# International Workshop on Next Generation 3D City Models

## Workshop report

This workshop was held at the Club of the University of Bonn, 21-22 June 2005.

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## Introduction

126 delegates from Austria, Belgium, Croatia, the Czech Republic, Denmark, Finland, France, Germany, Iran, Kosovo, The Netherlands, Northern Ireland, Norway, Spain, Sweden, Switzerland and the United Kingdom attended a Workshop on 'Next Generation 3D City Models' on 21-22 June 2005 in Bonn. The Workshop was organized by EuroSDR Commission 3, ISPRS WG III, the DGPF (Deutsche Gesellschaft für Photogrammetrie und Fernerkundung, German Society for Photogrammetry and Remote Sensing) and the University of Bonn.

The Workshop was opened by Wolfgang Förstner, Chair of ISPRS WG III, who welcomed the delegates to the Club of the University of Bonn. His presentation compared the current workshop with a similar workshop held at the University of Bonn 12 years ago. He pointed out the changes and advances made in the last 12 years and posed the main problems which are unsolved yet:

- GIS-CAD integration
- 3D-GIS -2D-GIS interface
- smooth scale transitions and efficient data acquisition for high resolution

Eberhard Gülch, President of EuroSDR Commission III, also welcomed the delegates. In his welcome address, he sketched the history of EuroSDR and pointed out the services EuroSDR offers to industry and the scientific community.

In his keynote address entitled 'The road from maps to 3D representations and beyond' Martien Molenaar, the director of the ITC, The Netherlands, drew a bow from earlier 2D maps to modern 3D visualizations and 3D topology and discussed the impacts of this paradigm shift in modeling on the GI sector.

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## Session 0: Results from EuroSDR Building Extraction Test

Juha Hyyppä presented the results of the EuroSDR Building Extraction project (Final report to appear as EuroSDR publication No. 50). The target of this project was to evaluate the quality, accuracy, feasibility and economical aspects of Semi-automatic building extraction based on photogrammetric techniques, on high density laser scanner data, and on the integration of laser

scanner data and aerial images. The methods which have been analyzed and compared were: Hamburg, Stuttgart, Dresden, Aalborg and Delft models, CyberCity, IGN, TerraScan, ICC, Nebel and Partner and C+B Technik (paper).

## Session 1: Modeling

This session chaired by Lutz Plümer began with a presentation by Jürgen Döllner from the Hasso-Plattner-Institute, University of Potsdam, entitled 'Smart Buildings - A Concept for Ad-Hoc Creation and Refinement of 3D Building Models'. He introduced the concept of 'Smart Buildings', which represent building models at different Levels-of-Detail and between discreet Levels-of-Detail at a continuous level of quality. The focus was on the automatic generation of building models on a coarse level, while in higher levels floor and wall prototypes are constructed manually or semi-automatically. Thematic and application-specific data can be attached to buildings or its parts (floors, walls, or wall sections). The concepts integrates different levels of detail respectively quality of buildings in a smooth manner and defines incremental transitions between the levels (paper).

In his presentation entitled '3D geo-information indoors: structuring for evacuation', Martijn Meijers from the TU Delft described a concept to derive the topological network structure of indoor configurations of buildings. This structure may be stored in a relational database and be used to compute evacuation routes by standard graph algorithms. Detailed access properties of the indoor elements may be assigned to the corresponding edge or node of the network and thus can be taken into account in the process of path finding (paper).

## Session 2: Modeling (cont.)

Andreas Geiger from the 'Forschungszentrum Karlsruhe' shed a light on the crucial interface between architectural models (CAAD) and GIS. In his presentation entitled 'Flexible Generation of semantic 3D Building Models', he introduces the 'QUASI' model for the out- and indoor modeling of buildings, which represents semantic and geometric aspects, the latter in a parametric manner. The focus is on the interface to the IFC (Industry Foundation Classes) building standard from CAAD. Methods to generate the footprint and the outer hull of building from IFC models and to map the thematic objects in both models are presented , facilitating the integration of both worlds (paper).

In her presentation entitled 'Integrating Urban Knowledge into 3D City Models', Claudine Metral from the University of Geneva applied methods from the fields of ontology languages and knowledge representation to integrate thematic knowledge into 3D city models. The aim is to improve communication of spatial, urban planning concepts to non-experts (paper).

