Towards Comprehensible Digital 3D Maps

Symposium on Service-Oriented Mapping 2012

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Symposium on Service-Oriented Mapping
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4DnD·Vis

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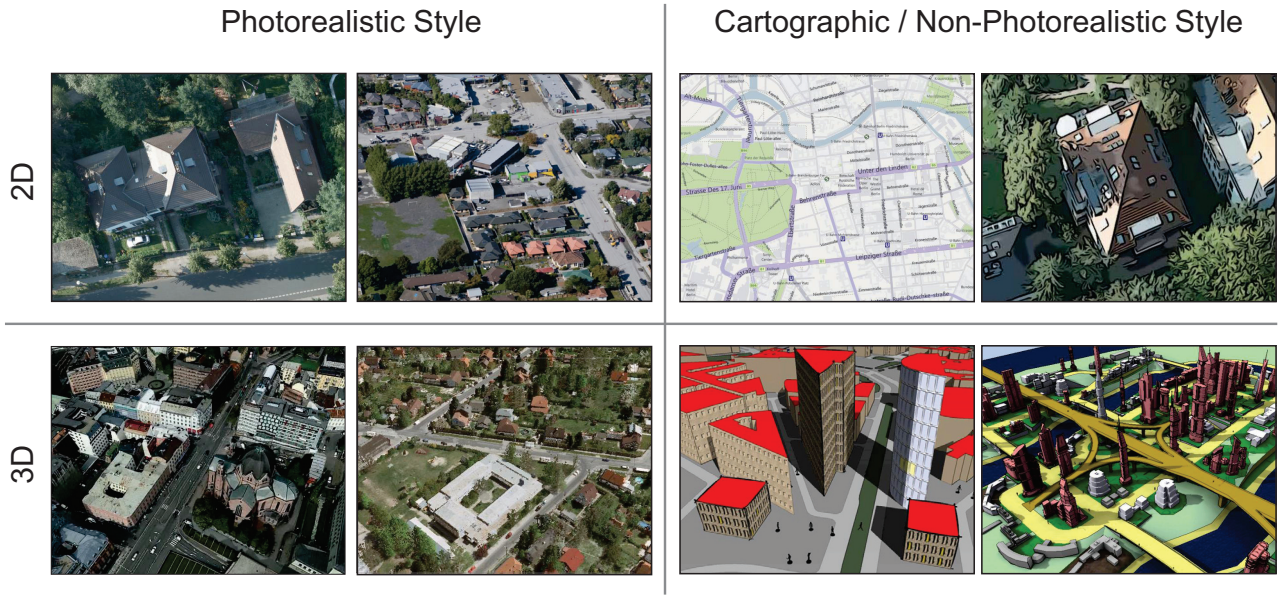
Digital Mapping Services (DMS)

- DMS are established tools for a variety of applications, e.g., navigation, education, and environmental analysis
- User can interactively
  - explore multi-layered map contents
  - customize the visual appearance

Two differently stylized 2D maps of Vienna (Left: Google Earth, Right: OpenStreetMap)

Digital Mapping Services - Overview

- An adequate graphic style makes a visualization meaningful in its context and usage scenario [MacEachren, *How Maps Work*, 1995]
- e.g., 3D photorealistic style to aid exploration of local environments vs. 2D maps for navigation tasks

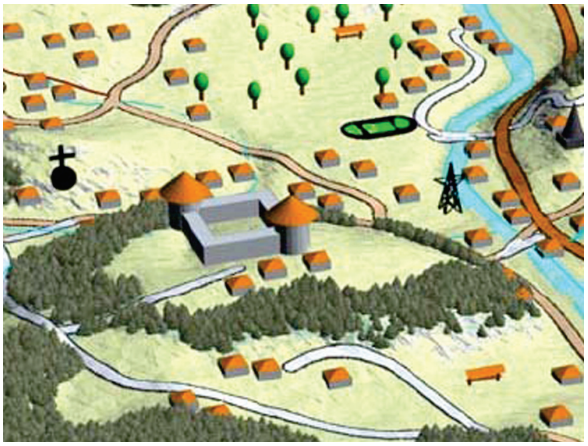


Digital 3D Maps - Characteristics

Digital 3D Maps (D3DMs)

- utilize a perspective view,
- are based on generalized data models,
- depict geographical reality in an abstracted, symbolized way, and
- are utilized when spatial relations are of primary relevance.

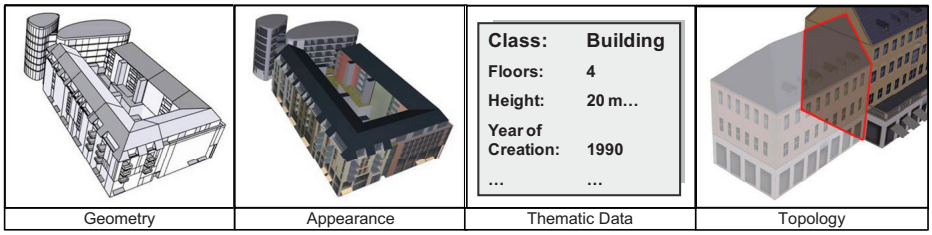
Virtual 3D City Model of Vienna (Google Earth)



