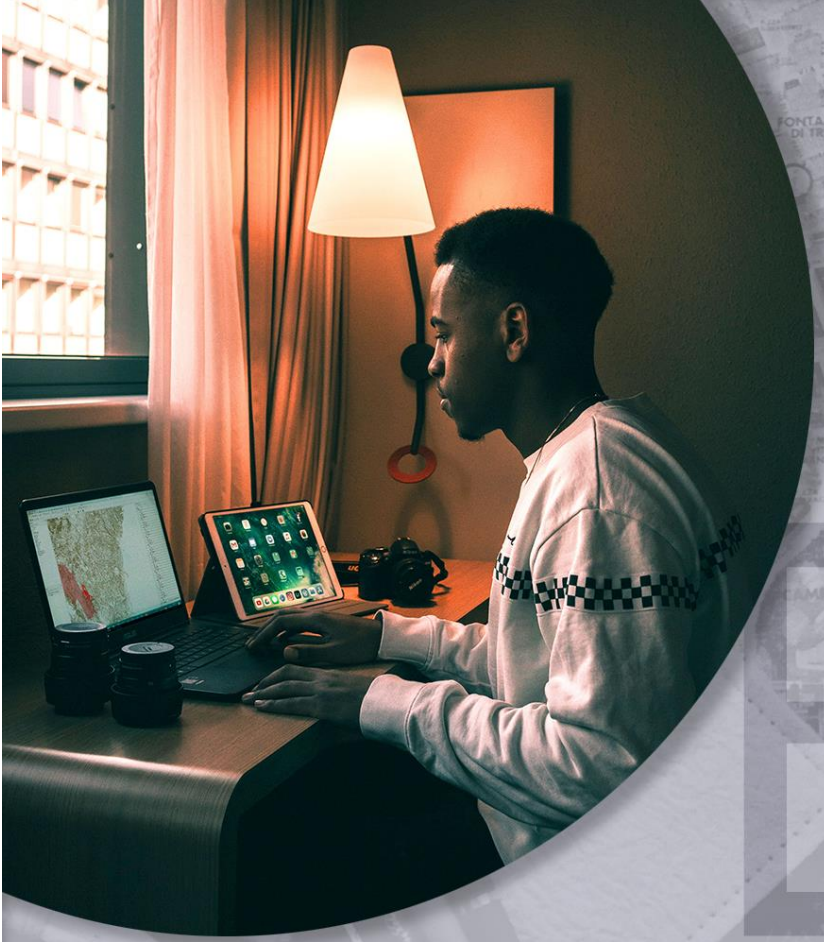

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1.1 Concepts of 3D Modelling

April 2025

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Concepts of 3D Modelling

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Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Understand main concepts and different types of 3D geographical modelling
- Understand principles of 3D raster / voxel models
- Describe creation and advantages of reality-mesh models

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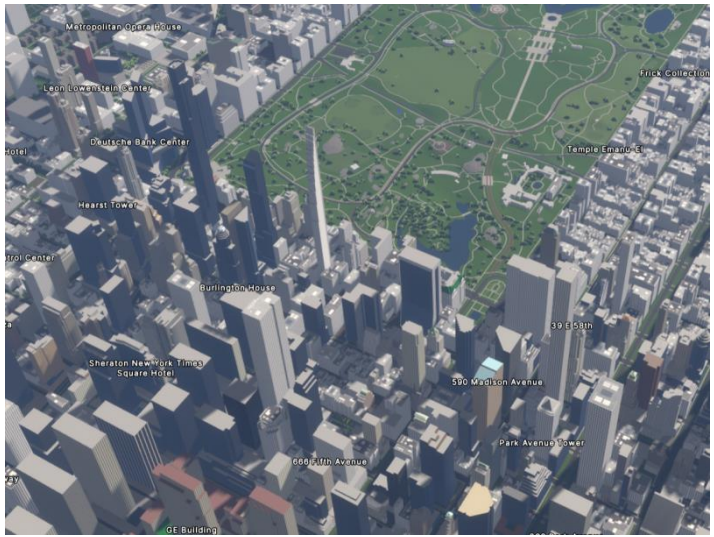
Why 3D?