Frank Thiemann from the Institute of Cartography and Geo-Informatics of the University of Hanover focuses in his presentation 'Interpretation of Building Parts from Boundary Representation' on the classification of building parts - walls, balconies. The result may be used for automatic texturing, labeling and generalization. The classification is based on a semantic building model with explicit spatial relations between building parts (paper).

Gerhard Gröger from the Institute of Cartography and Geoinformation, University of Bonn, discussed three dimensions of multi-representation necessary for the sustainable management and continuation of 3D city models: Level-of-detail, concurrent planning versions, and history over time. In his presentation 'Integrating Versions, History, and Levels-of-Detail within a 3D Geodatabase ', he introduces a concept to integrate all three aspects in the framework of spatial relational database management systems (paper).

## Session 3: Acquisition and Applications

Linde Vande Velde from Tele Atlas, Belgium, opened the third session, which was chaired by George Vosselman. She proposed the introduction of 3D visualizations in displays used for navigation and Location Based Services. In contrast to navigation by car, pedestrians need support in choosing the direction to move, which can be achieved by 3D visualizations of city models in multiple levels-of-detail. The focus was on cost-efficient methods to acquire such models by using image sequences (paper).

Frank Bildstein from Rheinmetall Defence Electronics, Bremen, presented typical applications of 3D city models for simulation and training purposes in his presentation '3D City Models for Simulation and Training - Requirements on Next Generation 3D City Models'. The demands and requirements these applications pose to the city models were discussed in detail, including the appropriate Level-of-Detail. Finally, the workflow from the source GIS data to the final simulation and visual databases using texture libraries and 3-D prototypes was illustrated (paper).

The presentation 'Efficient reality-based 3D City Modeling with CyberCity Modeler - Management in ArcGIS (ESRI) and Visualization with Terrainview ' by Kilian Ulm from CyberCity, Switzerland, describes the whole workflow of generating large-area 3D city models, starting with the semi-automatic acquisition from stereo aerial images or laser scanner data. The facades and roofs of those models are textured automatically, by means of aerial images. For the sustainable management of the models, standard relational databases are employed. These data may be accessed by standard GIS, or by tools for real-time visualization of large data sets using streaming and level-of-detail techniques (paper).

The day concluded with a very enjoyable dinner at the famous 'Brauhaus Bönnsch'.

## Session 4: Visualization

The session on visualization was chaired by Juha Hyyppä. The first talk was from Jörg Haist from the Fraunhofer Institute for Computer Graphics (Fhg IGD) on 'The W3DS-Interface of CityServer3D'. CityServer3D is a modular system for building 3D GIS applications developed at the Fhg IGD. It was shown how an OGC conforming Web 3D Service (W3DS) could be set up as a web interface to the system. Furthermore, client development for mobile devices was discussed (paper).

Gunnar Misund and Morten Granlund from the Department of Computer Science, Ostfold University College in Norway, discussed 'Global Models and the W3DS Specification – Challenges and Solutions'. They identified problems wrt. to the 3D geo-visualization using the OGC Web 3D Service on a global level. In order to allow the navigation within a W3DS delivered scene down to the scale of the whole earth, they propose to extend the W3DS output by multi-scale scene graphs with specific links between different scales. They also discussed the possibilities and performance issues of on-the-fly generation of 3D models by a W3DS (paper).

Daniel Patel from Christian Michelsen Research, Bergen in Norway, talked about 'FAVEum - Framework Architecture for Virtual Environments applied to Urban Modeling'. FAVE is a generic software framework for developing VR applications. Specific metaphors and techniques within the 3D graphical user interface have been developed and evaluated in the context of a 3D urban modelling application. It was shown how these techniques facilitate urban planning and risk analysis (paper).

In his presentation on 'Real-Time Non-Photorealistic Rendering of 3D City Models' Henrik Buchholz from the Hasso-Plattner-Institute, University of Potsdam, showed new methods for the illustrative and expressive rendering of virtual 3D city models. NPR techniques can be used if there are no textures available, but they can also be used to provide a more cartographic or sketchy styling of the 3D objects. This is especially relevant when uncertainty about the correct shape and geometric accuracies should be expressed. The presentation explained how coloring, shadow casting, facade texturing, and edge stylization are implemented for real-time rendering (paper).

