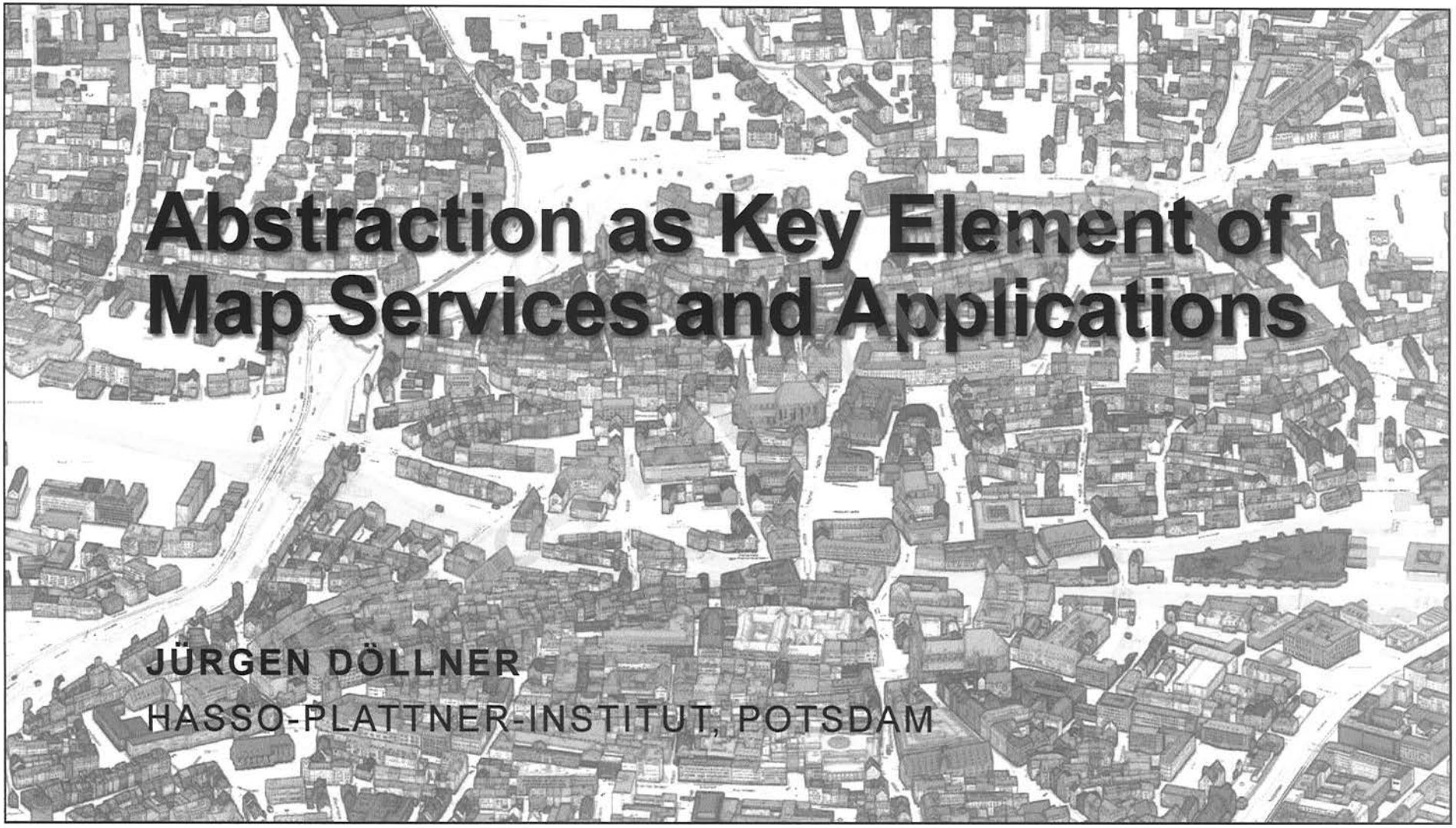


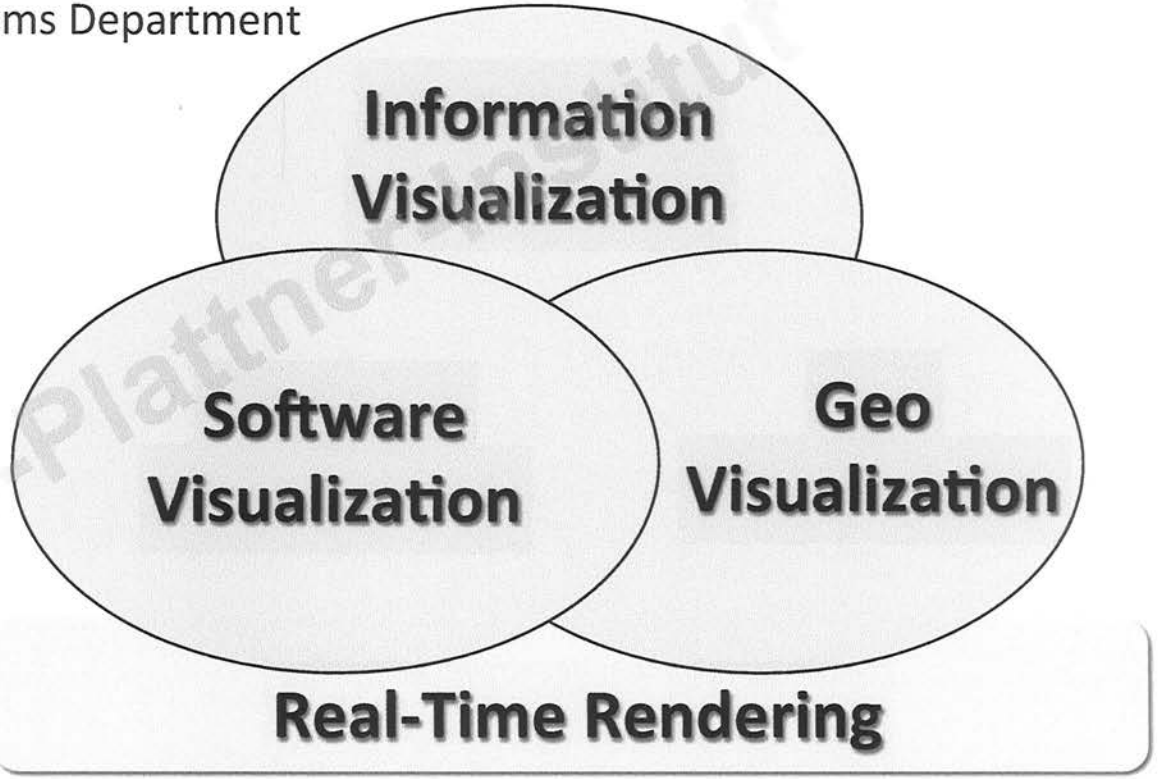
Abstraction as Key Element of Map Services and Applications

