Experiences with Delft Campus data

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Something completely different

- Our objective: to develop a 2.5D model of buildings and the surrounding terrain that is sufficient to support building safety, access and management (BSAM), dealing with:
  - Entities like near-building furniture, paths, ramps, steps
  - Functions like emergency exit routing, disabled access, complex deliveries
- This is a pragmatic challenge between solid modelling and 2D GIS, and generates new data demands
  - Doors, exits, infrastructure connectivity
  - High resolution surfaces
  - Large scale maps and imagery
- Challenge is to model real building geometry and topology
  - Find balance between expressiveness with interactivity and sparse modelling with generality

Two parts

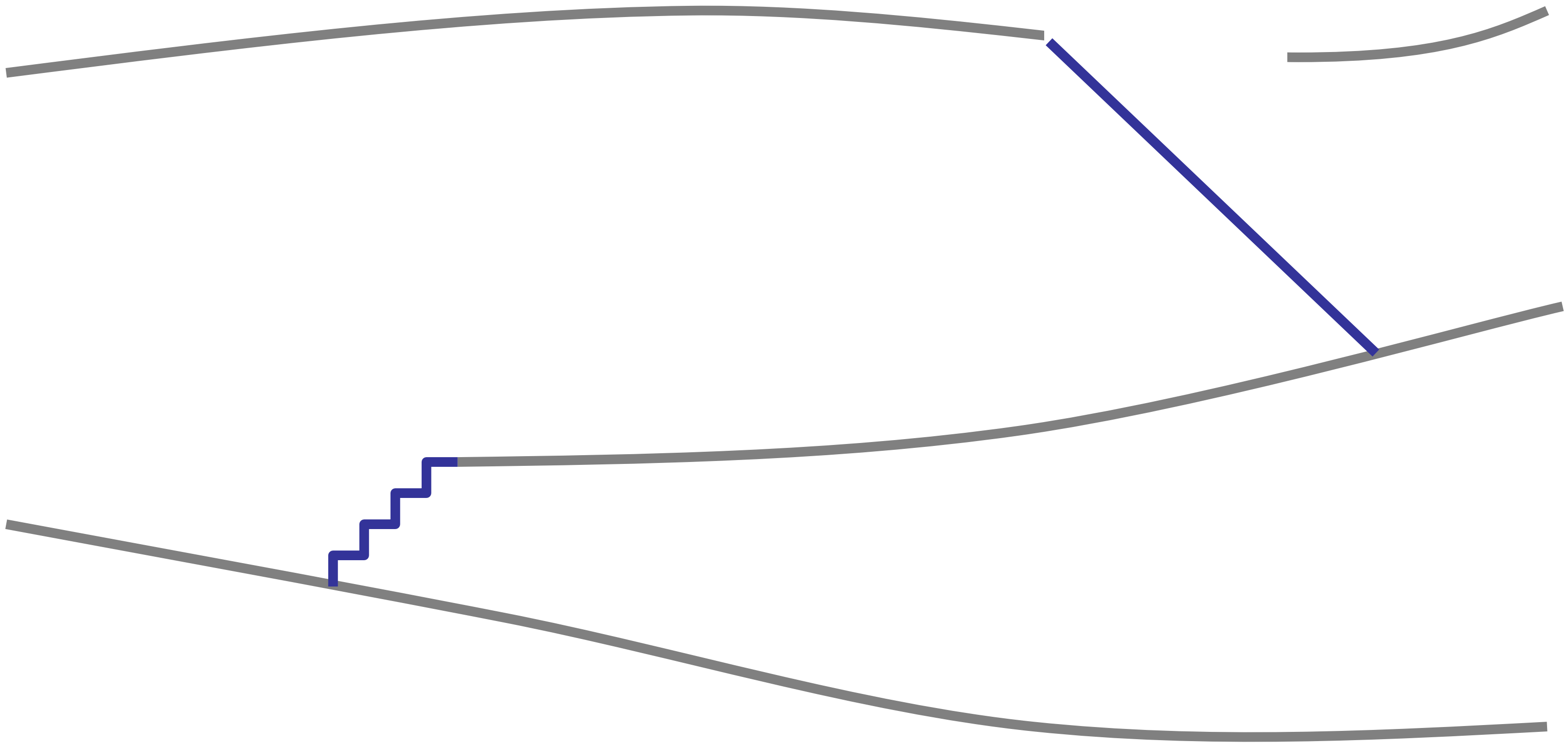
- Part 1: Our model
  - description of approach and model
  - experiences of importing Delft campus data
  - examples
- Part 2: The terrain
  - microscale detail
  - relationship to buildings