- World is in 3D
- X, y and z axis



Figures – central New York on 2D map and as 3D model (both based on Open Street Maps)

Better understanding of object shapes and spatial relationships

Many analyses possible only in 3D (e.g. noise, flooding)

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Digital Models of Built Environment

Different techniques to create 3D models

3D information:

- Geometric
- Topological
- Semantic

Abstraction – limiting model complexity, e.g. inner parts

https://static.turbosquid.com/Preview/2018/11/07__08_45_37/1.jpgF16C9D5E-43CF-473A-9052-87F6D4FCEF1DZoom.jpg

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Obtaining 3D Data

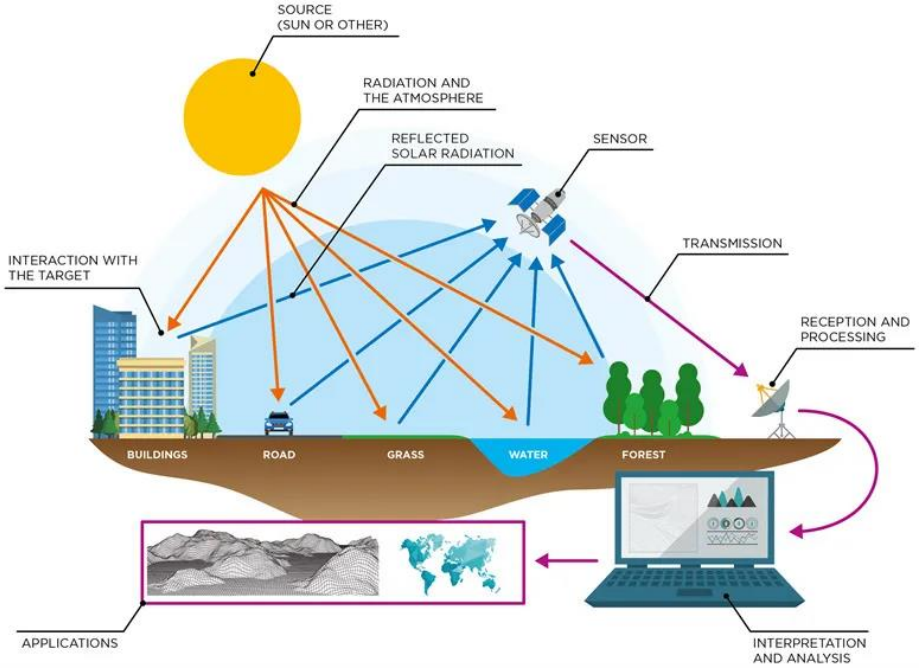
Traditional methods – stationary laser scanners

Remote sensing – laser, radar, mobile mapping

Photogrammetry – digital images, aerial photography

Extraction from 2D footprints

Conversion from architectural models



Remote sensing. Source:https://i0.wp.com/geolearn.in/wp-content/uploads/2022/09/Remote-Sensing-Process.jpg

