11 December 2007, Delft, The Netherlands

The 3D Topography project - background

- Introduction
- Status
- Results
- Agenda for today

Peter van Oosterom (TU Delft)

Project Goal

- Enforce major break-through in the application of 3D Topography in corporate ICT environments due to structural embedding of 3D methods and techniques

- So: more than ad-hoc model visualization
- Two international top-ups:
  - RGI-011A: model comparison
  - RGI-011B: tetrahedron network computation

Partners

- TU Delft
- ITC
- Topografische Dienst Kadaster
- Rijkswaterstaat – Adviesdienst Geo-informatie en ICT
- Oracle USA & NL
- NedGraphics CAD/GIS B.V.
- Stuurgroep AHN

Added partners

- RGI-011A, 3D model comparison:
  - TU Vienna (Andrew Frank)
  - City University London (Jonathan Raper)
  - University College London (Paul Longley)
  - University of Glamorgan (Chris Gold)
  - Sweco (private company) Sweden (Ludvig Emgård)
  - Queensland Government (Rod Thompson)
- RGI-011B, tetrahedron computation:
  - Weierstrass Institute for Applied Analysis and Stochastics, Berlin (Hang Si)

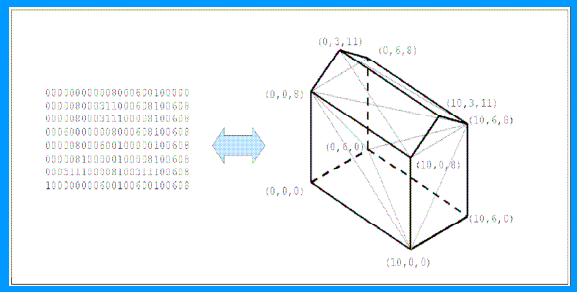
Facts and figures – Period

- RGI-011, 3D topography:
  Period 11-01-2005 – 31-12-2008
- RGI-011A, 3D model comparison:
  Period 01-01-2007 – 31-12-2008
- RGI-011B, tetrahedron computation:
  Period 01-09-2007 – 01-09-2008

Position within RGI/NGII

- Many indications of growing need of 3D topography as part of NGII framework data
- Our project analyses 4 use-cases: (Municipality Den Bosch, Google Earth at RWS, Lekdijk dike control, TOP10NL) support this
- Same is true at international level, both from demanding side (e.g. INSPIRE) and research side (→ top-ups)

3D data modelling (1/3)

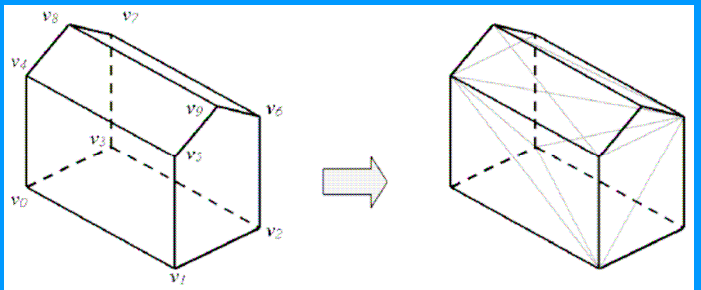


Objective: develop a data structure capable of handling large data volumes and offers support for querying, analysis and validation.

Model characteristics:
- full 3D decomposition of space;
- apply a tetrahedron structure;
- based on Poincaré simplicial homology as mathematical foundation.

Main researcher: Friso Penninga (TUD)

3D data modelling (2/3)