Part 1: Our model

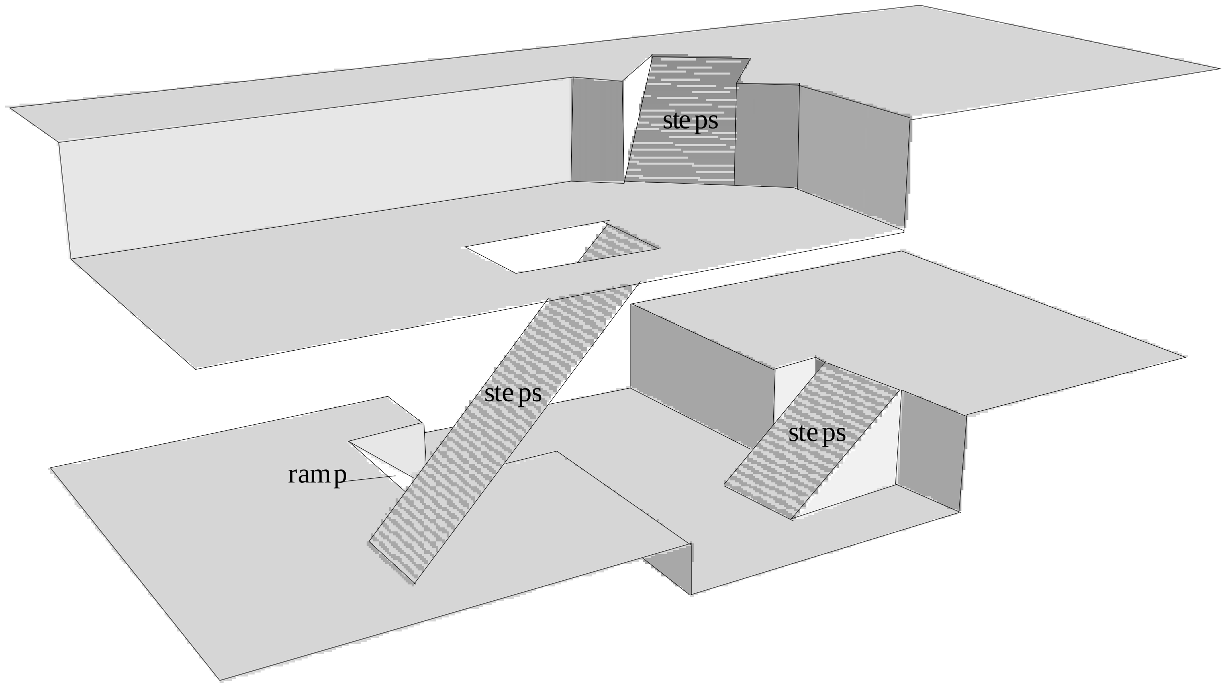
Model Overview

- Developed as part of Aidan's PhD
- Concentrates on the topology of space, particularly in terms of pedestrian navigation
  - integrates exterior and interior spaces
  - allows pedestrian access information to be embedded
- Uses a 2.5D layered approach
  - Topologically structured layers
  - Connected to form a multi-layered surface
- Parts of surfaces (and implicit space above) can be grouped into 'features'