JÜRGEN DÖLLNER

HASSO-PLATTNER-INSTITUT, POTSDAM

About HPI

- HPI Computer Graphics Systems Department



About HPI

- InfoVis|SoftVis|GeoVis : Map-based visualization strategies and techniques

(Source: Software Diagnostics, www.softwarediagnostics.com)

1 Motivation

1 Motivation

Photorealistic (2D+3D Geospatial) Visualization

- 3D Modeling and Texturing
- Real-Time 3D Rendering
- Perspective Projections

Visualization Goals:

- "...gaining insights..." (into non-simple structures, relations, etc.)
- "...making something visible to the human mind..." (not to the eyes only)

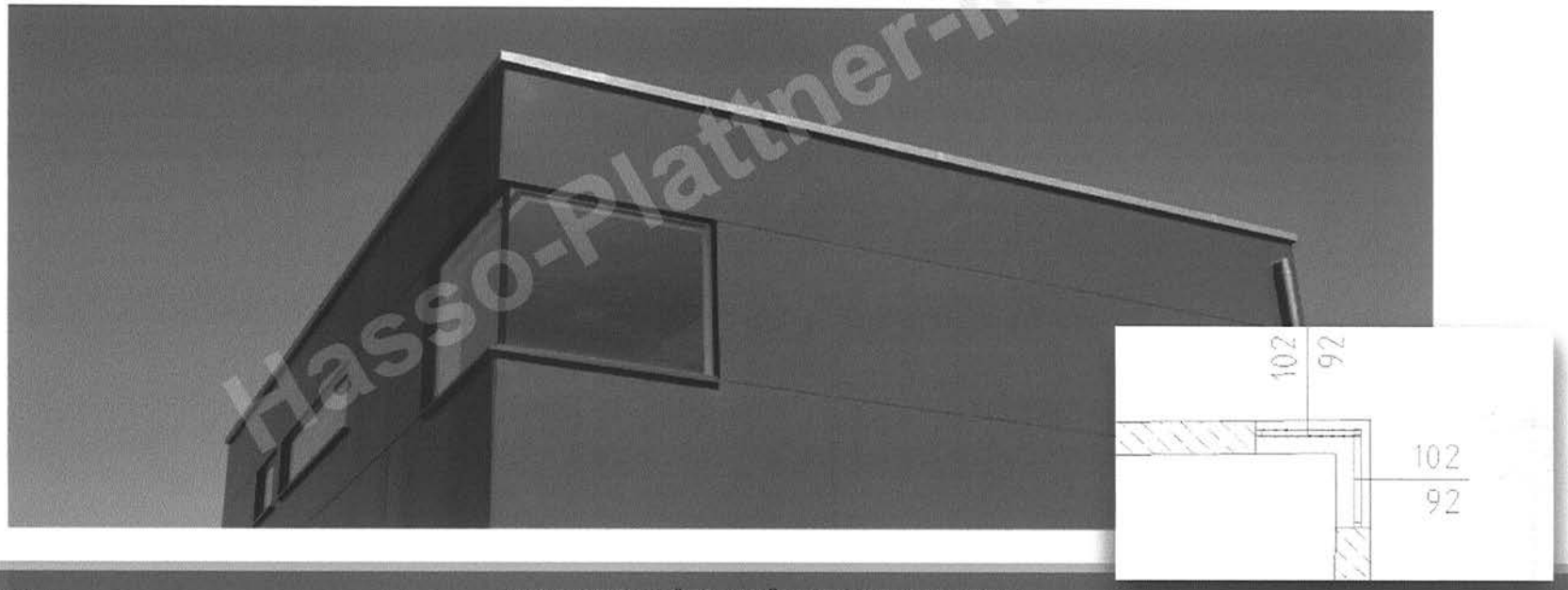
Lack of Abstraction

- Information density (e.g., visual clutter, occlusion, ambiguity)
- Conceptually difficult blending with georeferenced/geospatial thematic information

1 Motivation

Technology that Shapes

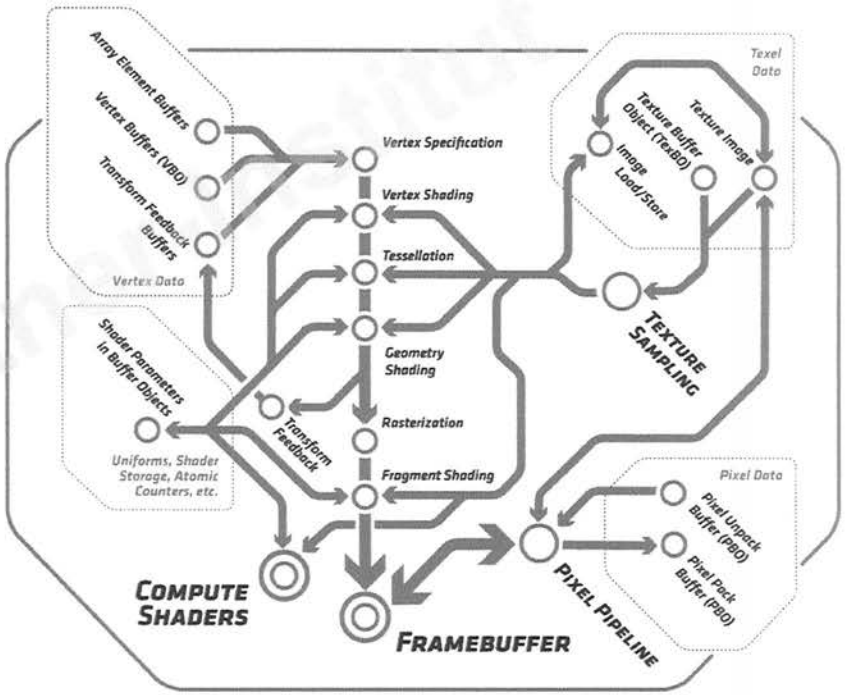
- Systems, applications, and tools define to a (rapidly growing) significant degree the scope of our –personal and professional– processes and their methodology.