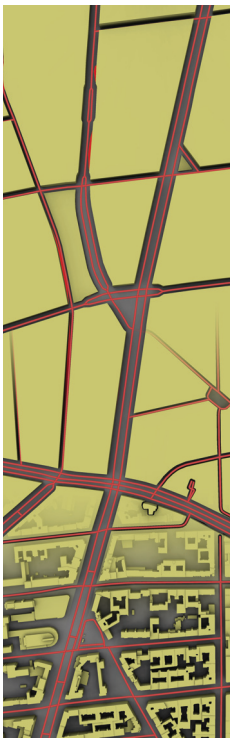
Cartography-Oriented 3D Map [Petrovic, 2003]

Digital 3D Maps - Related Work

- Design principles [Häberling et al., 2008] and semiotic model [Jobst, 2008] for D3DMs
- Guidelines for 3D symbols [Petrovic, 2003]
- Generalization/abstraction of 3D virtual city and landscape models [Glander et al., 2011, Kada, 2005]
- Generalized data model and exchange format (CityGML [Kolbe, 2009]).



[Kolbe, 2009]



[Glander et al. 2011]

Digital 3D Maps - Drawbacks

D1 Occlusion

D2 Unlimited number of cartographic scales

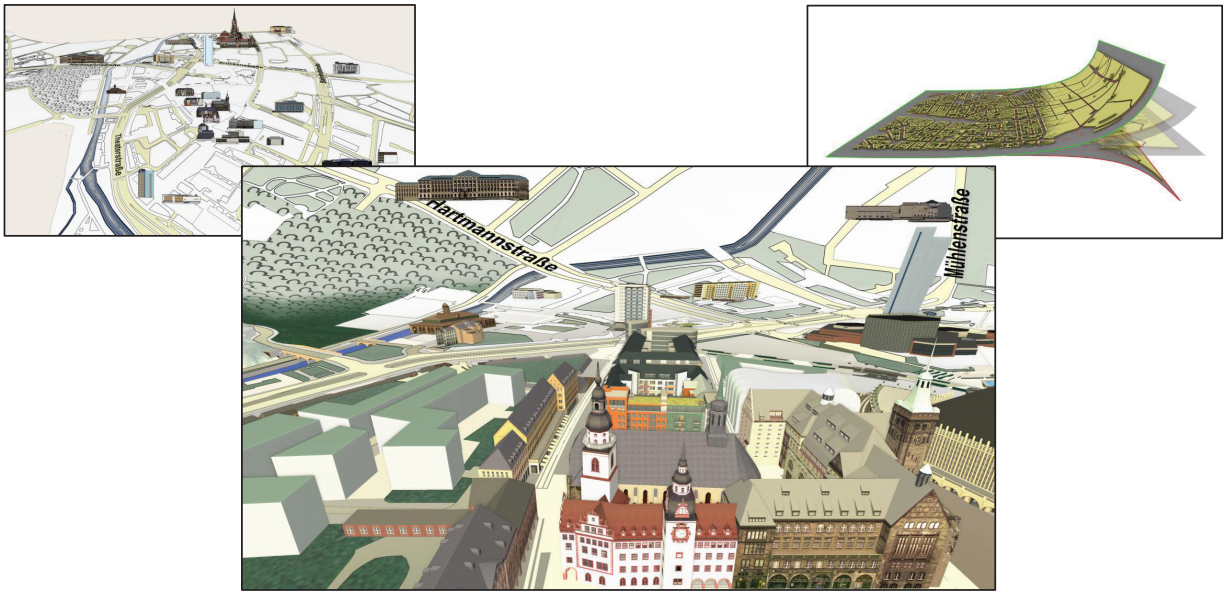
Virtual 3D city model of Berlin (image generated with HPI Web-View-Service)

D3 Visual Clutter

D4 Insufficient use of screen-space

Virtual 3D city model of Berlin (image generated with HPI Web-View-Service)

Combine cartography-oriented visualization (COV) with interactive view-dependent multiperspective views (MPVs).

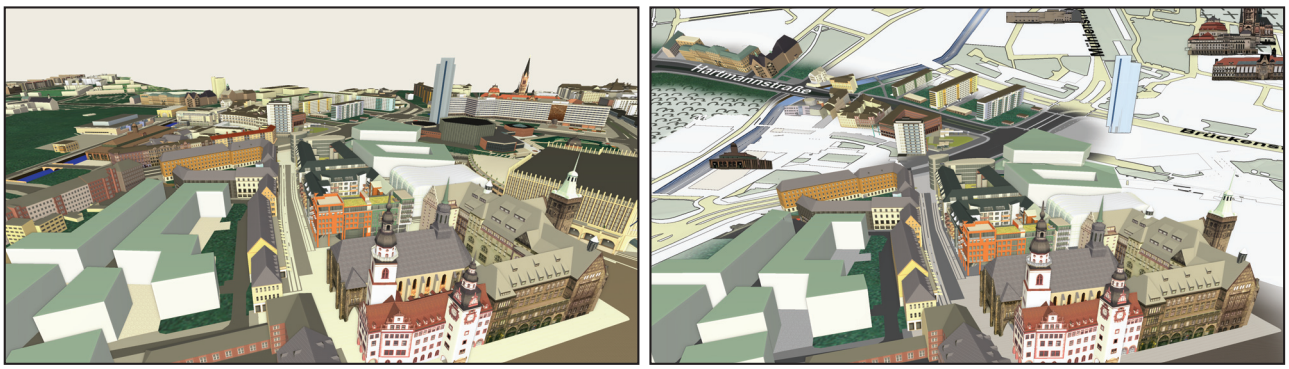


DA1 Decrease of visual complexity by classification, symbolization and abstraction [Häberling et al., 2008, Semmo et al., 2012]