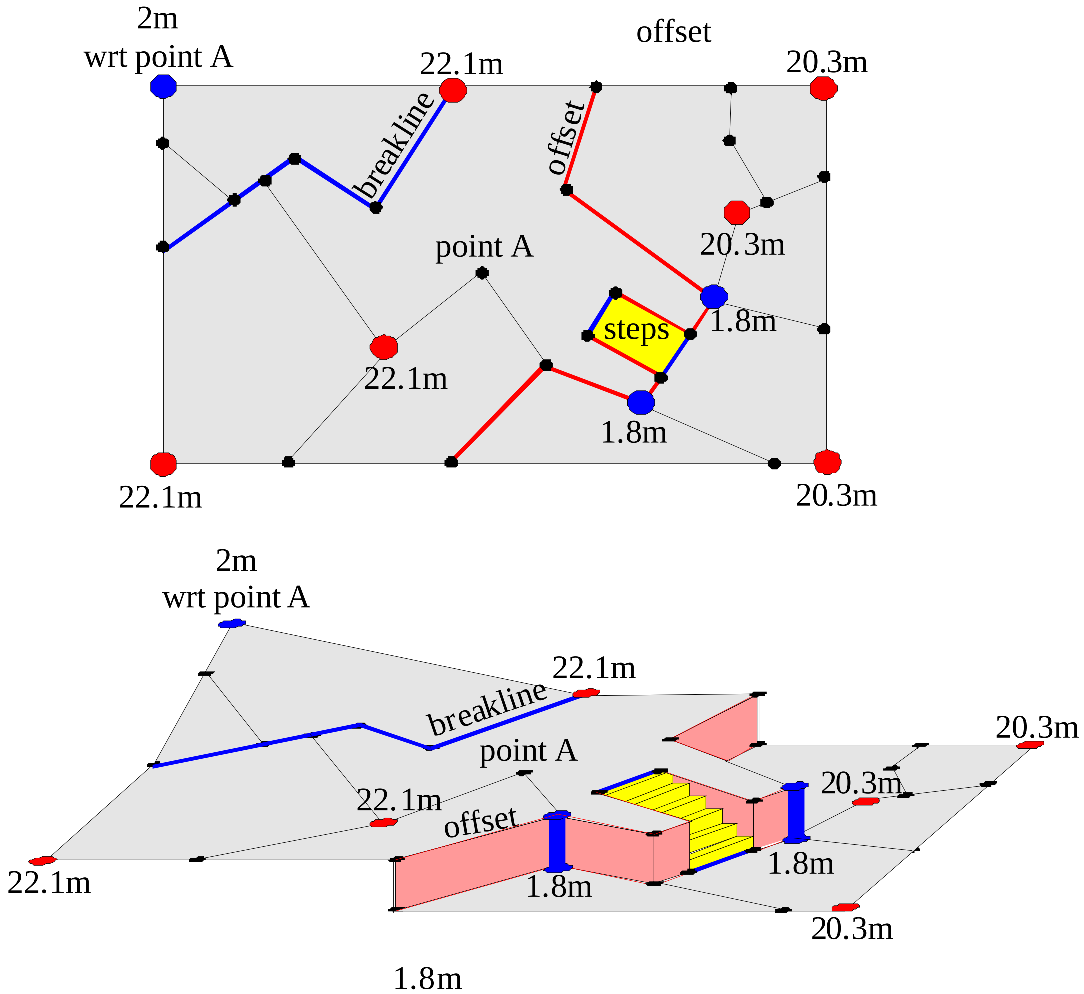
Model Structure: Layers



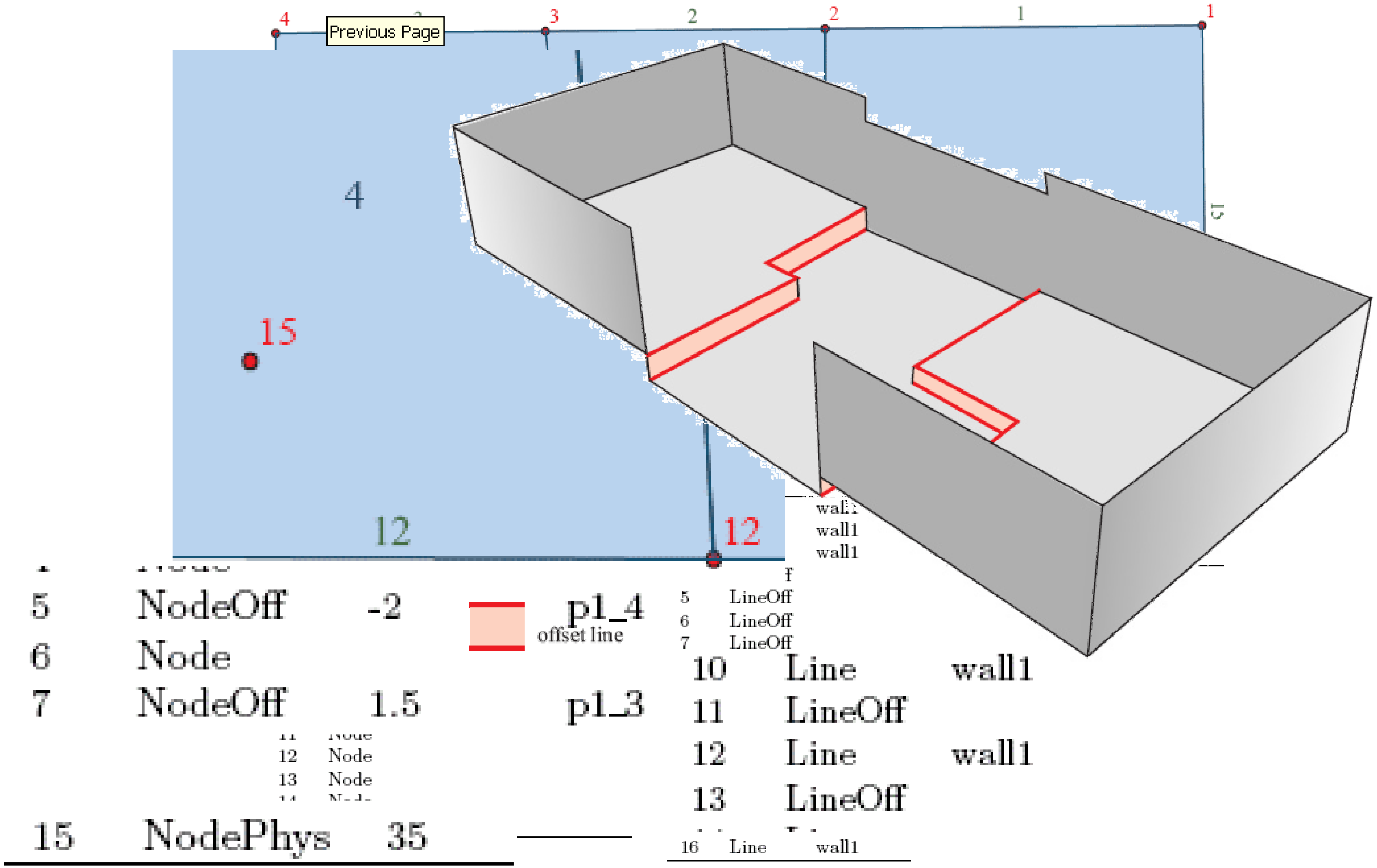
Model Structure: Layers



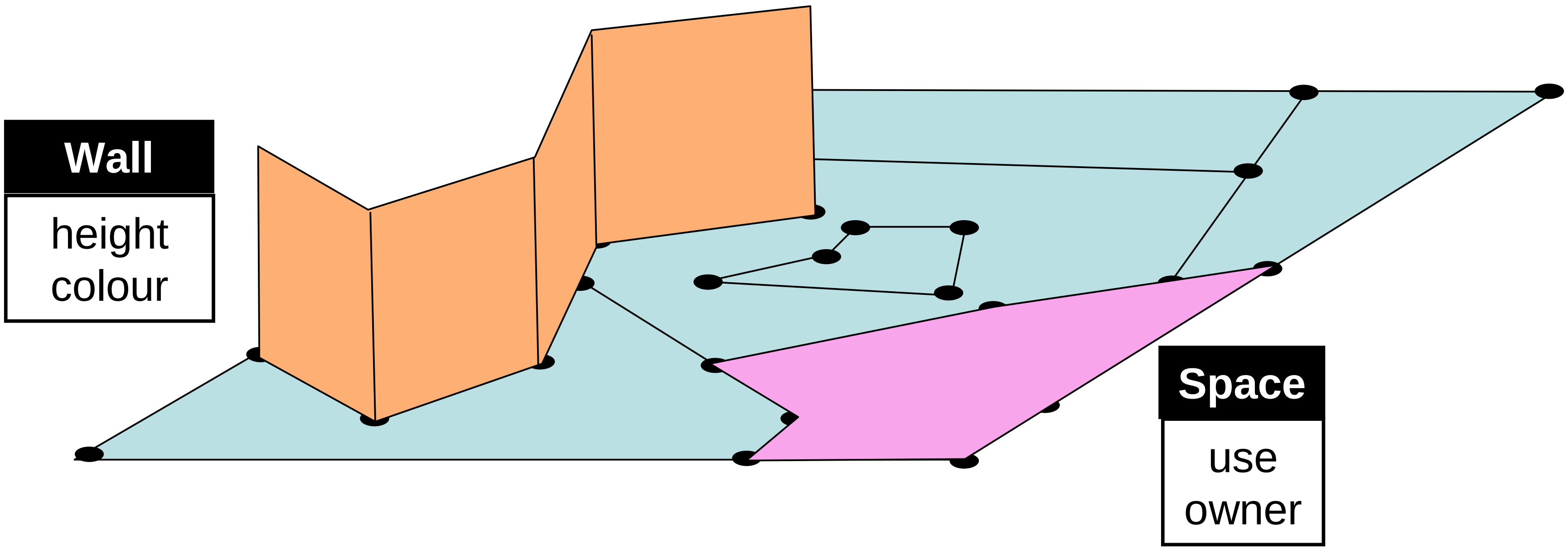
Model structure: Geometry