1 Motivation

Rapid Growth of 3D Computer Graphics as a Ubiquitous Technology

- Massive parallel processing power
- Available on mobile devices, supported by web browsers, and (effectively) standardized
- Long-term strategic development, e.g. OpenGL, OpenGLSL, OpenGLES (www.opengl.org)



1 Motivation

Rapid Growth of 3D Computer Graphics as a Ubiquitous Technology

- Massive parallel processing power
- Available on mobile devices, supported by web browsers, and (effectively) standardized
- Long-term strategic development, e.g. OpenGL, OpenGLSL, OpenGLES (www.opengl.org)
- "Programmable Shader Stages" – the technical back bone

```
out vec4 v4FragmentColor;


// shader entry point
void main(void)
{
  // sampling 2D texture using texture coordinates
  vec4 v4Diffuse = texture(textureAlbedoRGB, DataIn.texCoords);

  // set the specular term to black
  vec4 spec = vec4(0.0);

  // normalize both input vectors
  vec3 n = normalize(DataIn.normal);
  vec3 e = normalize(vec3(DataIn.eye));

  // compute local intensity
  float intensity = max(dot(n,l_dir), 0.0);

  // if the vertex is lit compute the specular color
  if (intensity > 0.0)
  {
        // compute the half vector
        vec3 h = normalize(l_dir + e);
        // compute the specular term into spec
        float intSpec = max(dot(h,n), 0.0);
        spec = specular * pow(intSpec,shininess);

  }//endif

  v4FragmentColor = max(intensity * v4Diffuse + spec, ambient);
  return;
}
```

2 Multiperspective Views

Abstracting geospatial geometry by multiperspective views
- "bended maps", similar to panorama maps
- interactive 3D rendering
- 3 zones: near, middle, far, each with own styling

Bundesministerium für Bildung und Forschung

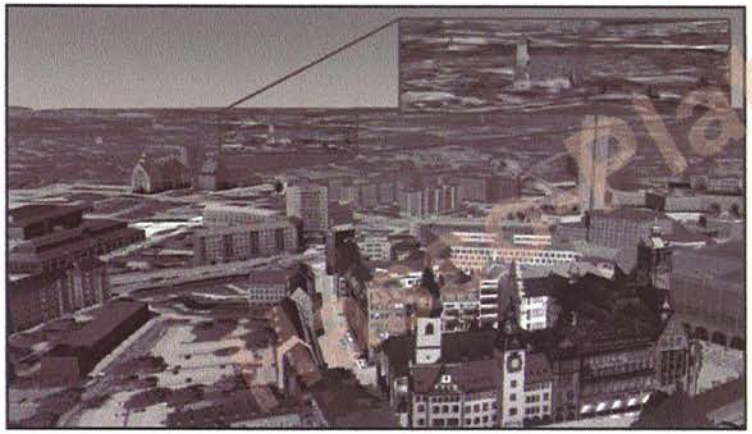
HPI Hasso Plattner Institut
www.hpi3d.de

INNOPROFILE UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder

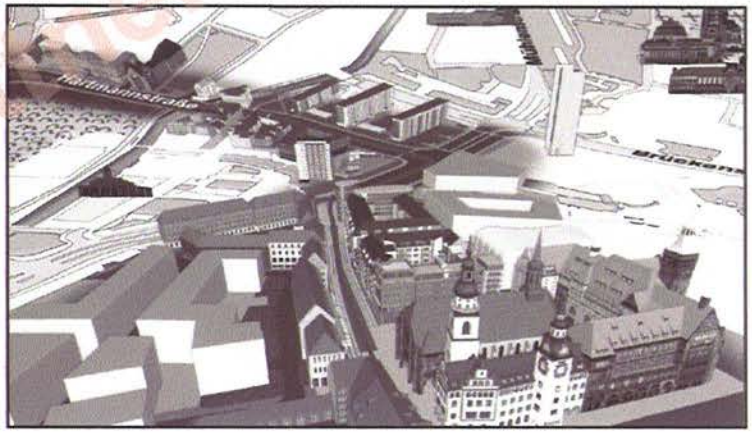
2 Multiperspective Views

Characteristics of multiperspective views

- Exhaustive screen space usage
- Focus-&-context areas
- Control of visual clutter (perspective compression)
- ...