DA2 Decrease of occlusion and visual clutter [Pasewaldt et al., 2011]

DA3 Increase of screen-space utilization [Jobst and Döllner, 2008]

DA4 Increase of user involvement [Reichenbacher, 2007]



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Comprehensible Digital 3D Maps - Design Aspects

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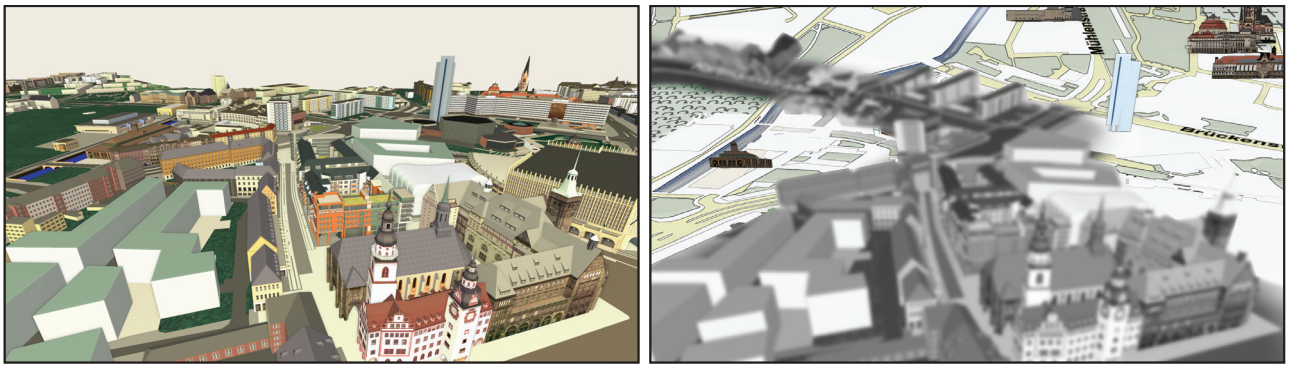

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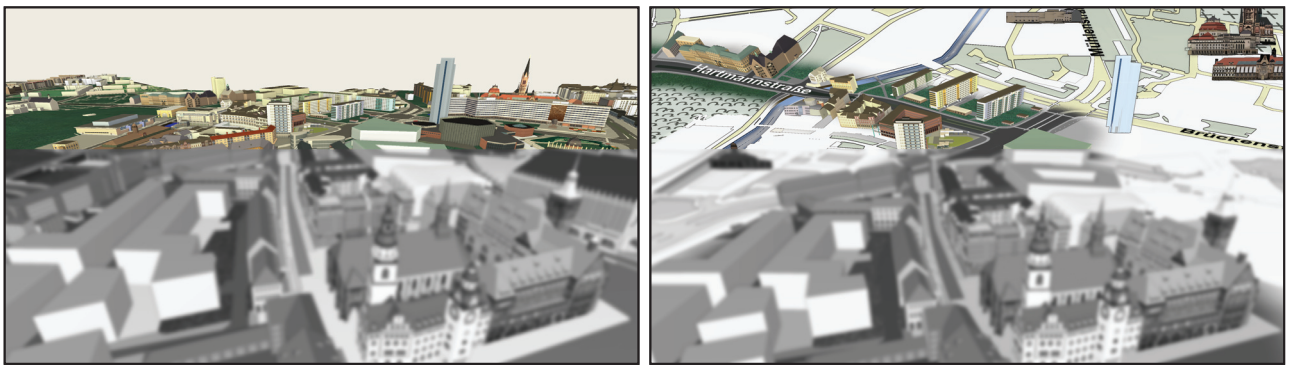

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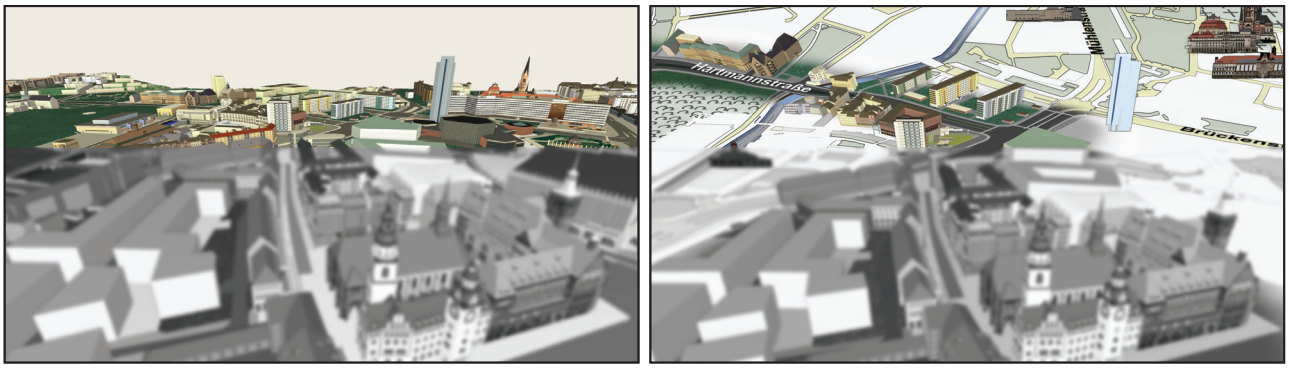