Model structure: Geometry



Model Structure: Features

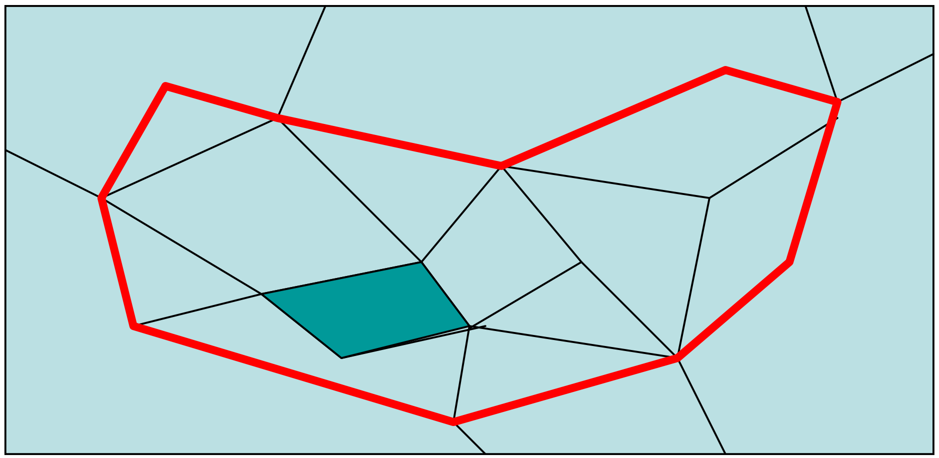


Model Structure: Access

- Pedestrian access is embedded within relevant features

Model Structure: ‘Bounded Space’