$$S_{31} = \langle v_0, v_1, v_2, v_4 \rangle \qquad \partial S_{31} = \langle v_1, v_3, v_4 \rangle - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle$$
$$S_{32} = \langle v_1, v_2, v_3, v_6 \rangle \qquad \partial S_{32} = \langle v_2, v_3, v_6 \rangle - \langle v_1, v_3, v_6 \rangle + \langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle$$
$$S_{33} = \langle v_1, v_3, v_4, v_6 \rangle \qquad \partial S_{33} = \langle v_3, v_4, v_6 \rangle - \langle v_1, v_4, v_6 \rangle + \langle v_1, v_3, v_6 \rangle - \langle v_1, v_3, v_4 \rangle$$
$$S_{34} = \langle v_1, v_4, v_5, v_6 \rangle \qquad \partial S_{34} = \langle v_4, v_5, v_6 \rangle - \langle v_1, v_5, v_6 \rangle + \langle v_1, v_4, v_6 \rangle - \langle v_1, v_4, v_5 \rangle$$
$$S_{35} = \langle v_3, v_4, v_6, v_7 \rangle \qquad \partial S_{35} = \langle v_4, v_6, v_7 \rangle - \langle v_3, v_6, v_7 \rangle + \langle v_3, v_4, v_7 \rangle - \langle v_3, v_4, v_6 \rangle$$
$$S_{36} = \langle v_4, v_6, v_7, v_8 \rangle \qquad \partial S_{36} = \langle v_6, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_6, v_8 \rangle - \langle v_4, v_6, v_7 \rangle$$
$$S_{37} = \langle v_4, v_5, v_6, v_8 \rangle \qquad \partial S_{37} = \langle v_5, v_6, v_8 \rangle - \langle v_4, v_6, v_8 \rangle + \langle v_4, v_5, v_8 \rangle - \langle v_4, v_5, v_6 \rangle$$
$$S_{38} = \langle v_5, v_6, v_8, v_9 \rangle \qquad \partial S_{38} = \langle v_6, v_8, v_9 \rangle - \langle v_5, v_8, v_9 \rangle + \langle v_5, v_6, v_9 \rangle - \langle v_5, v_6, v_8 \rangle +$$

$$C_3 = - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle + \langle v_2, v_3, v_6 \rangle + \langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle - \langle v_1, v_3, v_6 \rangle - \langle v_1, v_4, v_6 \rangle - \langle v_1, v_4, v_5 \rangle - \langle v_3, v_6, v_7 \rangle + \langle v_3, v_4, v_7 \rangle + \langle v_6, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_6, v_8 \rangle + \langle v_4, v_5, v_6 \rangle + \langle v_5, v_6, v_9 \rangle - \langle v_5, v_8, v_9 \rangle + \langle v_5, v_6, v_8 \rangle$$

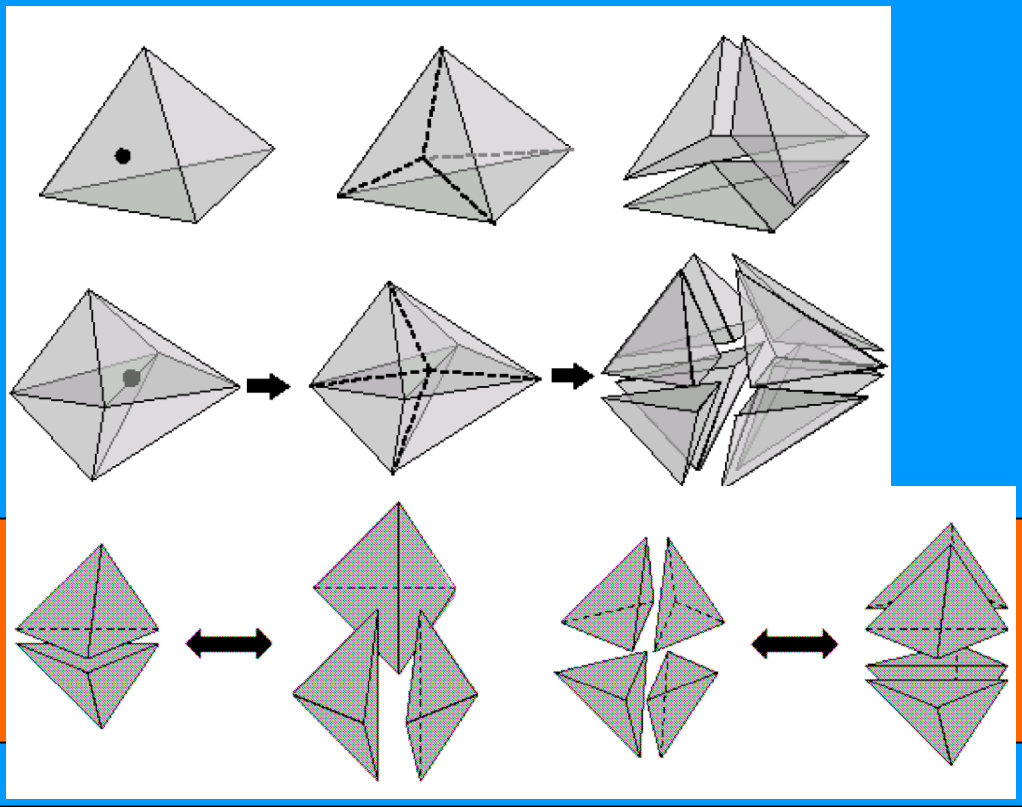
Results:

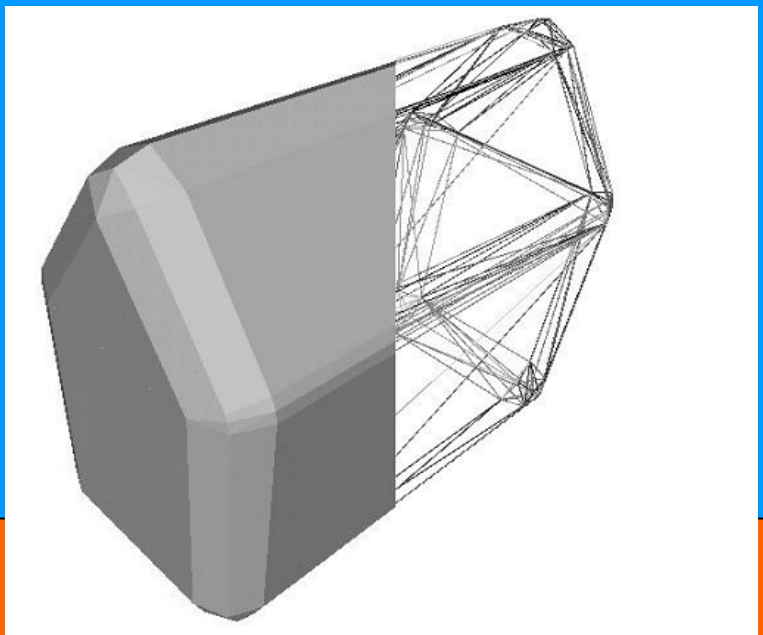
- a new innovative approach to 3D data modelling;
- validation and analysis through topology
- reduces data storage (stored in one single-column table!);
- no explicit updates of topology and less dimensional simplexes;
- full control over orientation;
- based on a solid theoretical foundation (100 years old math).

3D data modelling (3/3)

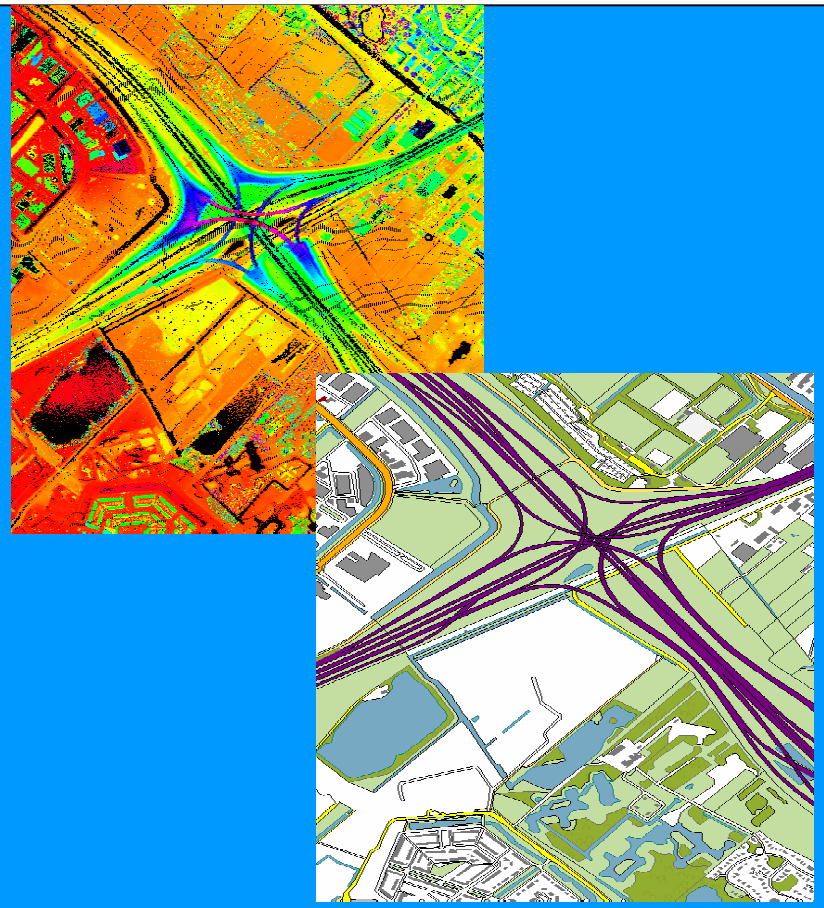
Updating and querying the DBMS with 3D data
Compare TEN structure to alternative (top-up RGI-011A)
Initial computing and updating TEN (top-up RGI-011B)