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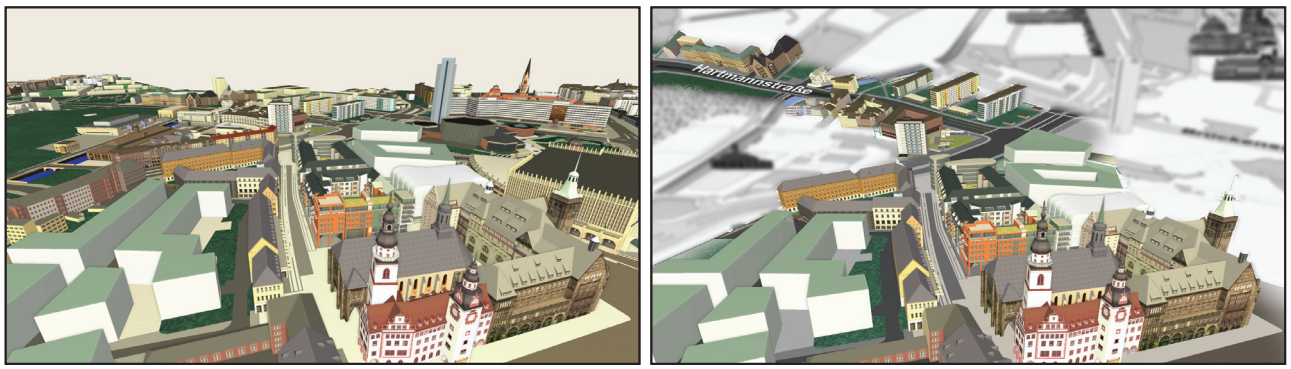
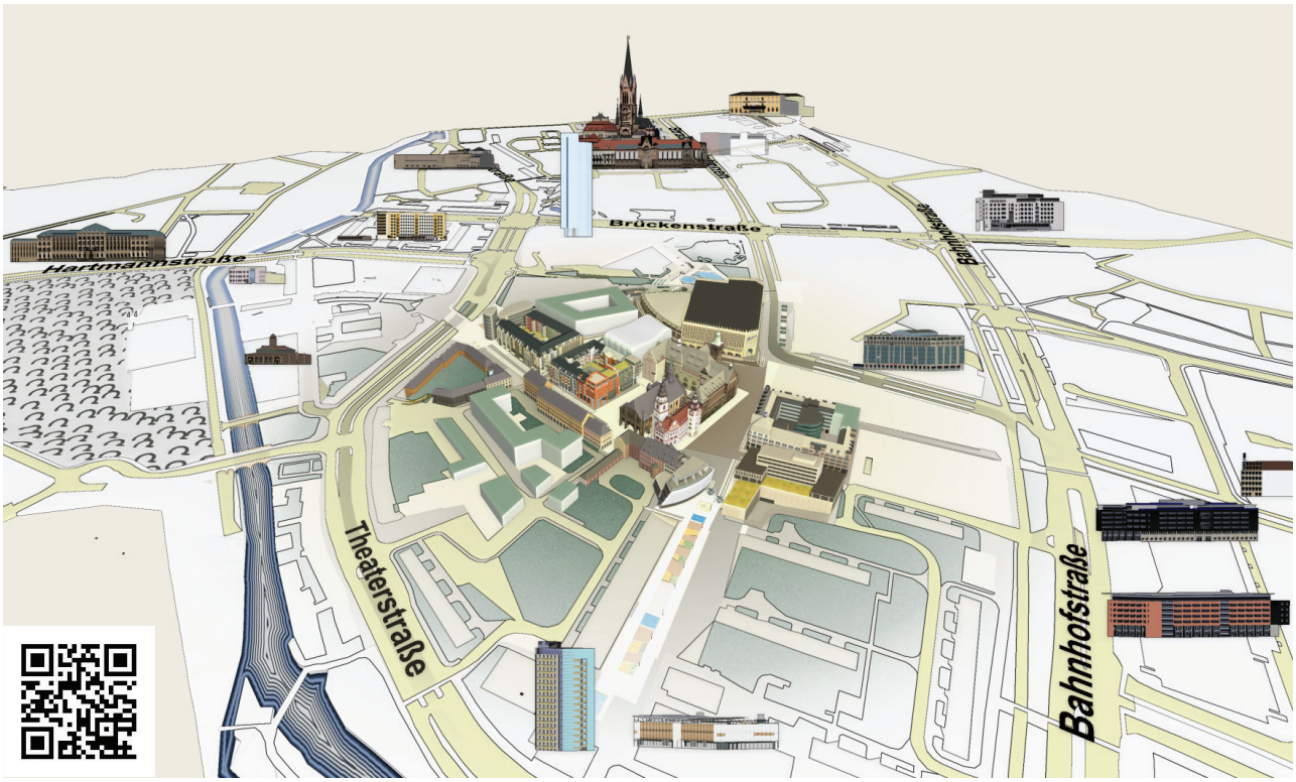
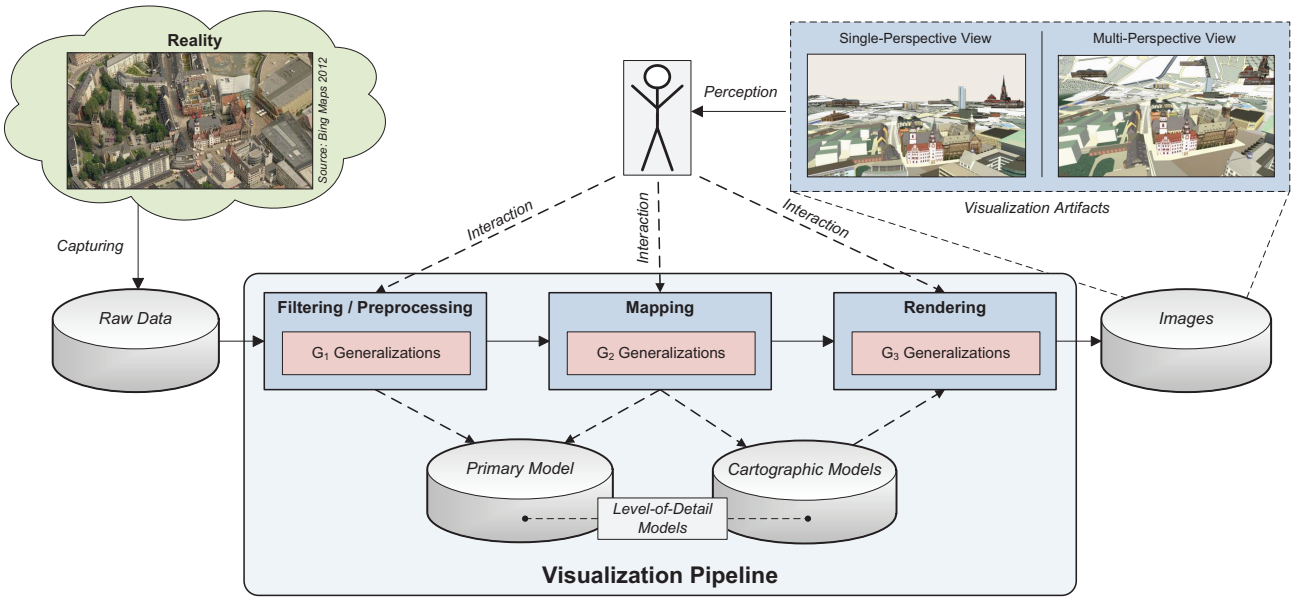