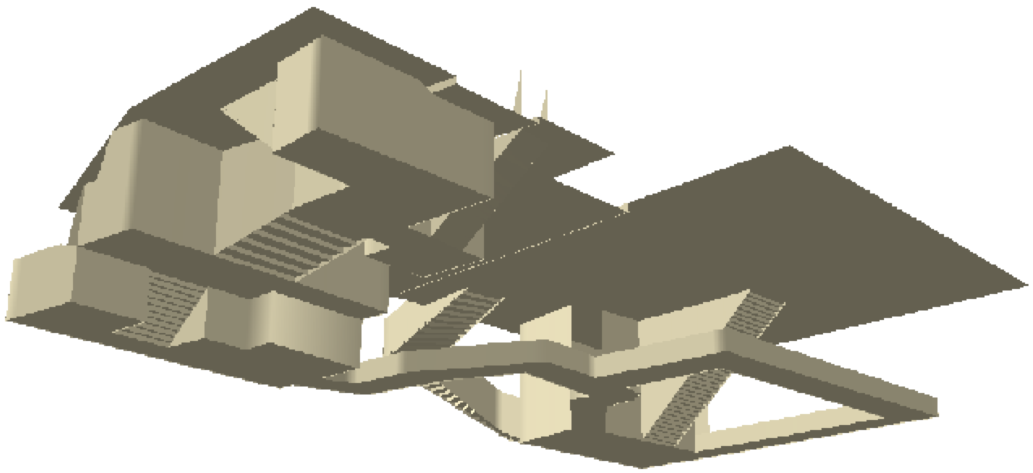
- Represents a space (explicit 2D; implicit 3D)
- The union of all the connected spaces with a certain amount of *accessibility*

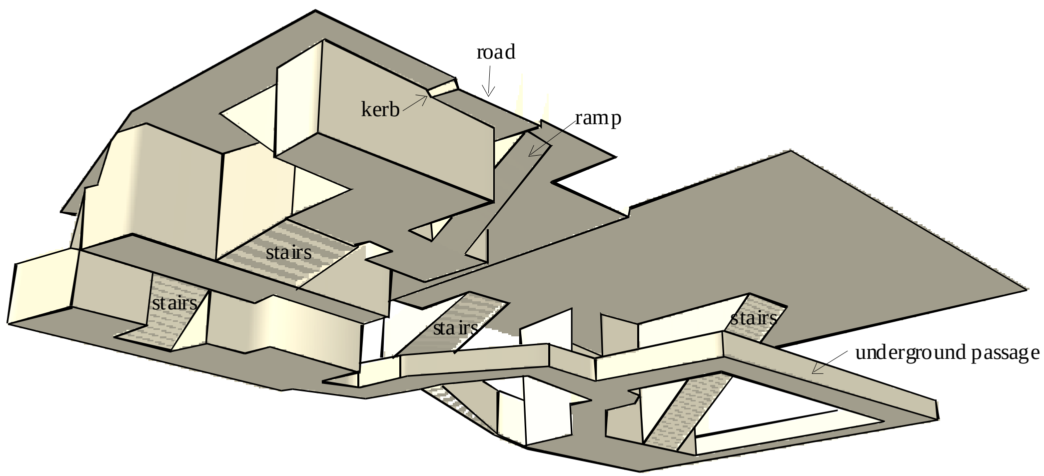


Implementation

- Java application
  - Database for storage (Ozone)
    - geometry objects
    - feature objects
  - Data are prepared in ArcGIS
    - imported/drawn
    - edited
    - prepared for input
  - Data are imported into Java Application
  - Data can be queried and exported
    - Will dynamically build the 3D geometry as required
    - Will resolve accessible spaces
  - 3D output can be viewed in ArcScene
    - Output as a 3D shapefile