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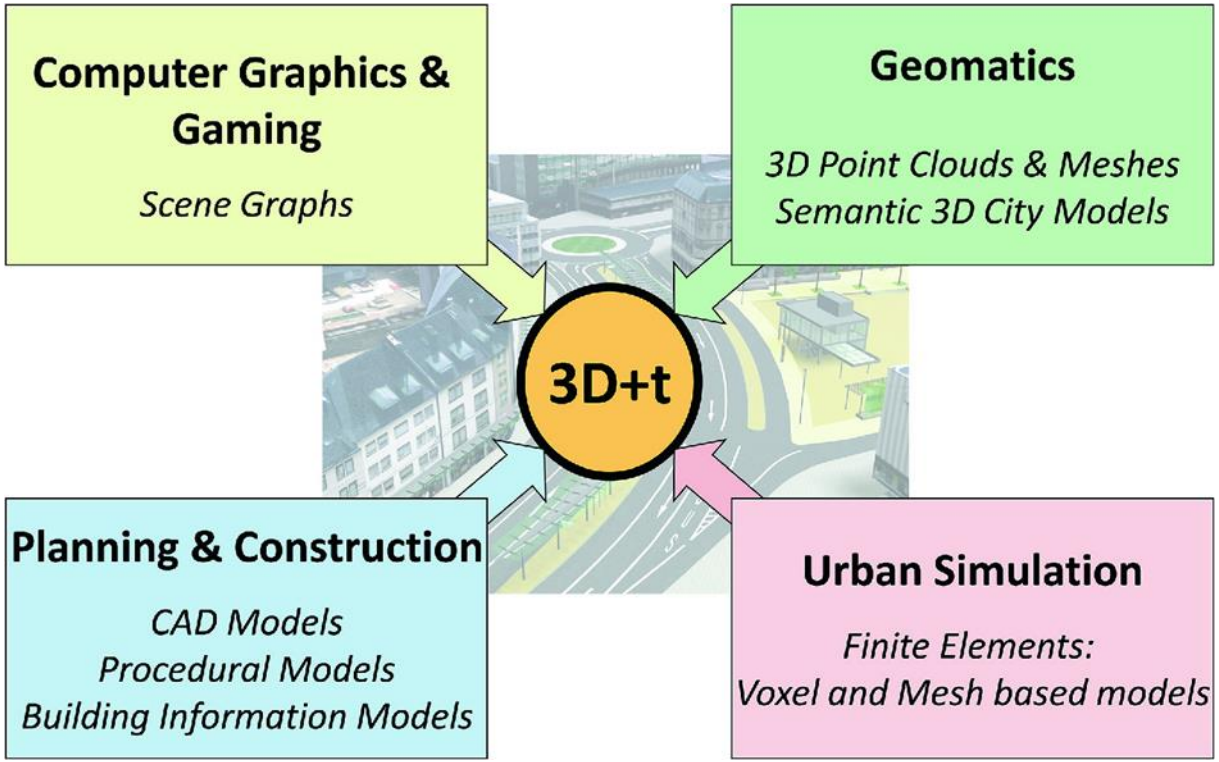
Different 3D Representations

Several ways of 3D information

Different scopes and industries

- High-graphic models
- High-detail models
- GIS-related models
- 3D voxel rasters



Kolbe & Donaubaue (2021): Semantic 3D City Modelling and BIM in: W. Shi et al. (eds.), Urban Informatics, The Urban Book Series

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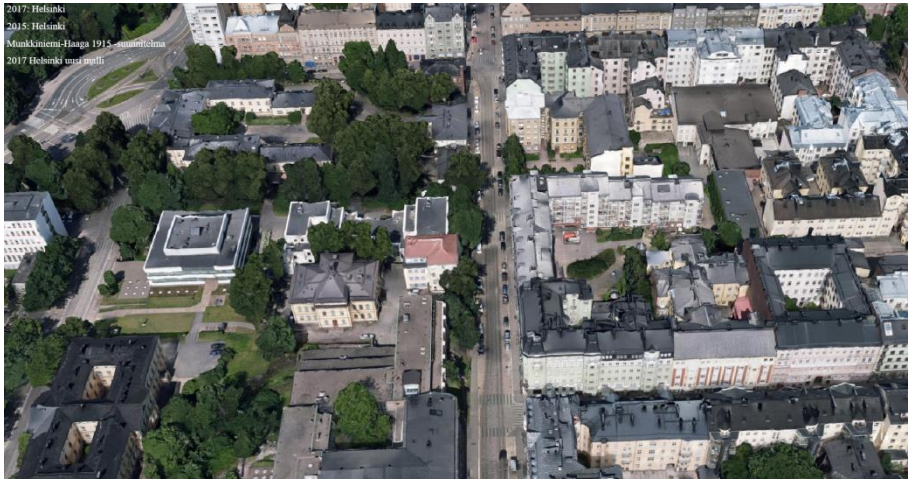
High-graphic 3D models

3D models focusing on high-quality visualisation



https://kartta.hel.fi/3d/mesh/

[3d-environment-design-for-game-3d-model-low-poly-animated-fbx-uasset.jpg (2688×1512) (cgtrader.com)]