Types of operations: buffer, overlay, topology, metric (volumes, distance),…





3D data acquisition (1/3)



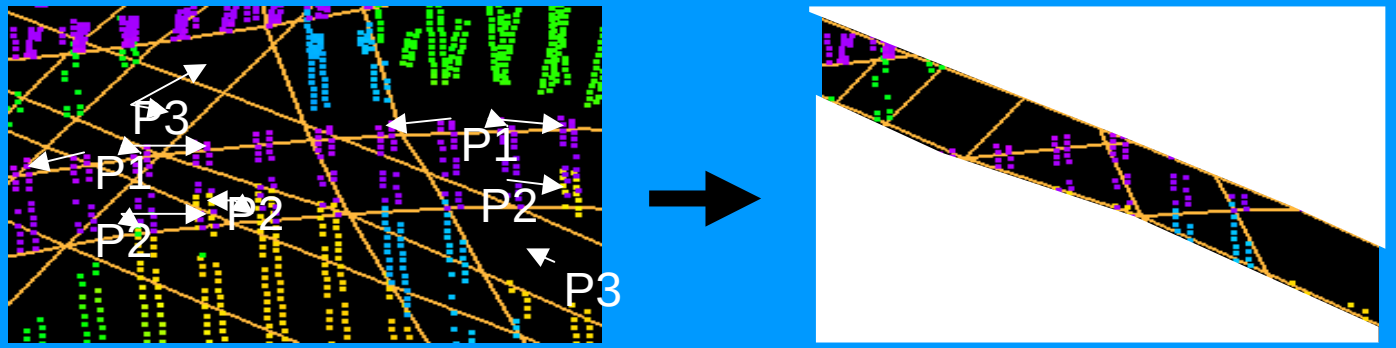
Objective: develop an automated 3D data acquisition method, by integrating laser altimetry data with 2D GIS data.

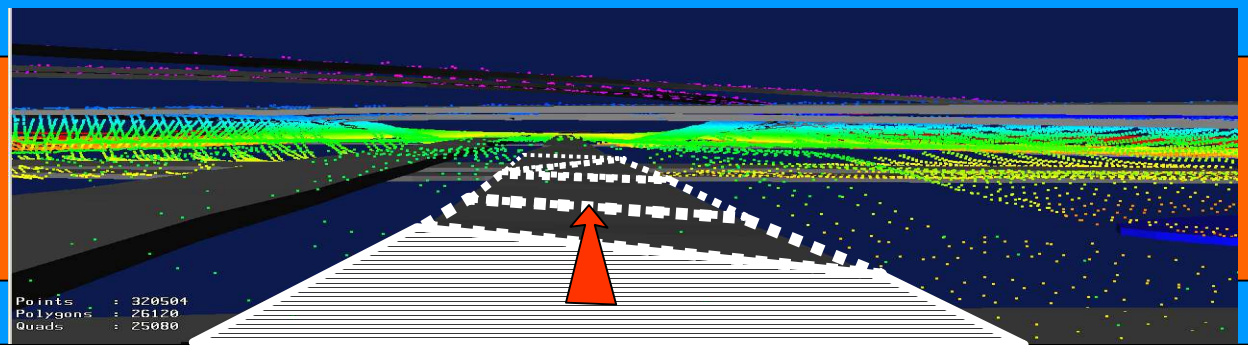
Main researcher: Sander Oude Elberink (ITC)