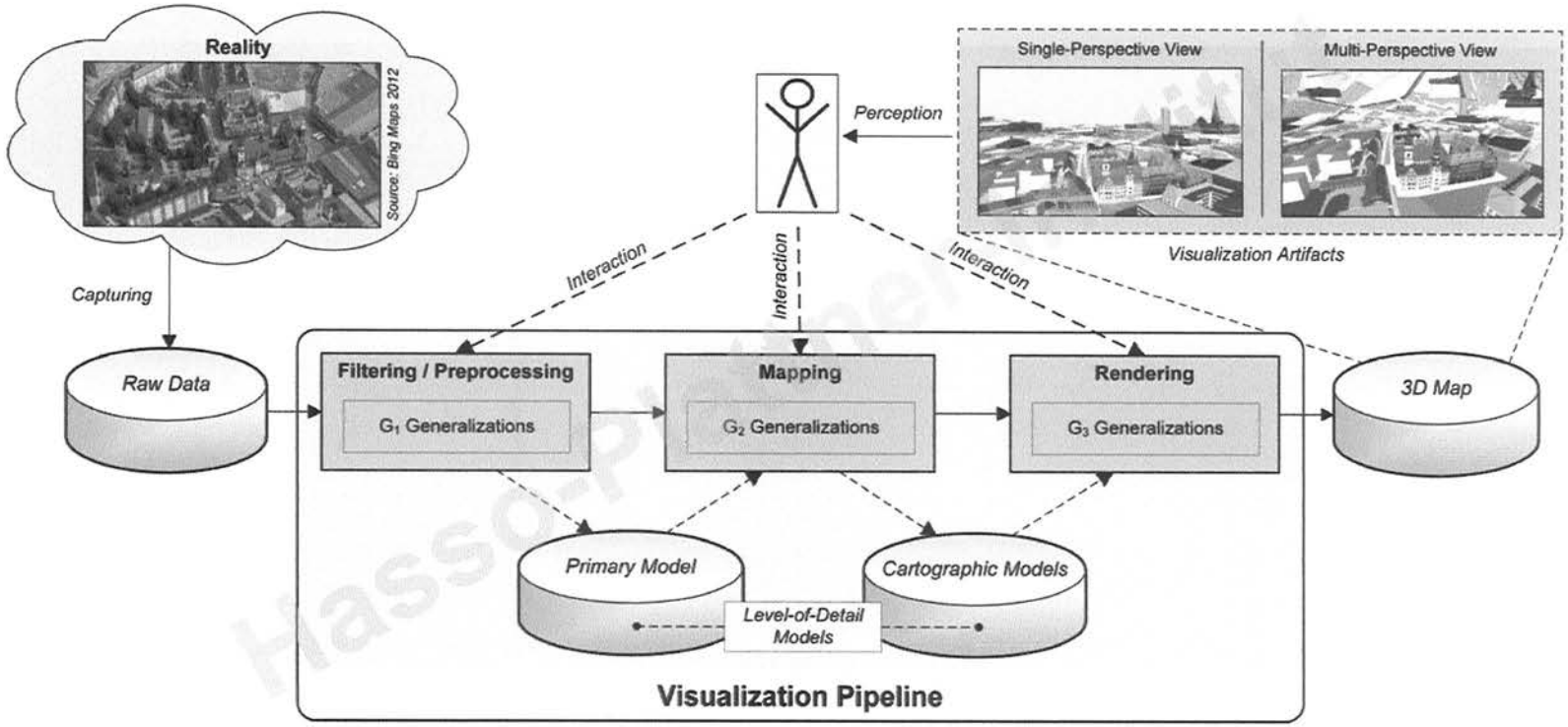


Single Perspective View

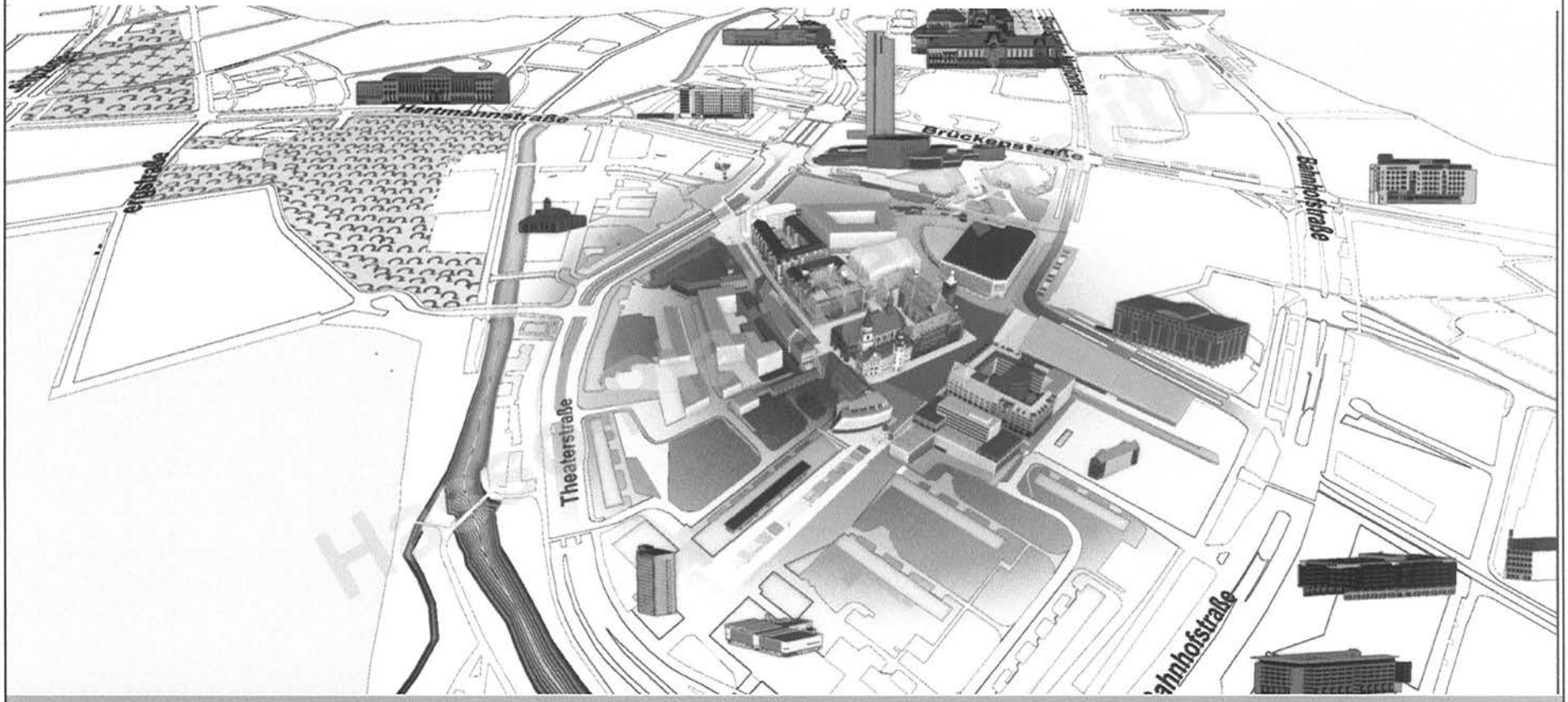


Multiperspective View

2 Multiperspective Views



3 Level-of-Abstraction (LOA)



3 Level-of-Abstraction (LOA)

Level-of-Detail (LOD):