Common as gaming environment
Some city models

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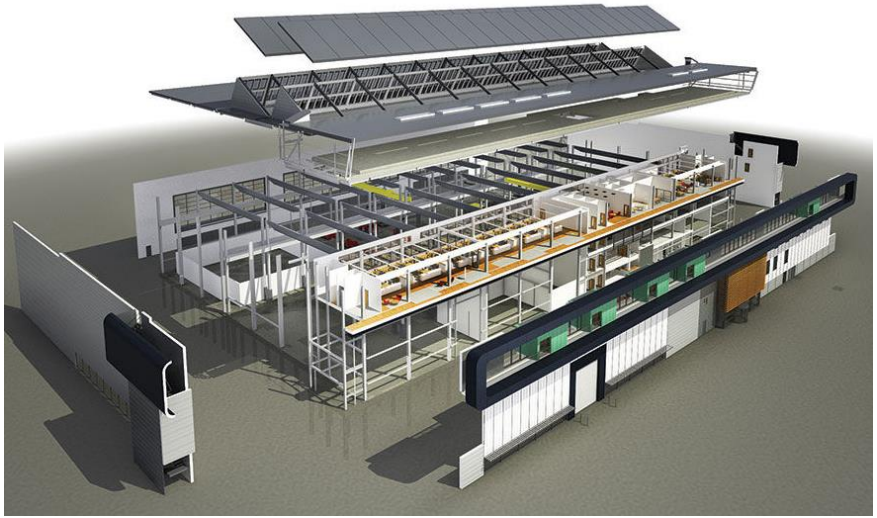
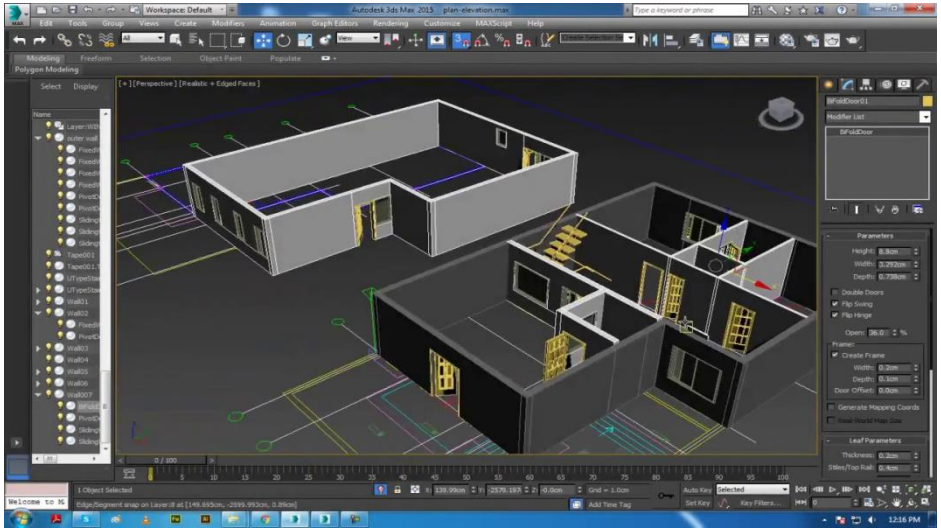
AEC Industry models

- Focus on detail
- Small scale (an asset only)
- Lot of object information
- CAD and BIM models