Cartography-Oriented Visualization



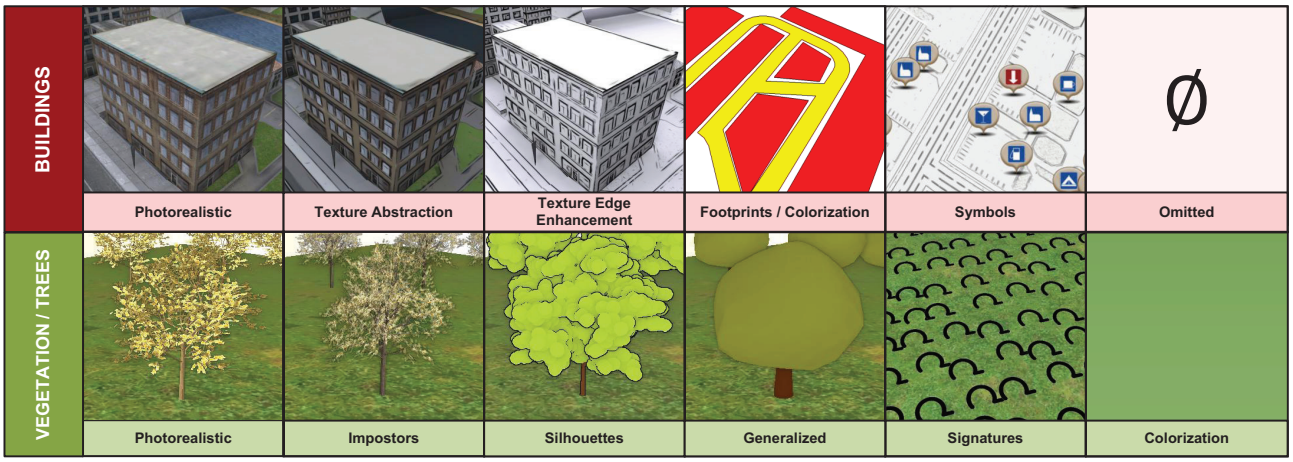
Cartography-Oriented Visualization - Visualization Pipeline