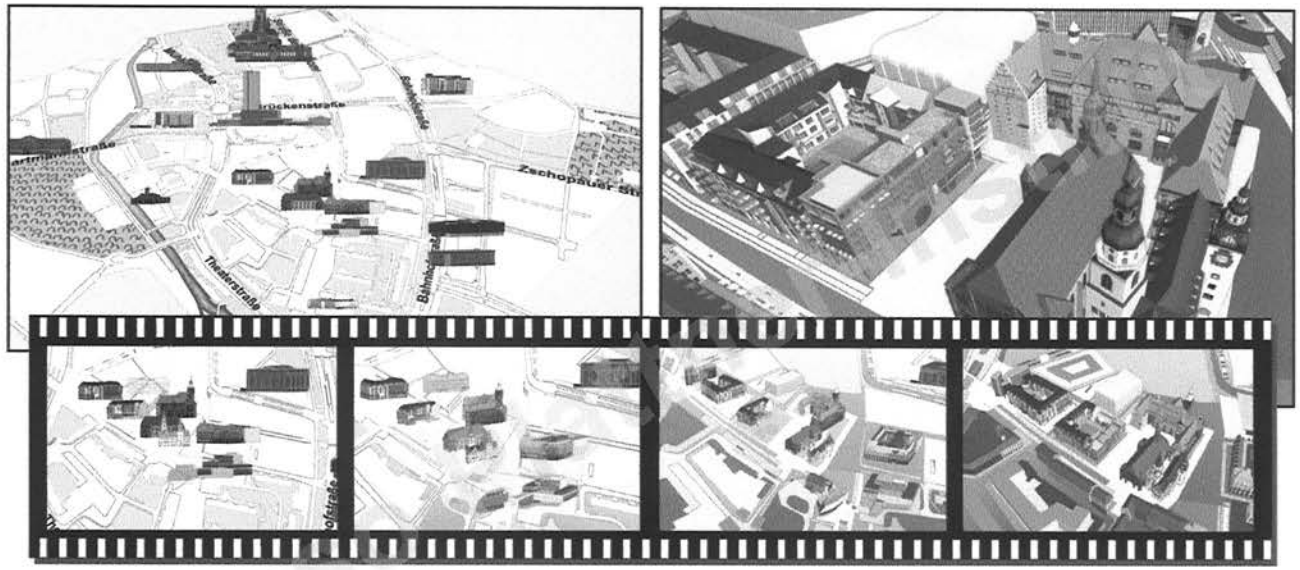
- Multiresolution representations of one given, high resolution 3D model
- LODs aim at efficient computer graphics representations, providing the same appearance at different computer graphics resolution levels

Level-of-Abstraction (LOA):

- Multiple representations of one given, high resolution 3D model, generalized with respect to geometry, appearance, and semantics.
- LOAs aim at effective communication of complex models, providing different levels of abstraction having different geometry, topology and appearance.
- Typical range: map signature, 2D icon, simplified 3D model, high-res 3D model

LOD ≠ LOA

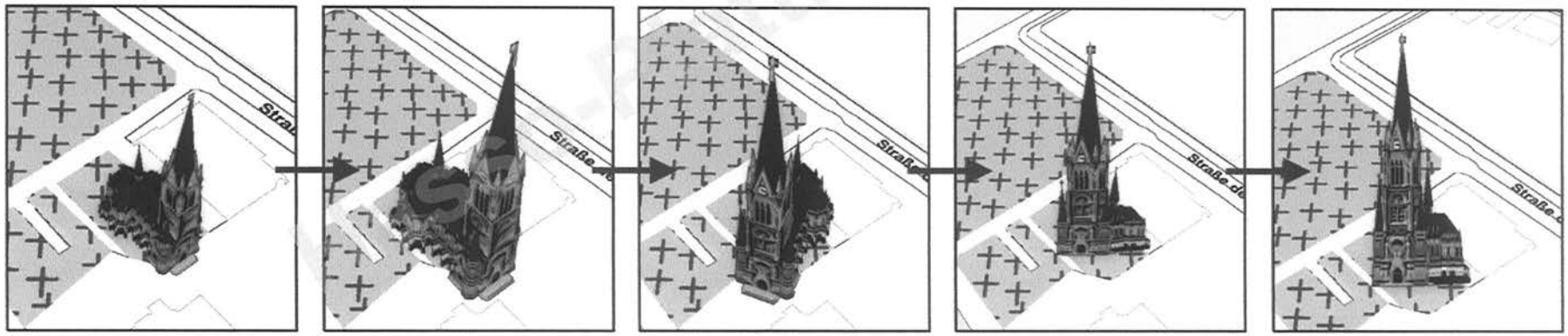
3 Level-of-Abstraction (LOA)



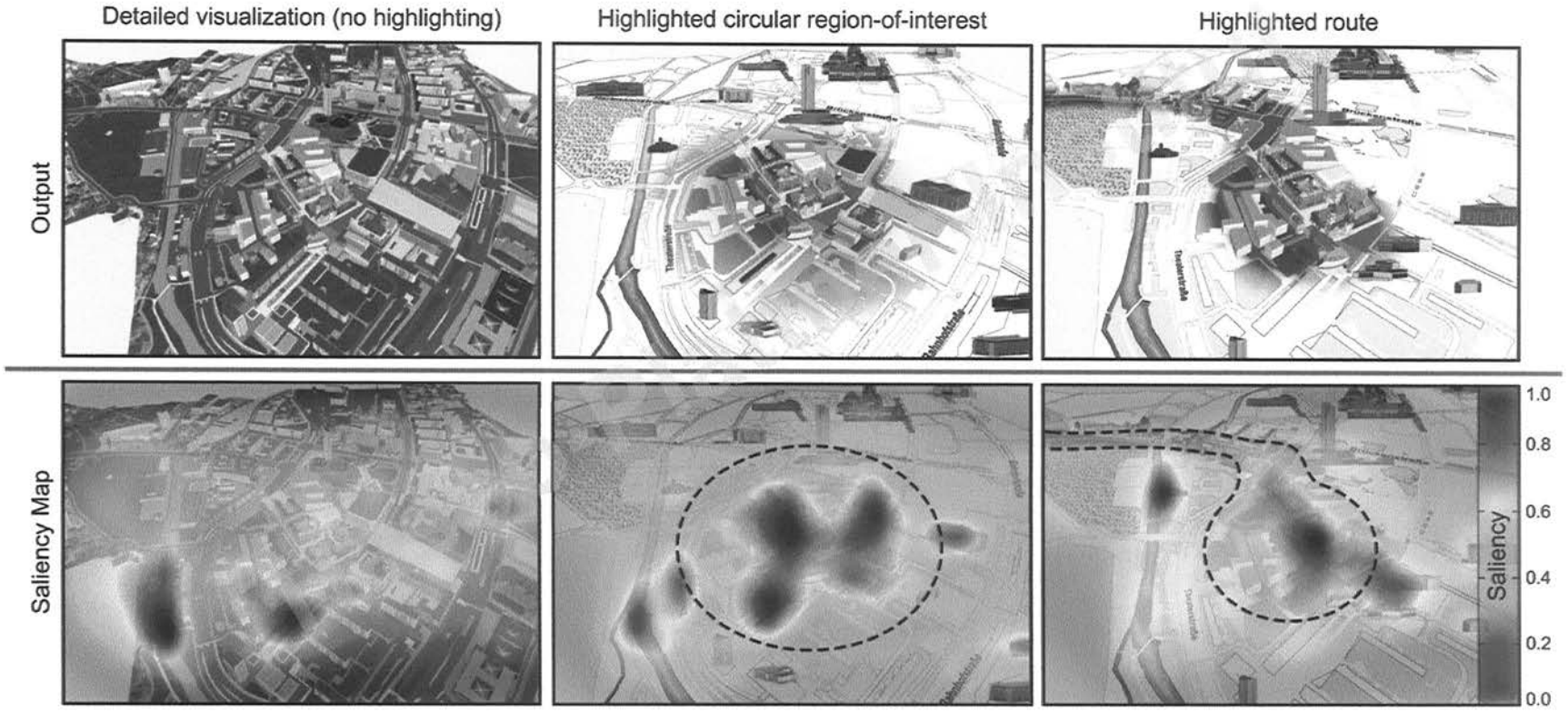
- How to compute different LOAs for a given 3D model?
- How to select LOA models in a context-dependent way?
- How to seamlessly switch among them during interaction?