Example of 3D output

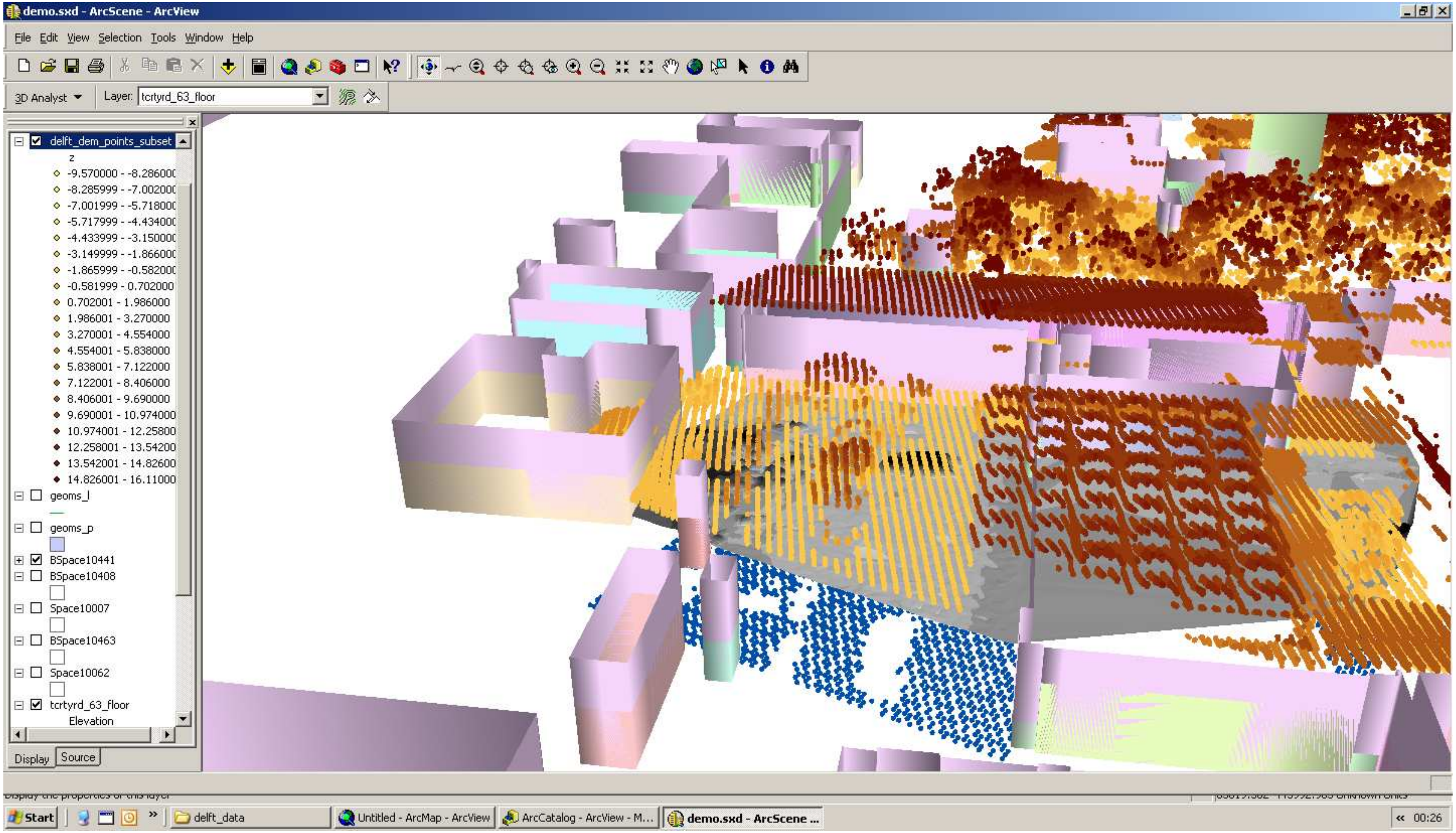




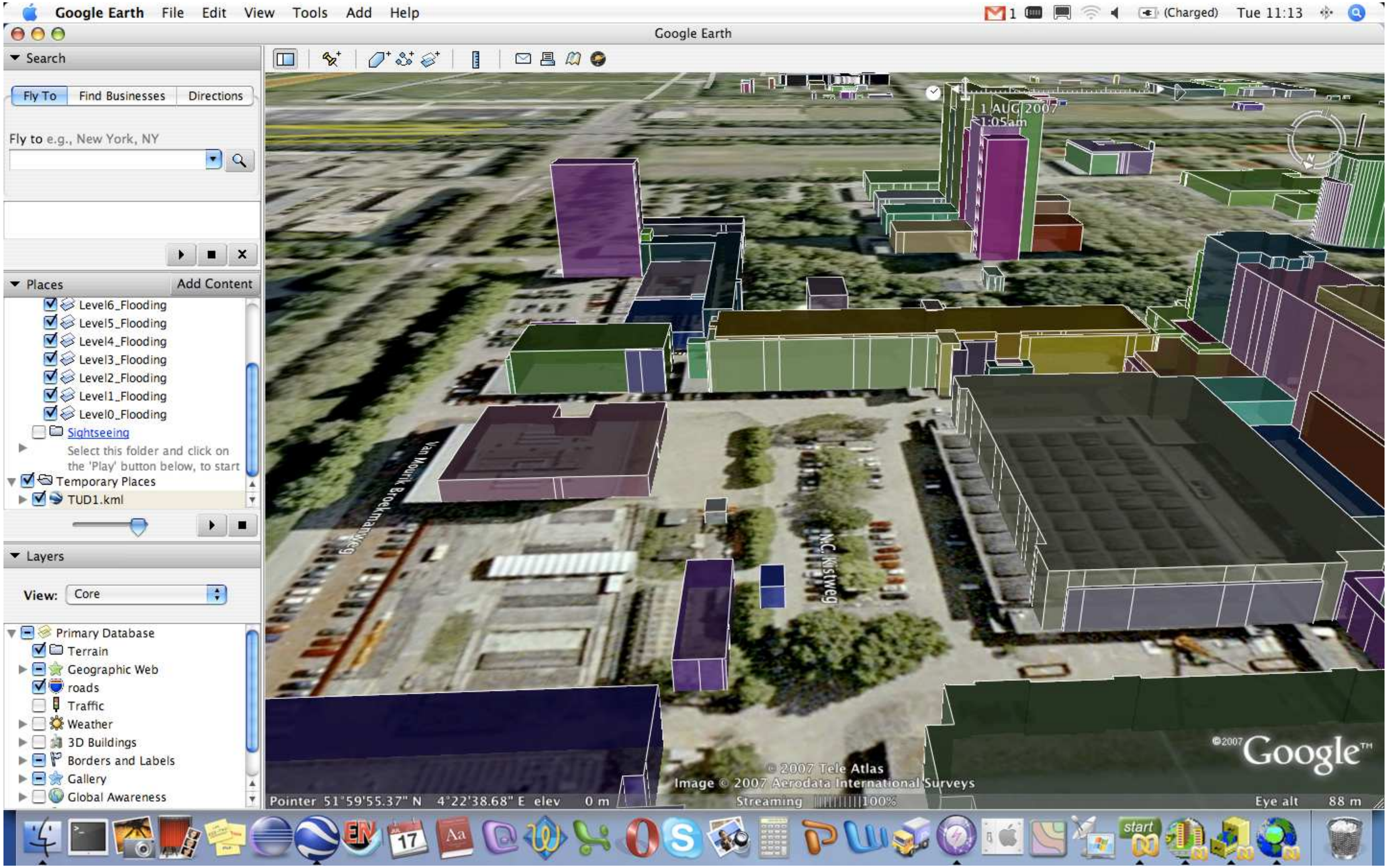
Delft Campus Dataset

- Had to get the data in a form that it could be imported
  - Wrote a converter (in Java) which output shapefiles from KML sourcefiles
  - Wrote scripts (in VBA) to define features (walls and ‘external’ space)
    - walls, spaces, bounded spaces
  - Added some initial terrain heights
- Imported it
- Exported all the features as 3D Shapefiles
- Processed the LIDAR terrain