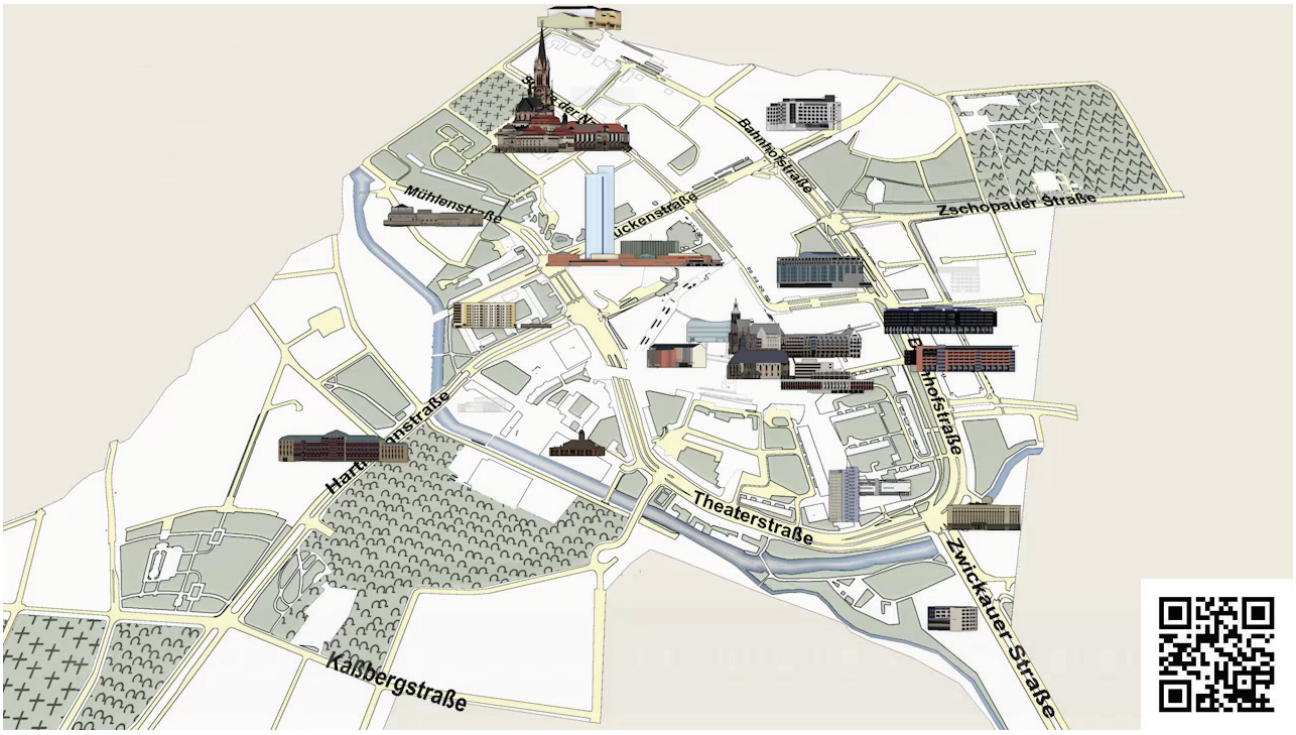


Cartography-Oriented Visualization - Filtering

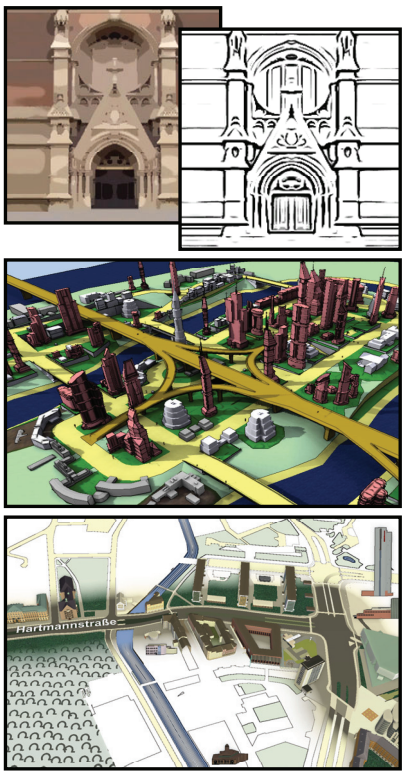
- Filtering stage converts raw data into primary model
- Primary model contains geometric and semantic geodata
- Primary model organizes geodata and geobjects into:
  - Feature classes (e.g., buildings, green areas, and roads)
  - Multiple Level-of-Detail (LoD) representations per feature class
  - User/Task-specific Regions- and Points-of-Interests

- Mapping stage converts primary model into cartographic model
  - Mapping of 3D geodata to rendering primitives (e.g., colored/textured triangles)
  - Multiple Level-of-Abstraction (LoA) representations are generated per feature class





