



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 Geoinformatie 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

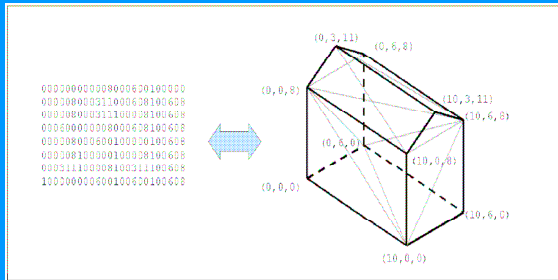


Position within RGI/NGII

- 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.

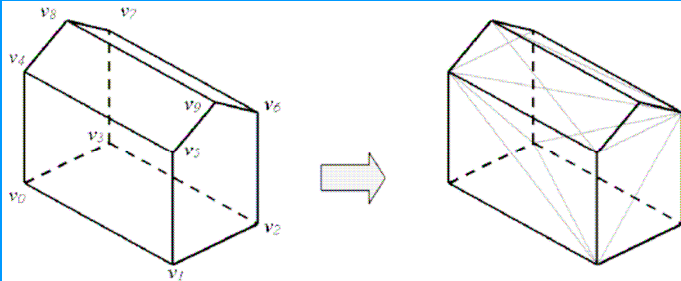
Model characteristics:

- 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)



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

$$\begin{aligned}
 C_3 = & - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_2 \rangle + \langle v_0, v_3, v_6 \rangle + \\
 & \langle v_1, v_3, v_6 \rangle - \langle v_1, v_3, v_2 \rangle - \langle v_1, v_3, v_5 \rangle - \langle v_1, v_4, v_5 \rangle - \langle v_1, v_6, v_7 \rangle \\
 & + \langle v_3, v_4, v_7 \rangle + \langle v_5, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_5, v_8 \rangle + \\
 & \langle v_5, v_6, v_8 \rangle - \langle v_5, v_6, v_9 \rangle + \langle v_5, v_5, v_5 \rangle
 \end{aligned}$$

Results:

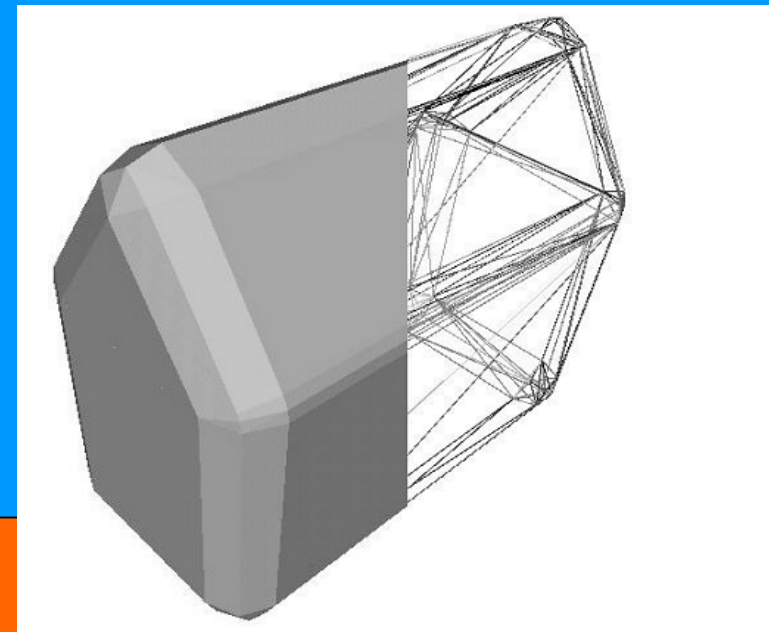
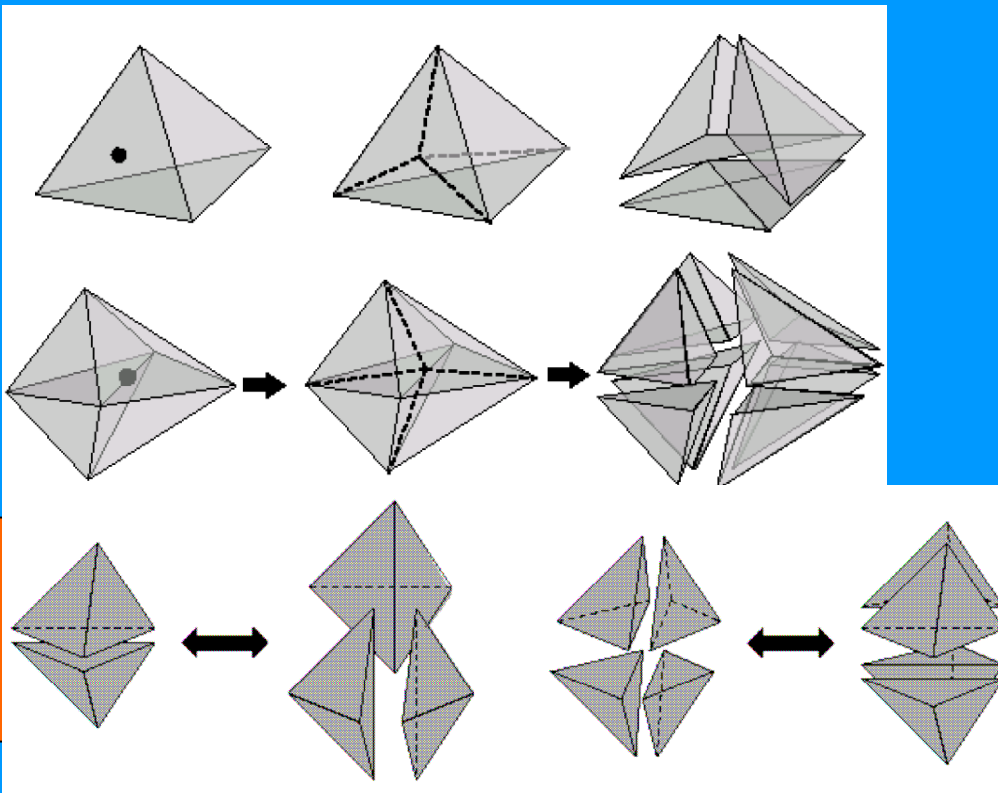
- a new innovative approach to 3D data modelling;
- validation and analysis through topology
- reduces data storage (stored in one single-column table!);
- no explicit updates of topology and less dimensional simplexes;
- full control over orientation;
- based on a solid theoretical foundation (100 years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