Up: 3D model in AutoCAD

https://cougardrafting.com/wp-content/uploads/2020/05/maxresdefault2.jpg

Left: BIM model

https://www.ckvango.com/wp-content/uploads/2015/11/bim-modeling-rendering.jpg

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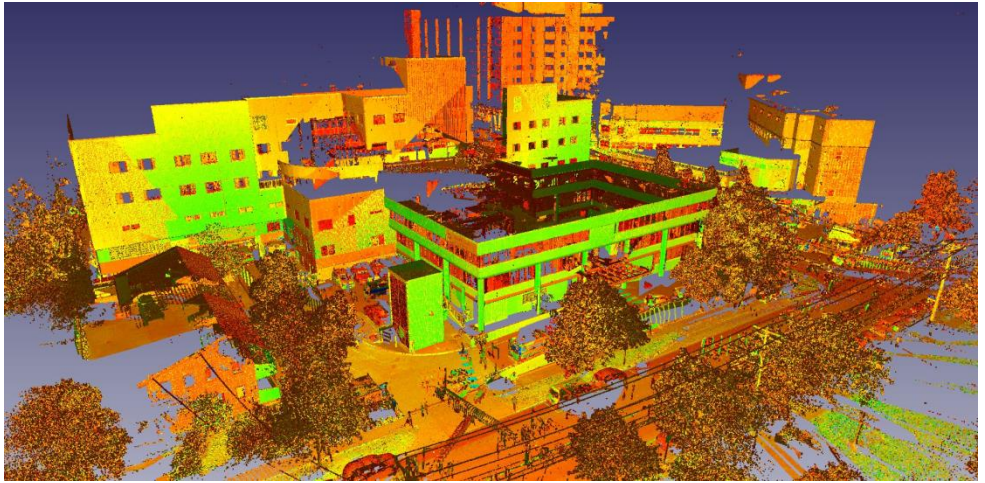
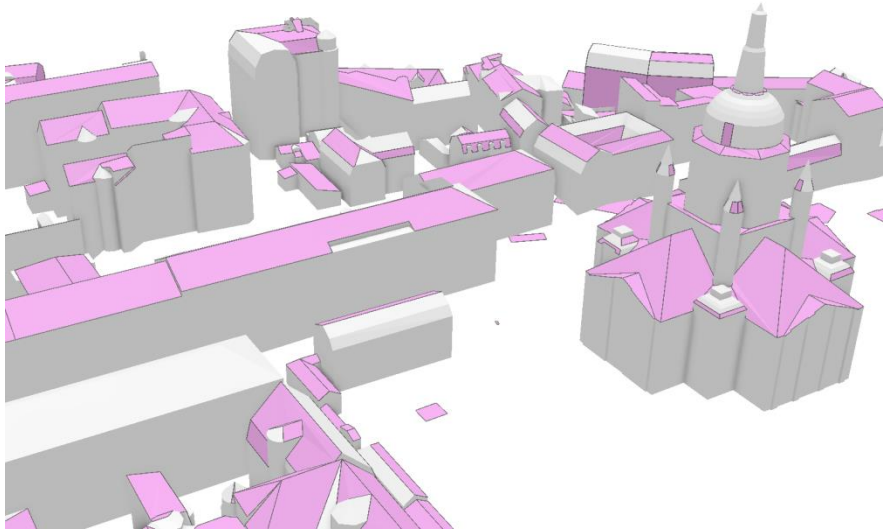
Geomatic / GIS models

- 3D point clouds
- 3D meshes
- Semantic city models – individual object and properties





Up: point-cloud from laser scanning
https://www.laserscanning.com.au/files/2014/04/6736-Image-3.jpg

Left: semantic city model of Stockholm
Downloaded from: Dataportalen (stockholm.se)