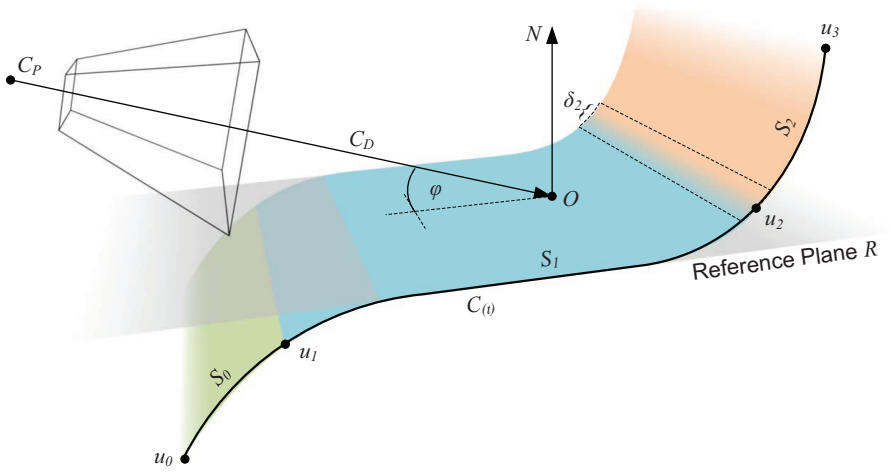
Cartography-Oriented Visualization - Summary