3 Level-of-Abstraction (LOA)

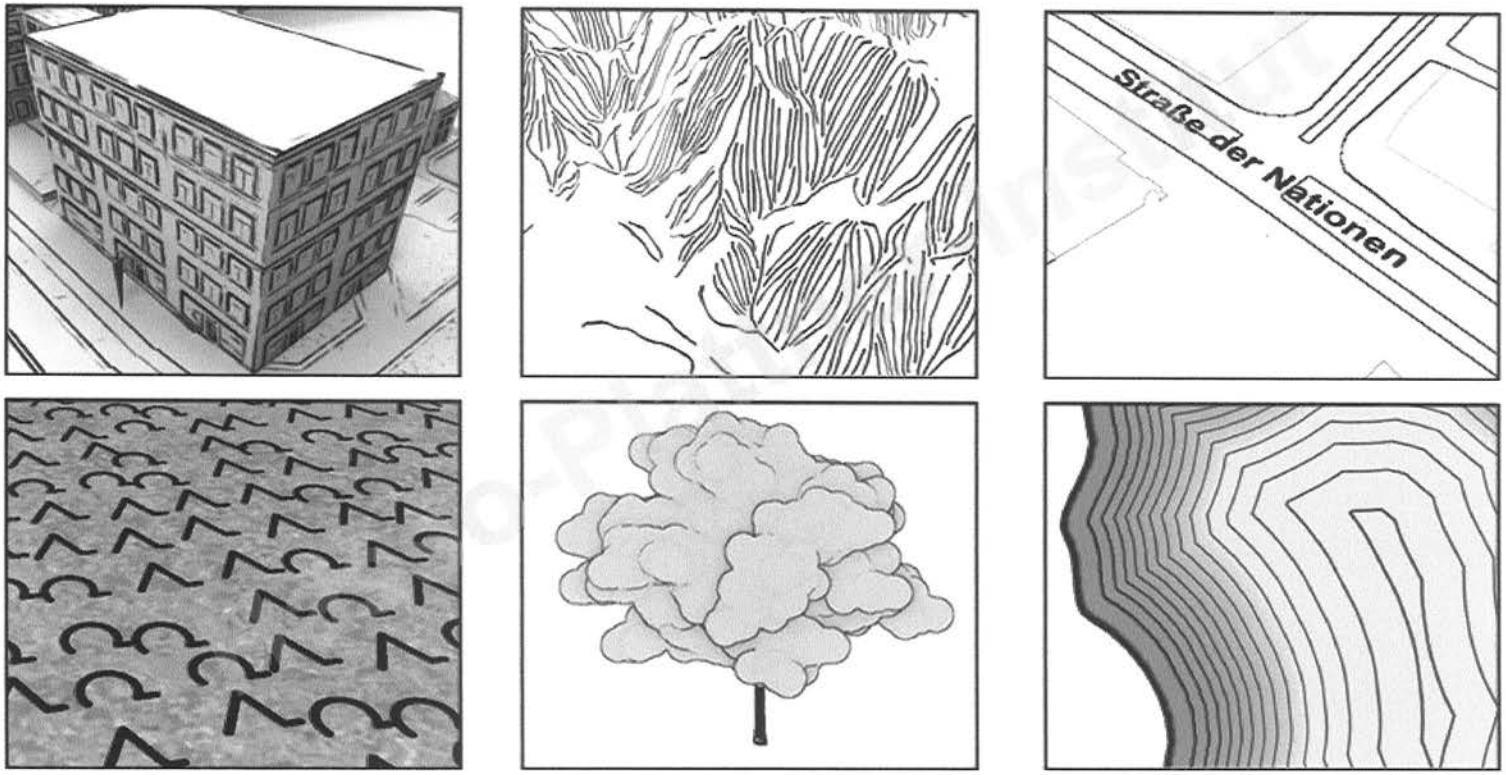
- Iconic visualization of landmarks, e.g., for localization, orientations, and navigation tasks
- Landmarks are deformed and rotated such that its „best view" and user's viewing direction match
- Best view information approximated using *viewpoint entropy*



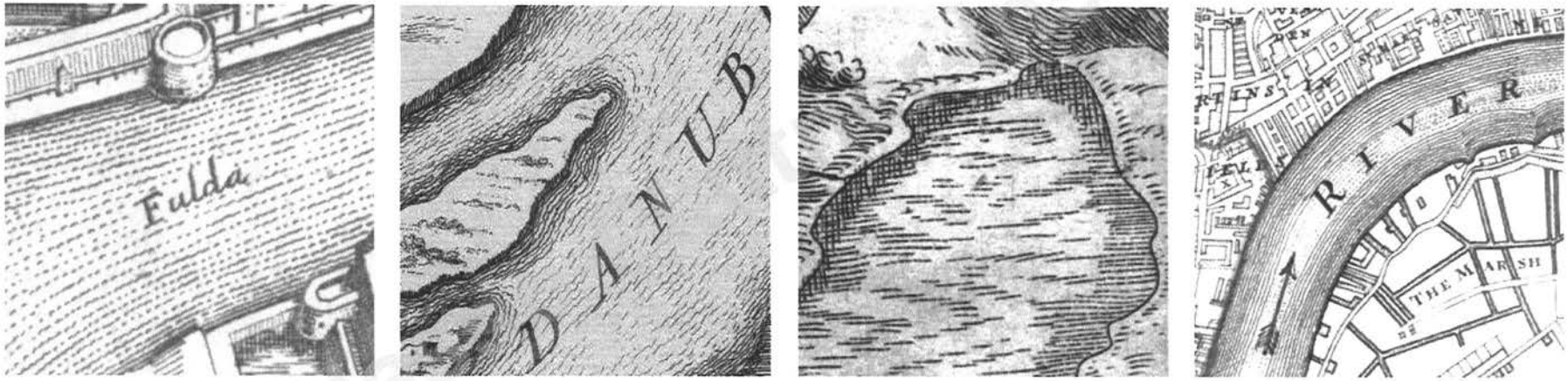
3 Level-of-Abstraction (LOA)