3D data modelling (3/3)

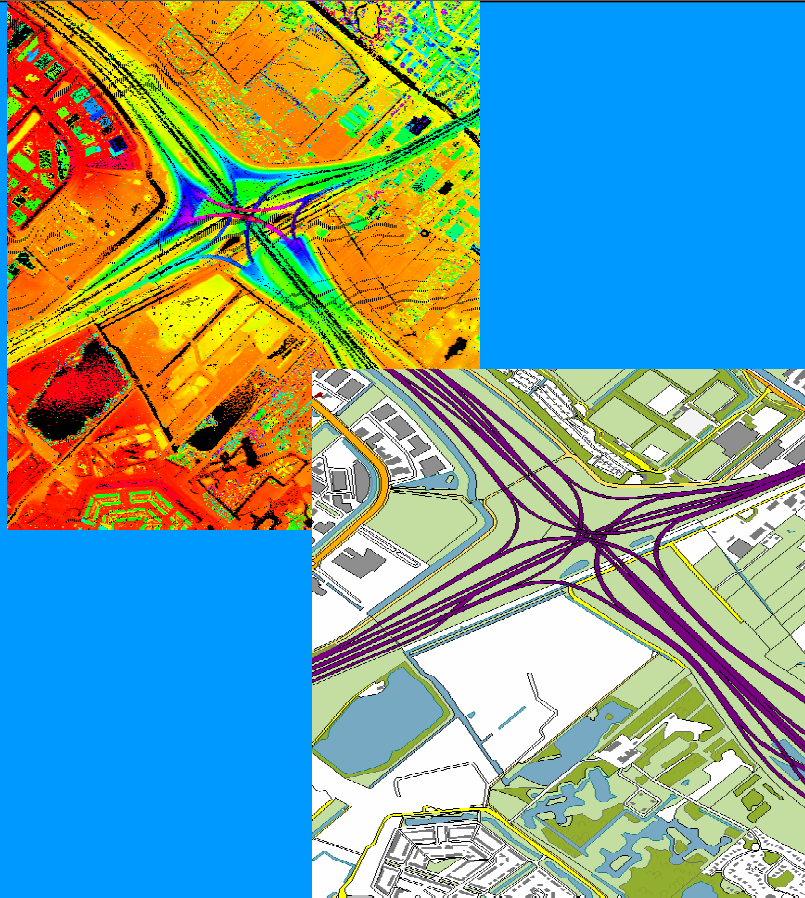
Updating and querying the DBMS with 3D data
Compare TEN structure to alternative (top-up RGI-011A)
Initial computing and updating TEN (top-up RGI-011B)

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.