3D data acquisition (2/3)

3D acquisition algorithm:

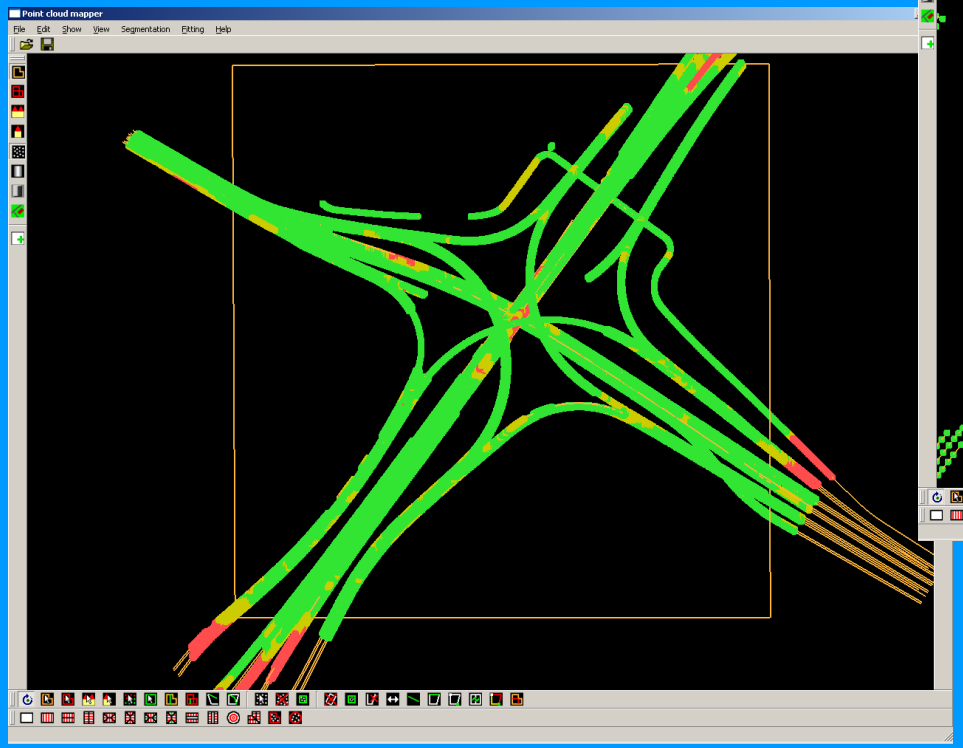
- segmentation based filtering of small objects in laser data;
- assigning laser data to map data in a sophisticated map and laser growing & fusion algorithm;
- integrating object knowledge to produce horizontal lakes and smooth roads;
- additional 3D boundaries have automatically been reconstructed to allow the reconstruction of 3D objects.