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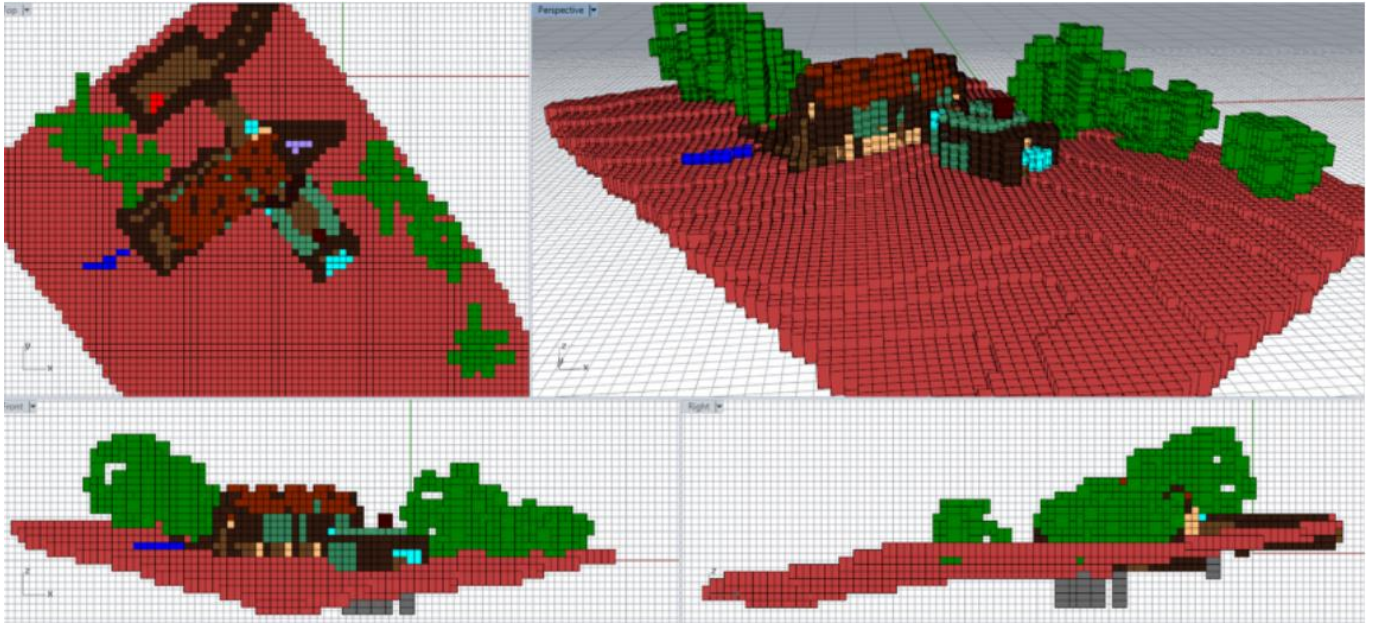
3D raster
= voxel model

- voxel is 3D parallel to 2D pixel in a raster map
- voxel models are 3D equivalent of 2D rasters
- precision based on the grid size



From: Ohori, Ledoux, and Peters (2020-2022): 3D modelling of the built environment, page 31

- Distribution and simulations of continuous variables (e.g. wind speed, air temperature)