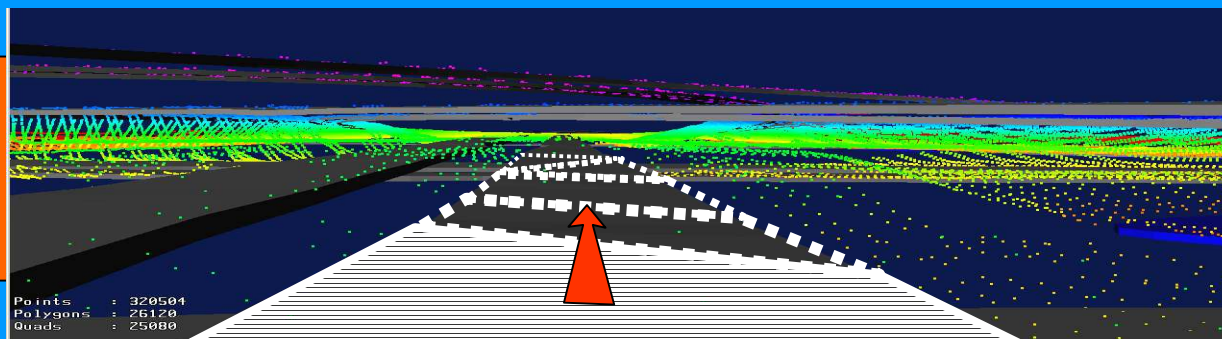
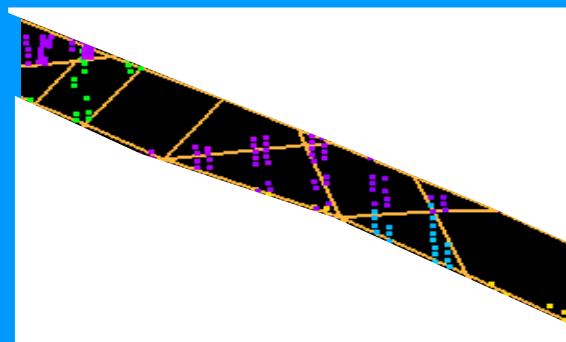
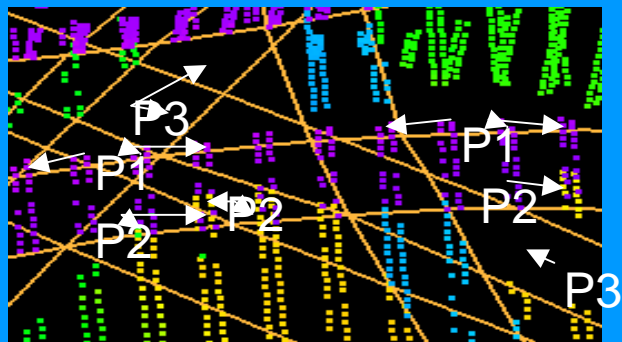
Main researcher: Sander Oude Elberink (ITC)



3D data acquisition (2/3)

3D acquisition algorithm:

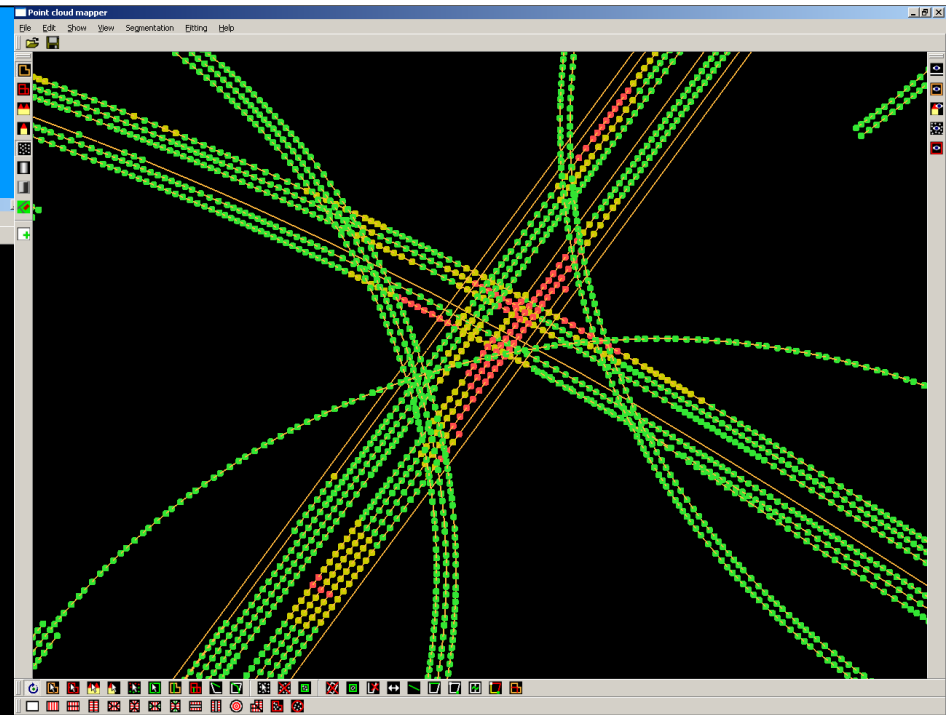
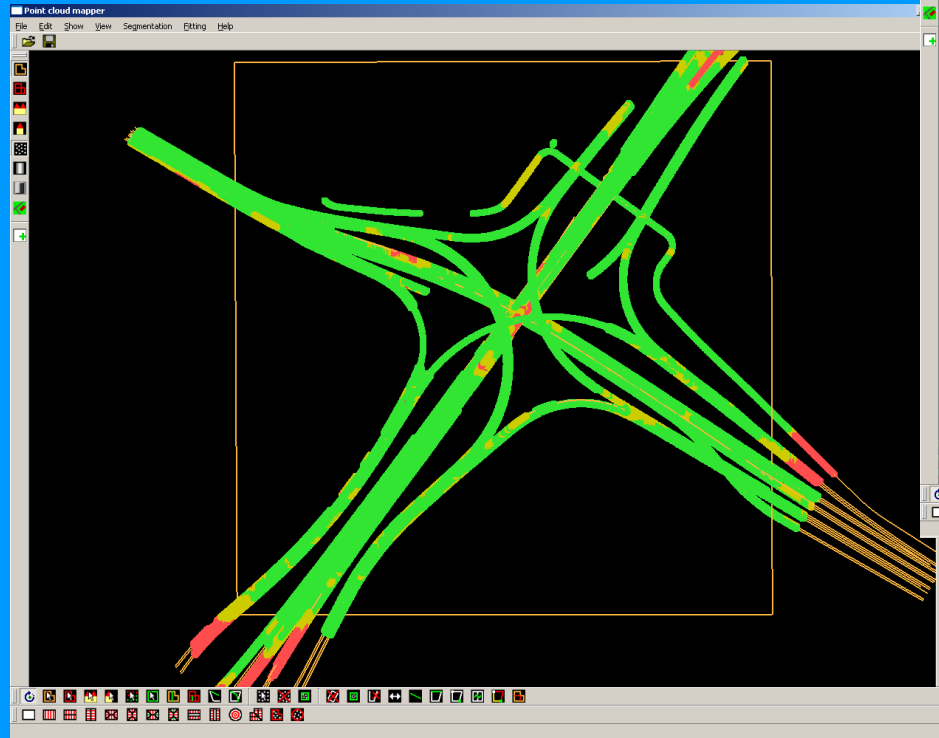
- segmentation based filtering of small objects in laser data;
- assigning laser data to map data in a sophisticated map and laser growing & fusion algorithm;
- integrating object knowledge to produce horizontal lakes and smooth roads;
- additional 3D boundaries have automatically been reconstructed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





3D data acquisition (3/3)