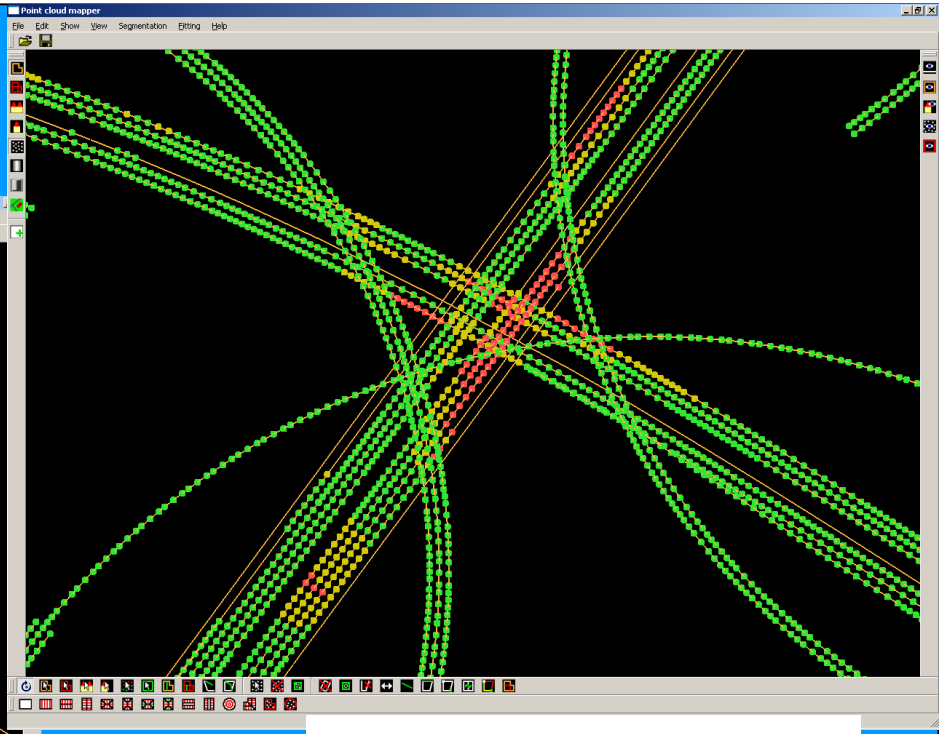




3D data acquisition (3/3)

Quality check





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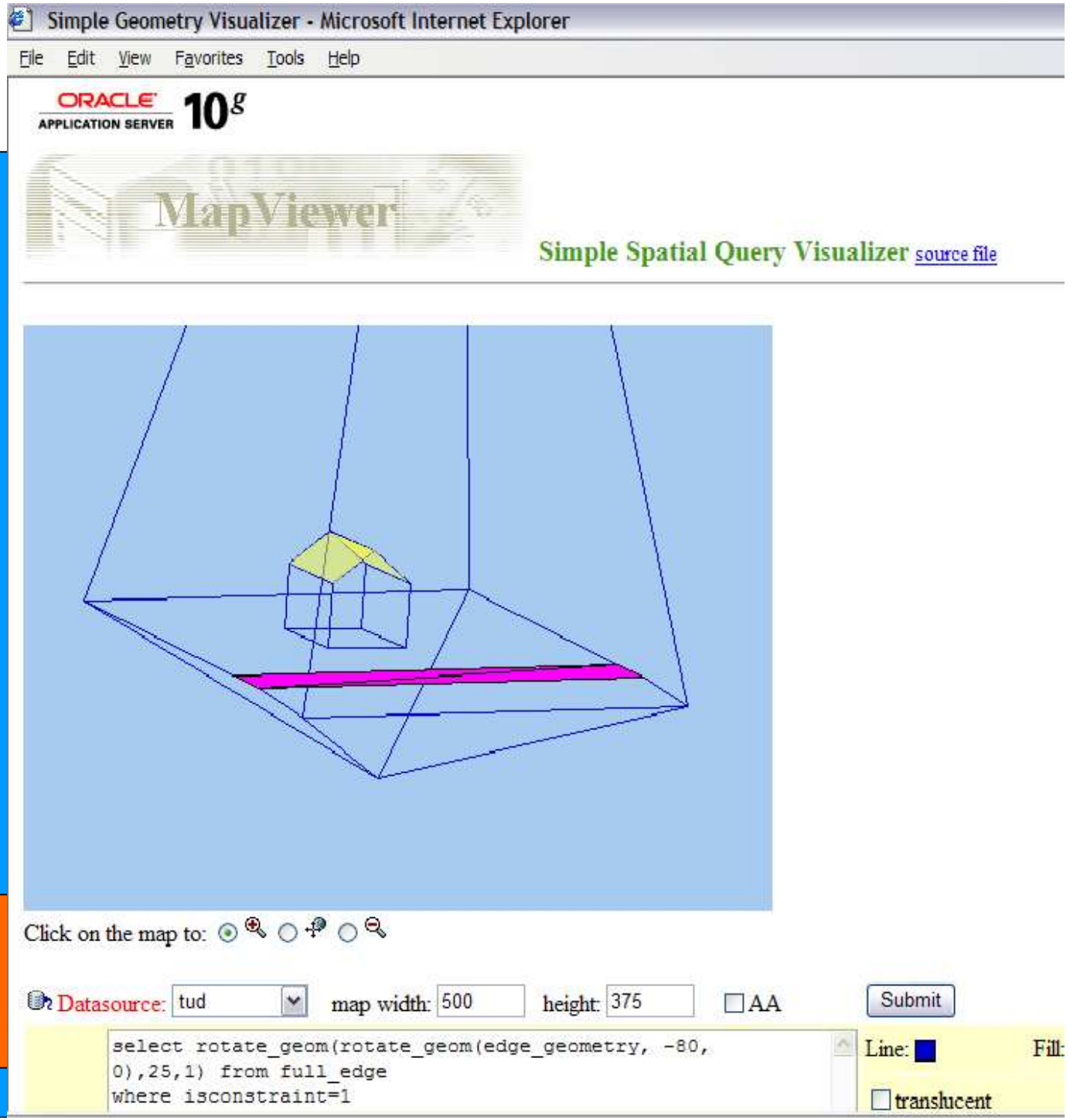
Quality check: compare with accurate DTB

