be unambiguous, detailed and easy to understand. Reports and common 2D maps can be supplemented by 3D models, which may help to understand clearly the statement of planning proposals.

One example is the OPPA-3D software developed in the EU-funded project "Virtual Environment Planning System" (VEPs) (Knapp et al 2008). It supports interactive web based applications to help people understand planning proposals, through realistic models of existing buildings that allow for exploration and discussion. Generally speaking, it has been developed to provide an alternative approach to planning consultation, allowing people to view and make comments on planning developments in 2D/3D within the context of an existing landscape or cityscape. The developed web applications can be linked to environmental information and urban simulations, such as flood modeling and noise propagation, to show how these might impact on the development. It can also be linked to discussion forums, for the sharing of views and the suggestion of alternative ideas related to proposed developments. By combining 3D views with discussion forums, VEPs allows people to freely explore and interact with 3D models and make comments directly via an online system. Anyone accessing the web application will be able to view these comments and share their own views online. As the VEPs tools are web-based, they will be available 24 hours a day, enabling people to view and comment on proposals without visiting a local planning office.

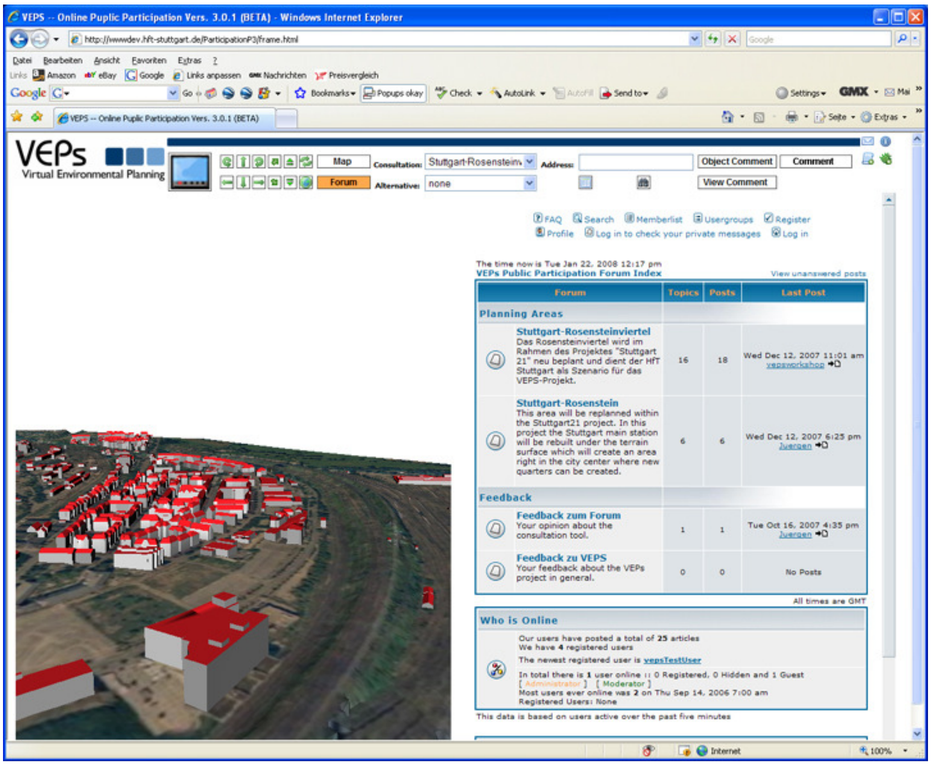

Figure 1: OPPA 3D

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