Quality check



<0.2 m green
0.2 – 0.5 m yellow
>0.5 m red

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

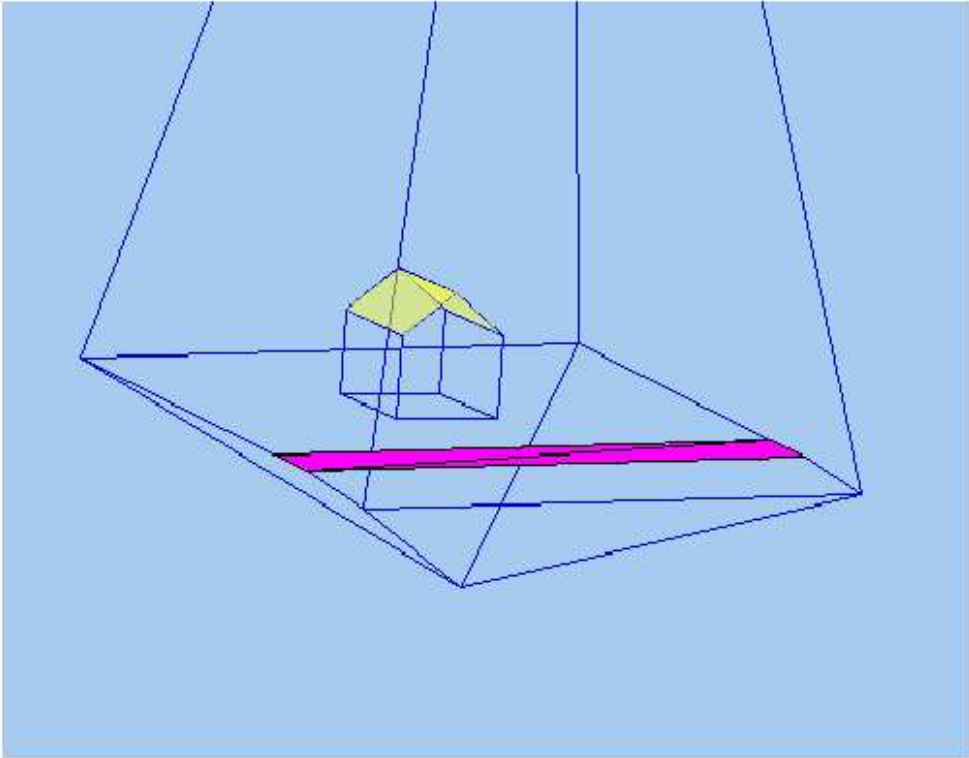
Simple Geometry Visualizer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

ORACLE APPLICATION SERVER 10^g

MapViewer

Simple Spatial Query Visualizer [source file](#)



Click on the map to:

Datasource: tud map width: 500 height: 375 AA

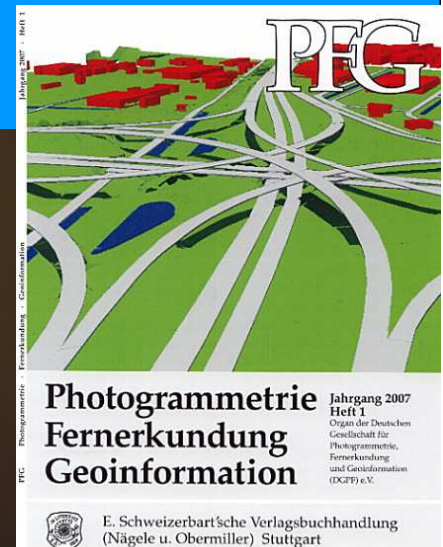
```
select rotate_geom(rotate_geom(edge_geometry, -80, 0),25,1) from full_edge where isconstraint=1
```

Line: Fill: translucent



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

RGI-011: 3D Topography

click here

HOME
project home
partners
events
publications
intranet
links

NEWS -- 3D topography project initiates international workshop 3D GeoInfo 07

3D-geoinfo07

From 12-14 December 2007, TU Delft will host 3D GeoInfo 07, the 2nd International Workshop on 3D Geo-Information: Requirements, Acquisition, Modelling, Analysis, Visualisation. The Workshop aims at bringing together international state-of-the-art research in the field of 3D geo-information. It offers an interdisciplinary forum to researchers in the closely related fields of:

- Data collection and modelling: advanced approaches for 3D data collection, reconstruction and methods for representation.
- Data management: topological, geometrical and network models for maintenance of 3D geo-information.
- Data analysis and visualisation: frameworks for representing 3D spatial relationships, 3D spatial analysis and algorithms for navigation, interpolation, etc. Advanced Virtual Reality and Augmented Reality visualisation.

The Workshop is intended as an interactive platform for both presentations on state-of-the-art research and discussions on open problems. The workshop will consist of a mixture of single-track presentations and discussion (PD) sessions and parallel working group (WG) sessions on specific themes (Requirements, Acquisition, Modelling, Analysis, Visualisation), according to the following format: current problems to be solved, potential solutions, and recommendations by WG (discussion under coordination of a chair and final presentation of the results at the closing plenary session). The presentations will be selected based on their quality by the scientific program committee (peer review of full papers).

Project home 3D topo

Space for Geo-information, project RGI-011 '3D topography':

There is an increasing need for real 3D topography due to a broad range of applications. Four prototypical applications are analysed with regard to the user wishes and the resulting 3D model requirements. On this basis, a new 3D topographical product model is further developed together with new methods and techniques and for data collection, storage and analysis. The project is spread over the period 2005-2008 and consists of the following sub-projects:

SUB1 Research on accessibility and user requirements of 3D topographic data and systems

Home // Background // Organisation // Workshop topics // Call for papers // Paper submission // Registration // Program // Venue // Contact

3D-geoinfo07

NEW: the preliminary program can be found at [Program](#)

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home