LIDAR raw data



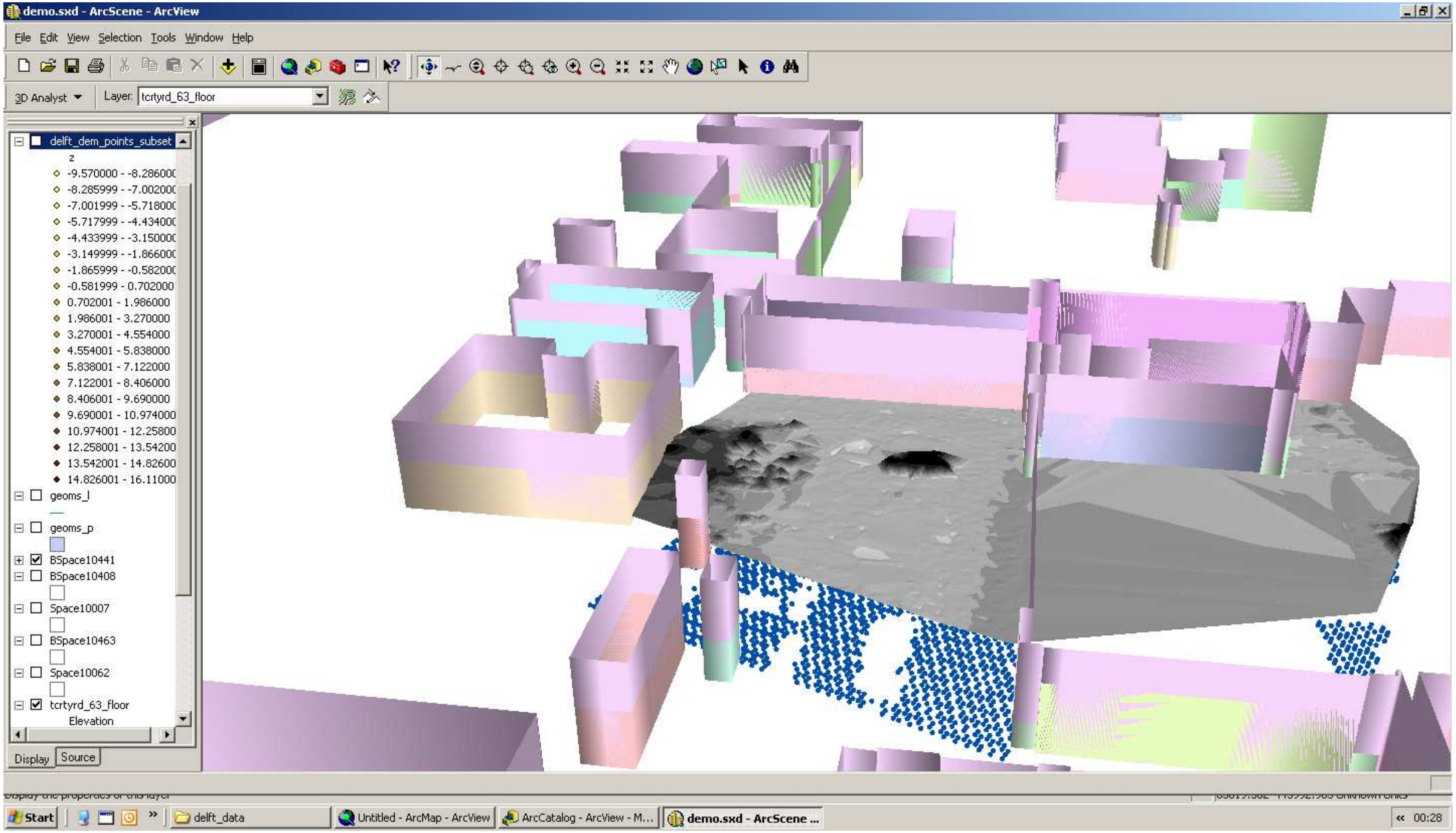
Google Earth



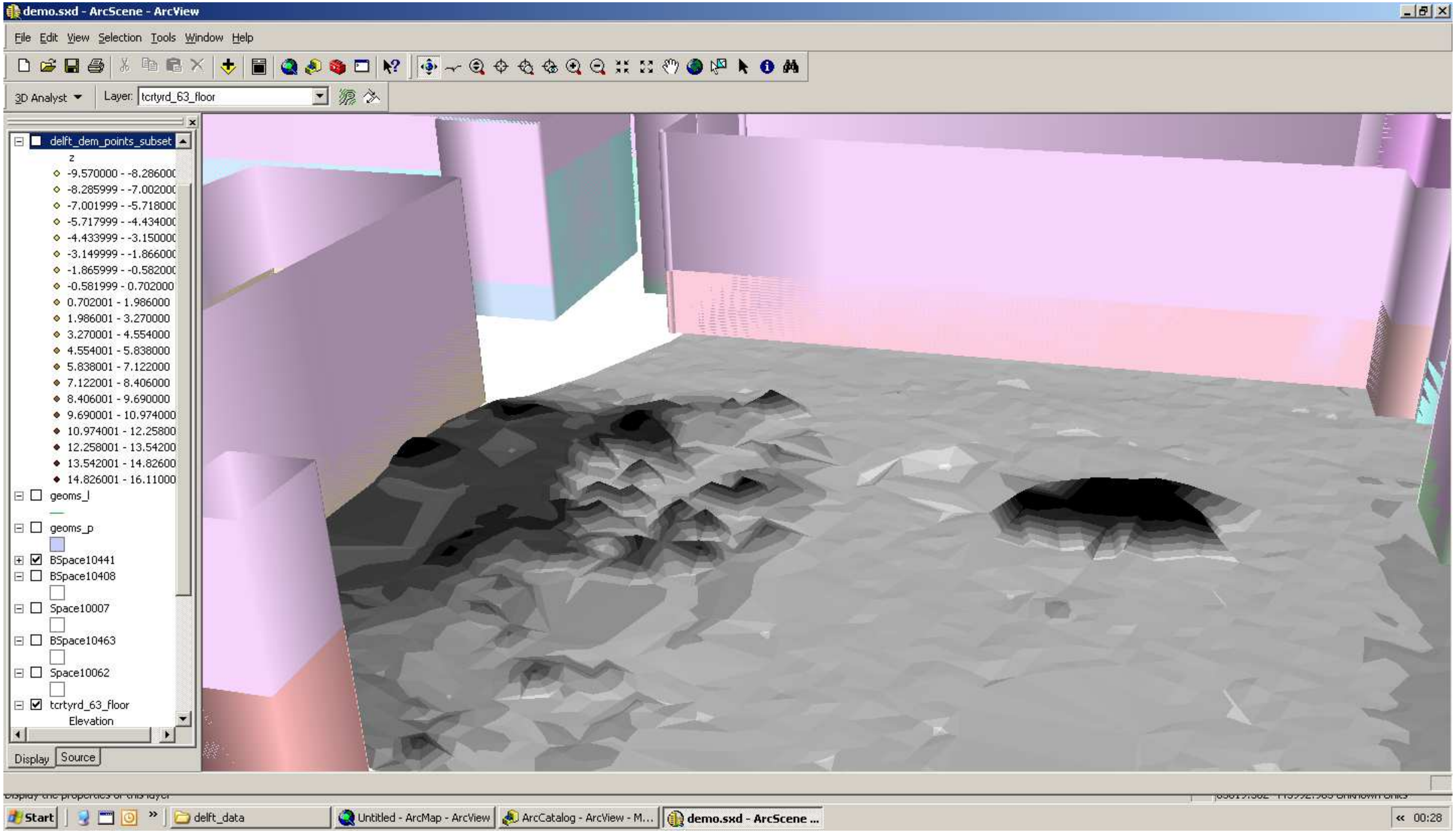
LIDAR processing

- Original LIDAR pointset very large
  - TIN had degeneracies (along-line vs across line resolution)
- Remove duplicate scan lines for a tile (a courtyard)
  - Data reduction step (interactively)
- Build a ArcInfo lattice at 1m resolution
- Use VIP algorithm to reduce from 100K to 9K points
- Remove trees and respect buildings
  - Selected points from base to (interactively defined) bare earth surface
  - Shift the LIDAR to fit with projected building KML
- Create TIN from remaining lattice points

LIDAR bare terrain



LIDAR bare terrain



Terrain/ building integration

- Define terrain constraints
  - Break of slope
  - Offset
- Run integration routine
- Can implement algorithms that move from terrain into building e.g. routing

Reflections on experience

- Data could be imported into this model design
- …but model is intended to describe richer dataset
- Model strengths
  - Semantically rich
  - important aspect of modelling currently neglected
- Model weaknesses (many)
  - Implementation is interactive
  - Does not support much analysis (yet)
  - Does not store complex 3D geometry

	Poly	TIN
High semantic	TEN	2.5D with embedded objects
Low semantic	Polytopes	TIN/ Voronoi