## Session 5: Industrial & Systems Session

This session was chaired by Gerhard Gröger and was dedicated to short presentations and information about the sponsoring companies.

Lars Bodum: 'GRIFINOR – An Object-Oriented Approach to 3D Geovizualisation of City Models'

Thomas Liebich: 'Harmonisation and mapping between IFC and gml developed within the Norwegian IAI/IFG project'

Mike Eissele: 'Nexus – Spatial World Models via GML'

Carsten Tille: '3D-Printing and Stereolithography – powerful manufacturing tools for textured and high-precision 3D city models'

André Streilein-Hurni: 'Statewide Topographic 3D Model of Switzerland'

Thomas H. Kolbe: 'CityGML - Interoperable Access to 3D City Models'

Company CPA Geo-Information GmbH, Siegburg, Germany: 'Deriving 3D City Models with SupportGIS'

Company TopoSys Topographische Systemdaten GmbH, Biberach, Germany, presented their product and service portfolio

Company 3D Geo GmbH, Schwielowsee, Germany

Company GTA Geoinformation GmbH, Neubrandenburg, Germany

## Session 6: Integration

Session chair: Eberhard Gülch

In the first talk in this session Volker Coors presented his work on 'Compressed 3D urban models for Internet-based e-Planning'. He introduced a new simplification method for 3D meshes called Delphi compression which is an advancement of the Edgebreaker algorithm. By using the the proposed method the geometry of 3D urban models can be reduced down to 5% of its original size (paper).

The presentation of Andreas Koch was on 'An Integrated Semantically Correct 2.5D Object Oriented TIN'. 2D Digital Landscape Models (DLM) are integrated with Digital Terrain Models in a consistent way with respect to topology, geometry, and semantics. The DLM elements like streets and lakes are introduced as break lines into the TIN. In order to ensure the correct morphology, class specific constraints on the object heights are incorporated. For example, all points and the shore line of lakes have to have same absolute height and have to be lower than the surrounding terrain (paper).

Stefan Kampshoff discussed 'Mathematical Models for Geometrical Integration'. He has derived a model for geometrical integration that allows to simultaneously integrate heterogeneous 3D spatial objects from fragmented sources into one consistent dataset. For homogenization, Kampshoff chooses the deterministic model of the topology of the euclidean plane where the connection between the true map and observed maps is treated as a homeomorphism. The model allows to estimate the unknown parameters (coordinates) in the

system of the true map and to simultaneously consider geometrical constraints, the linear trend, the nonlinear signal and the random noise (paper).

Hardo Müller showed in his presentation on 'Extending 2D Interoperability Frameworks to 3D' how complex 3D models can be stored and managed with current (geo) relational database systems. OGC's Web Feature Service is used as an interface to the storage component being independent from the supported geometry types on the database level (paper).

With 'A Model-driven Geospatial Content Management Framework with Support for 3D City Models' Stephan Nebiker presented a concept and system for 3D geo content management. The proposed geo-content exchange language GXL integrates 0D to 3D geographical objects, multimedia elements, symbols and appearance information. It is applied as an authoring language and exchange format within the Geo-Roaming project, which is a software framework for managing, updating and seamlessly accessing distributed 3D geoinformation services (paper).

## Closing Session

In his summary talk Peter Woodsford, President of EuroSDR Commission V, provided an excellent and critical review of the main topics and issues that have been presented and discussed during the workshop.

Finally, Thomas H. Kolbe closed the workshop thanking all presenters and the delegates for the high quality contributions and the fruitful discussions. A special thank was addressed to the local organizing committee and the supporting companies.

## Thanks

Thanks are due to the University of Bonn for their splendid facilities, to the local organizing committee: Viktor Stroh, Gundula Schmacke and Udo Quadt for excellent local arrangements and for maintaining the website, and to all presenters and delegates for a very lively and stimulating workshop. A special thank also goes to the members of the Programme Committee for their help in selecting the papers in order to offer a high quality programme.

Gerhard Gröger and Thomas H. Kolbe
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