Results, successes

- Geo-Innovation award, category Science
- Geo-Info magazine prize best paper
- Oracle 11g with 3D functionality
- Automated reconstruction
  Prins Clausplein
- TUD campus
  test data
- TEN prototype

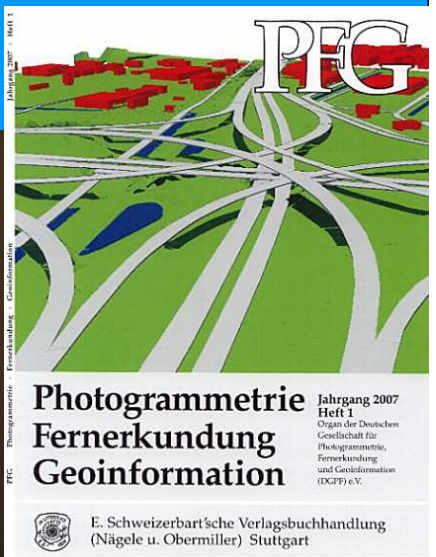
Results

- First TEN structure in DBMS
- Simple toy world



Relevance scientific/society

- So far: 17 conference papers, 6 professional publications, 6 reports and still counting!
- 3 PhD's: first 10 dec'07, next '08 modelling '09 aquisition
- 2 accepted papers for peer-reviewed journal
- Upcoming event: 2nd International Workshop on 3D Geo-Information: Requirements, Acquisition, Modelling, Analysis, Visualisation 12-14 December 2007, Delft, the Netherlands
- Workshop User requirements 3D Topography apr'06 (in Dutch, about 80 attendants, good press)



Agenda, tentative

9:00	background
10:30	international experience
12:30	lunch
13:30	international experience
14:30	admin&financial issues
15:00	related presentations
16:00	joint report
17:00	drinks

Evening of lights

- Location: center of Delft, Markt
- 19:00 Bas Verkerk, burgemeester van Delft, lights the Christmas tree
- Followed by singing and various other performances (by Santa et al)

Goal of today

- Understand different approaches to 3D modeling, article/report (per partner)
- Compare different approaches by applying it to the same test data set (campus TUD)
  - Explanation of test data
  - Test data experiences with different models
- Preparation of a joint comparison report

What to compare?

- 3D model requirements
  - type of model (main structure)
  - Implementation (environment, DBMS)
  - initial creation of data sets within model
  - model use (analysis, query, visualization)
  - model update
- Presentations on project website

3D Topography

www.rgi-otb.nl/3dtopo

www.3D-GeoInfo-07.nl