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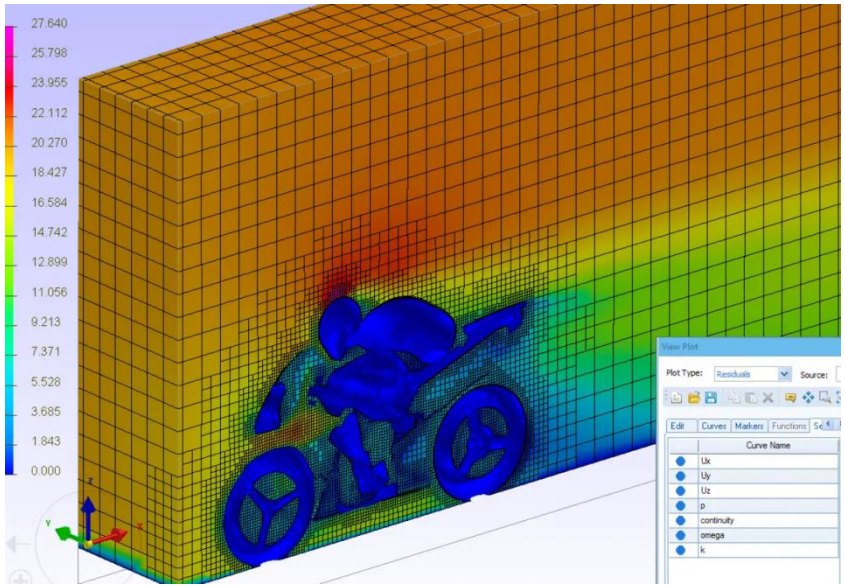
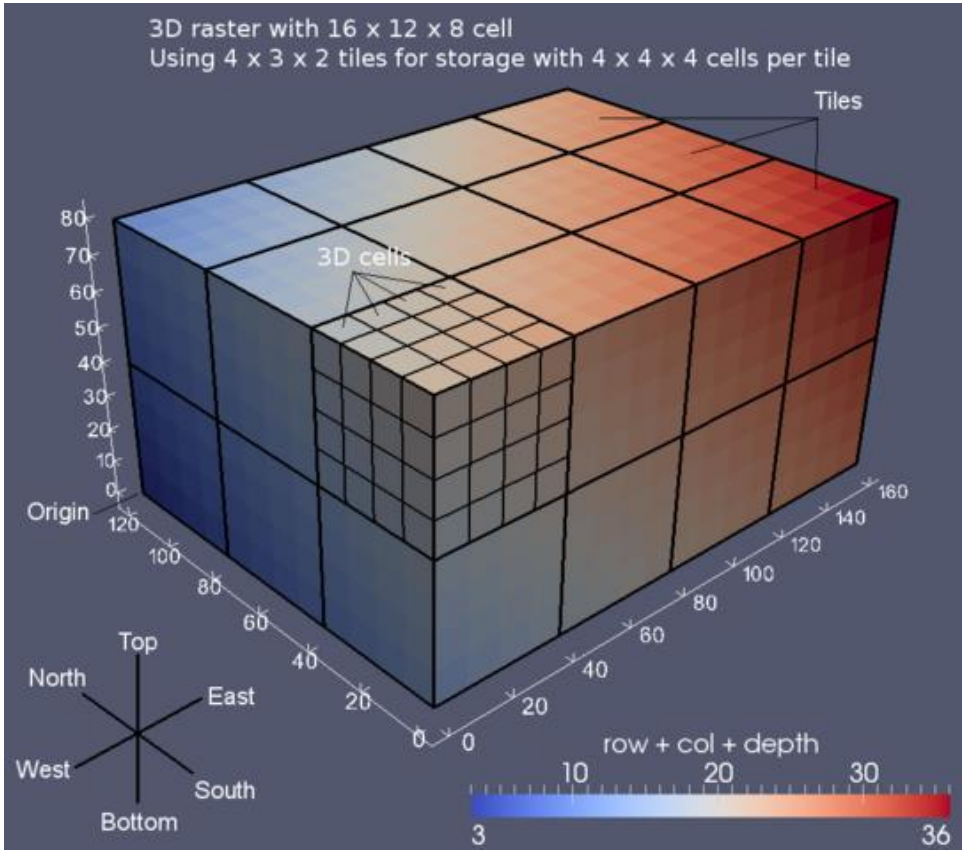
Voxels in City Modelling

- Both built and empty spaces can be visualised by voxels to cover all space
- Modelling of several variables together