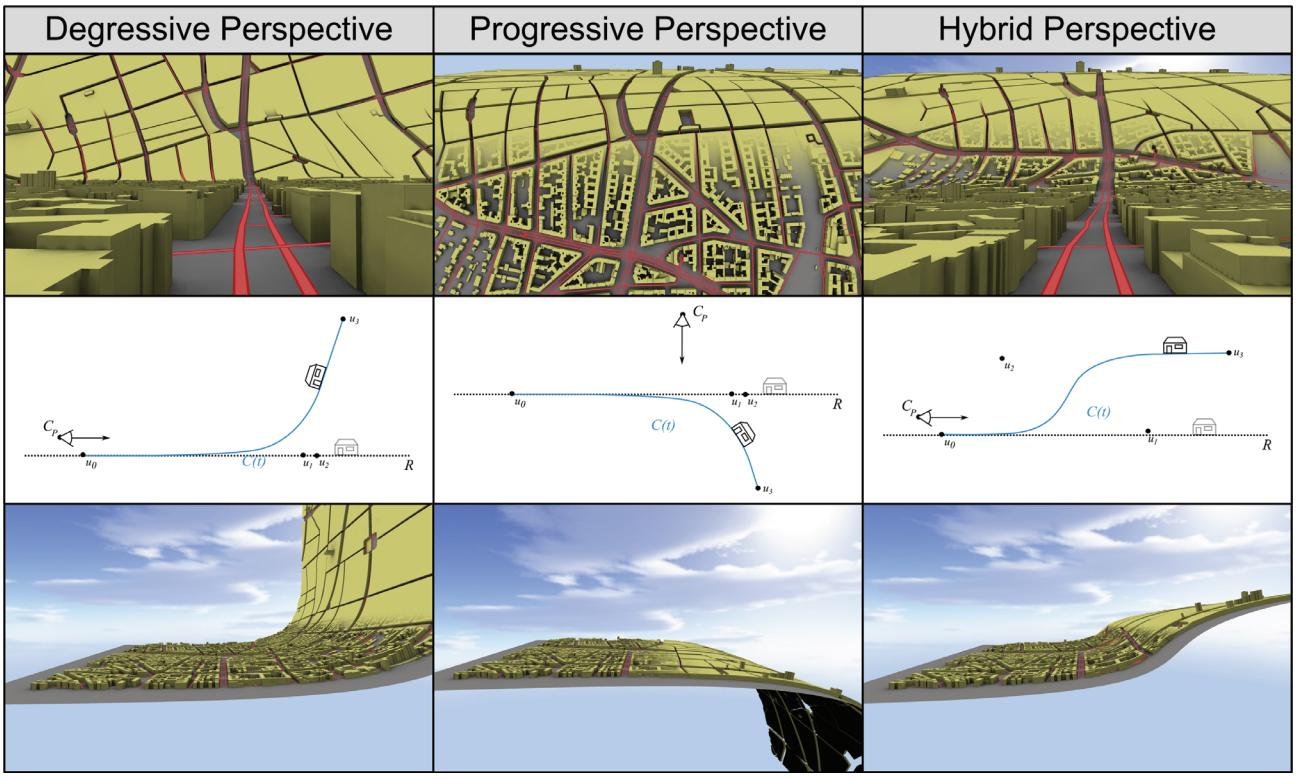


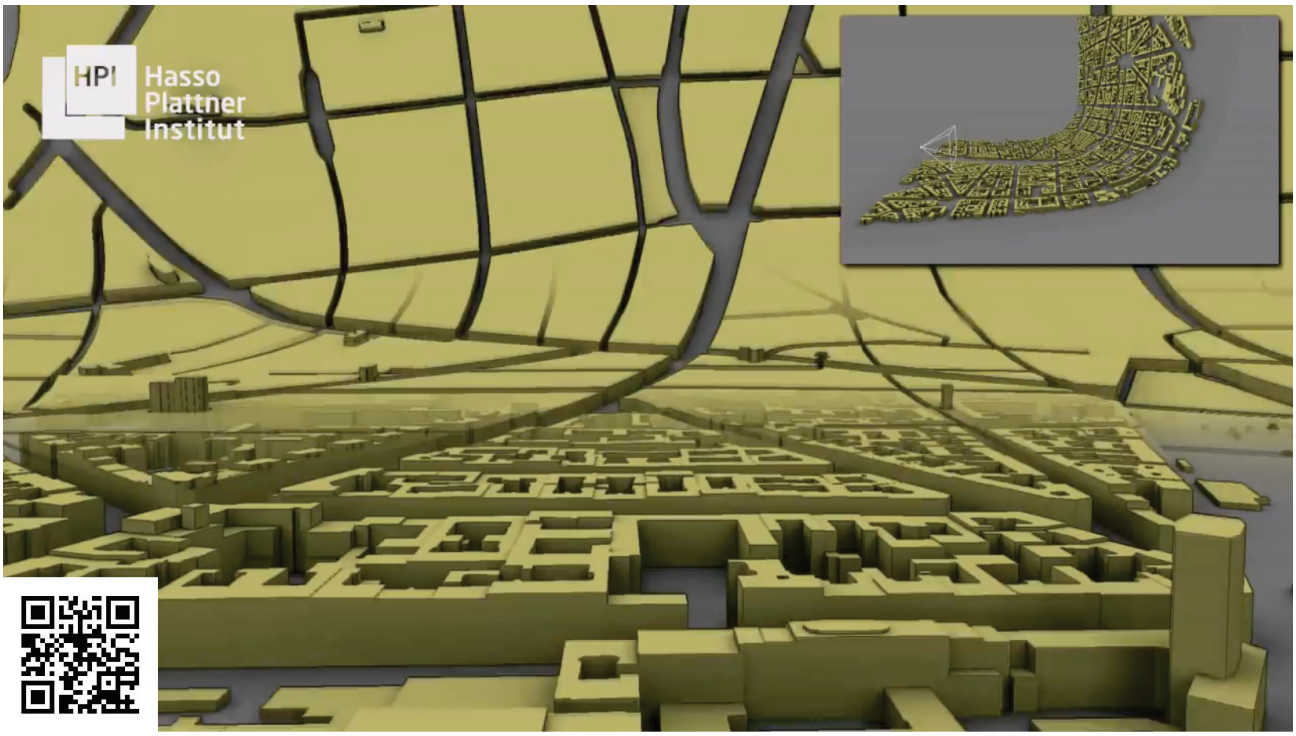
- Level-of-abstraction is a concept suitable for geometric and visual abstraction
- Cartography-oriented visualization can aid orientation, navigation, and exploration tasks within 3D geovirtual environments
- Parametrized level-of-abstraction can be used for seamless combinations of graphic styles

Multiperspective Views (MPVs)

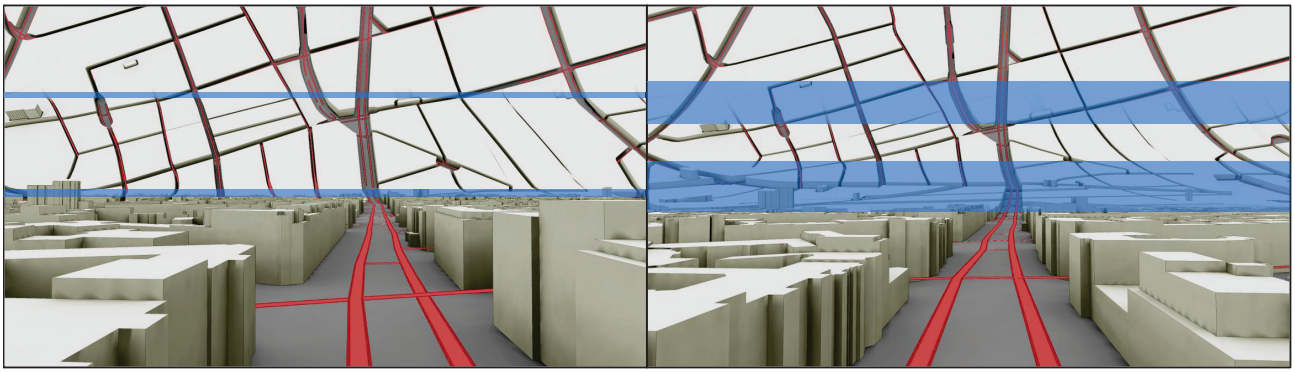
- Shape of the MPV is controlled by a parametric curve $C(t)$
  - $C(t)$ is defined by a set of control points
  - High degree of freedom enables different configurations
  - Map-producer defines multiple MPV-configuration, each associated with the control parameter ϕ (e.g., viewing angle)







- Subdivision of MPV into viewport-zones by minimizing transition zones
  - Each viewport-zone depicts geoobjects with one viewing angle
  - Eases comparison of geoobjects in one zone and decreases number of cartographic scales



Degressive perspective with (left) and without viewport-zones (right).

Discussion

- Combination of cartography-oriented visualization and multiperspective views is a promising approach for comprehensible D3DMs
  - Implements design aspects for D3DMs
  - Mitigates drawbacks of current D3DMs
- **But:** User study is required to proof its effectiveness

Conclusions

- Concept offers multiple options to adjust the graphic style of a D3DM to tasks and contexts
  - May serve as framework for more elaborate research on D3DMs
  - Map-producer must define a set of feasible configurations to hide complexity from the user
- View-dependent interpolation of different graphic styles reduces configuration overhead during map-usage
- User can be involved in the map-production process by integrating location-knowledge (e.g., retrieved from Google+ Local™)

Thank You For Your Attention

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