4 Cartographic Rendering Techniques



4 Cartographic Rendering – Water Surfaces



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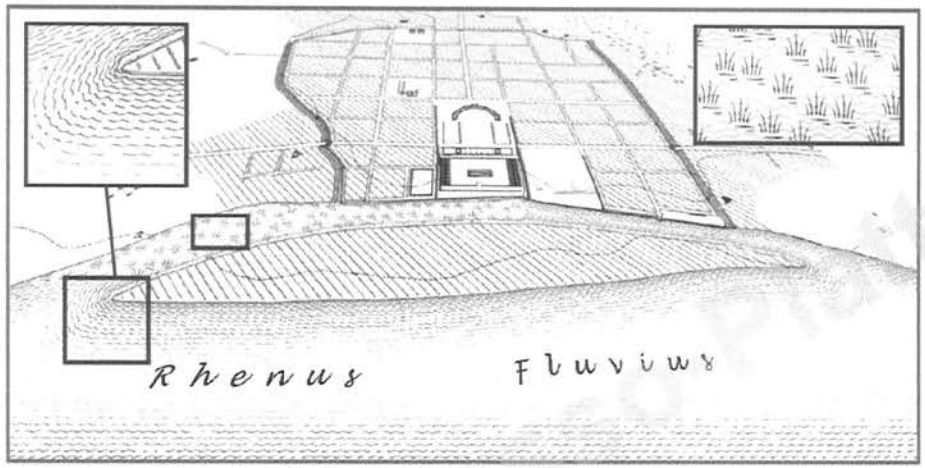

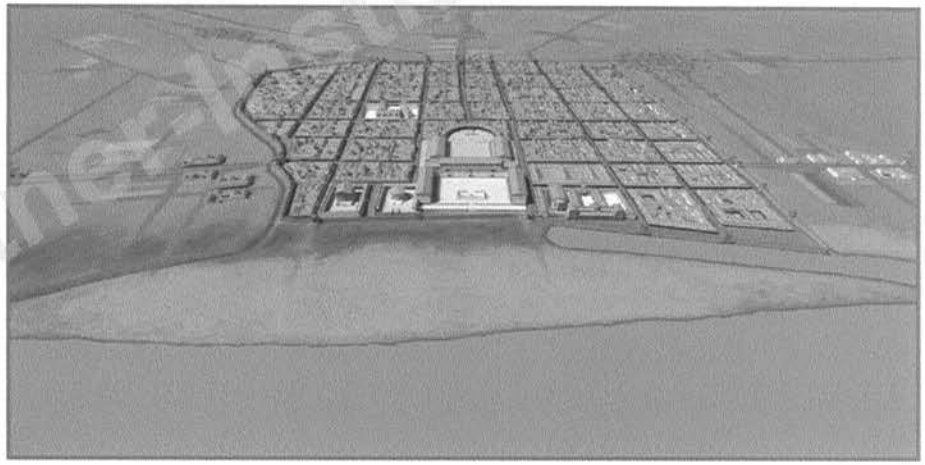

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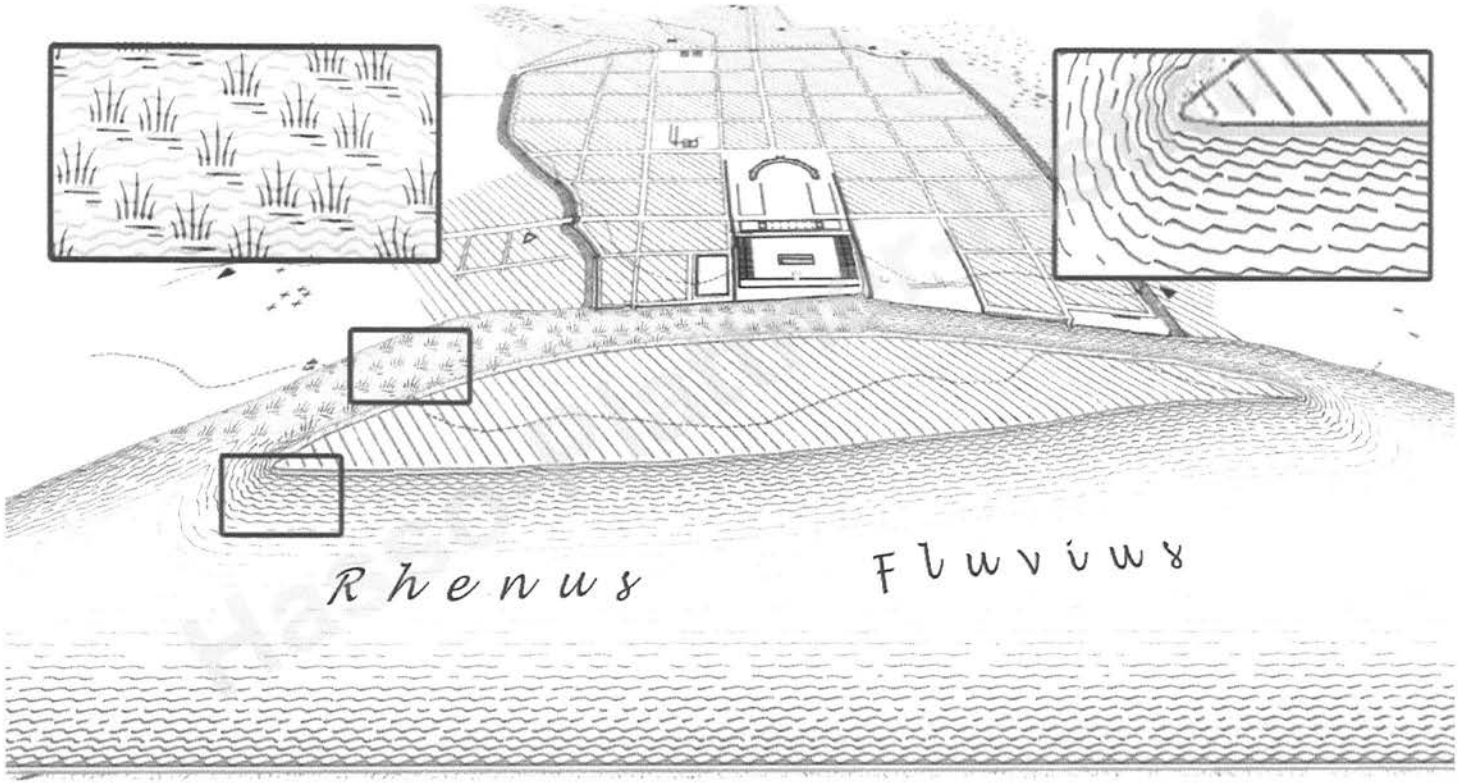