https://www.techyv.com/sites/default/users/Images-Folder/OpenFOAM-1.png



https://grass.osgeo.org/grass82/manuals/raster3d_layout.png

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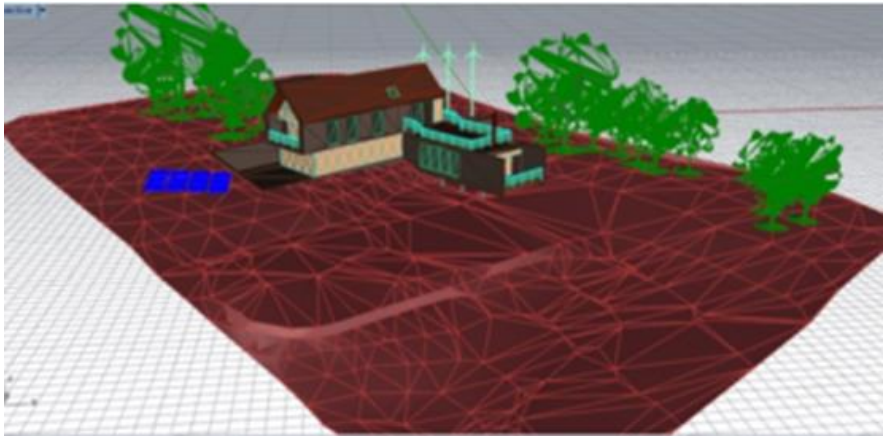
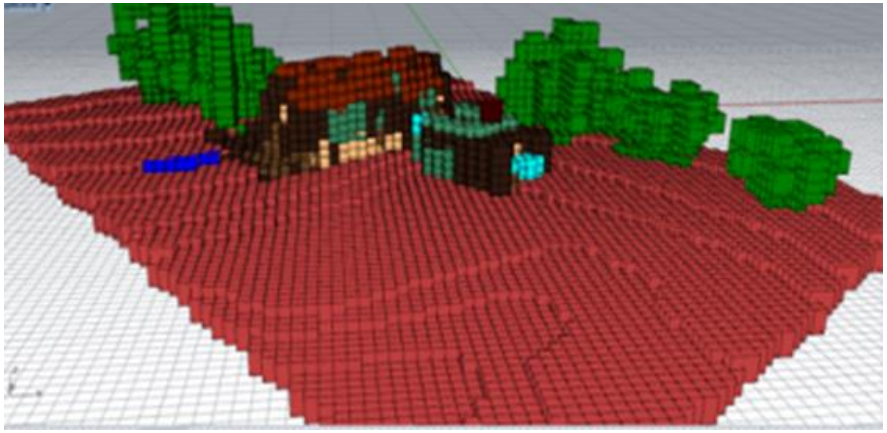
Reality-mesh city models I

If voxels are not suitable:

- Dividing of surfaces into triangles = meshing
- Decided characteristics, e.g. minimum angles – also finite-elements method
- Figures – comparison of mesh (up) and voxels (down) for the same objects





From: Ohori, Ledoux, and Peters (2020-2022): 3D modelling of the built environment, page 31

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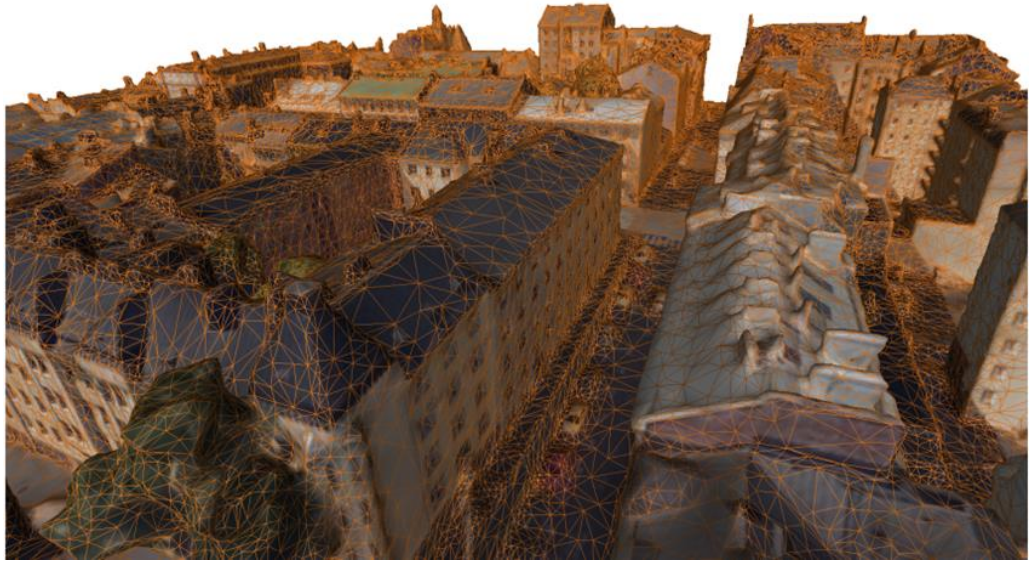
Reality-mesh city models II

- Triangular mesh models are fast and cost-effective to create
- First generation of city models
- Google Earth



Up: Reality-mesh of Helsinki city model
From: Ohori, Ledoux, and Peters (2020-2022): 3D modelling of the built environment, page 91

Left: Mesh-based model from Google Earth
Example of Prague, Google Earth

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Thank you for your attention

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