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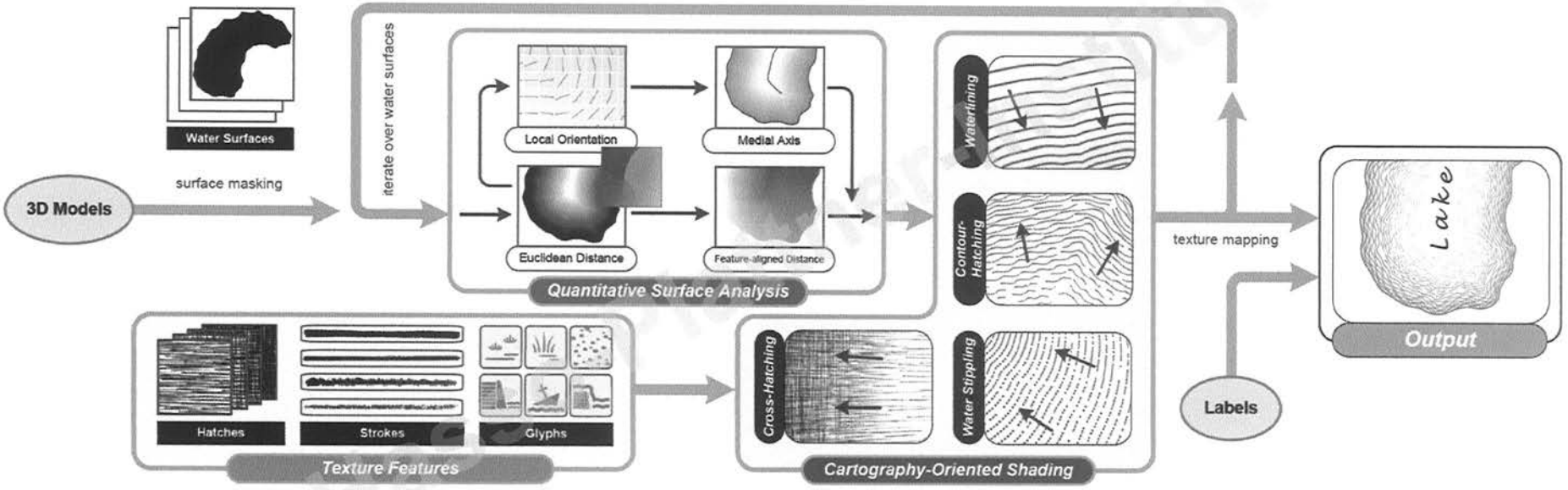

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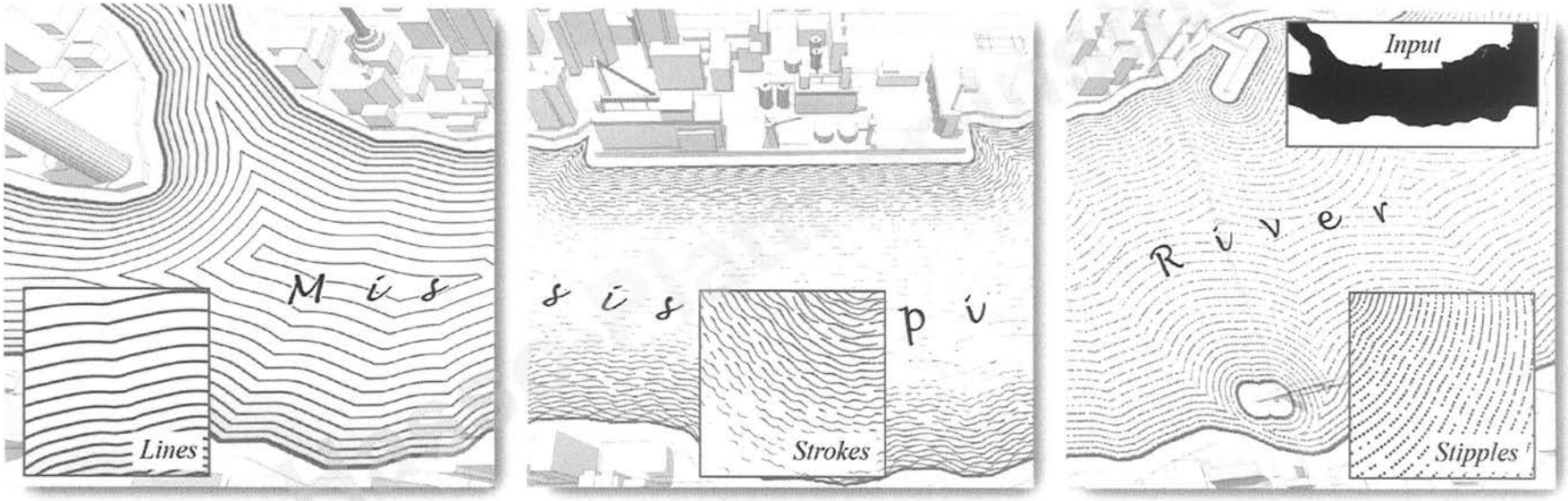

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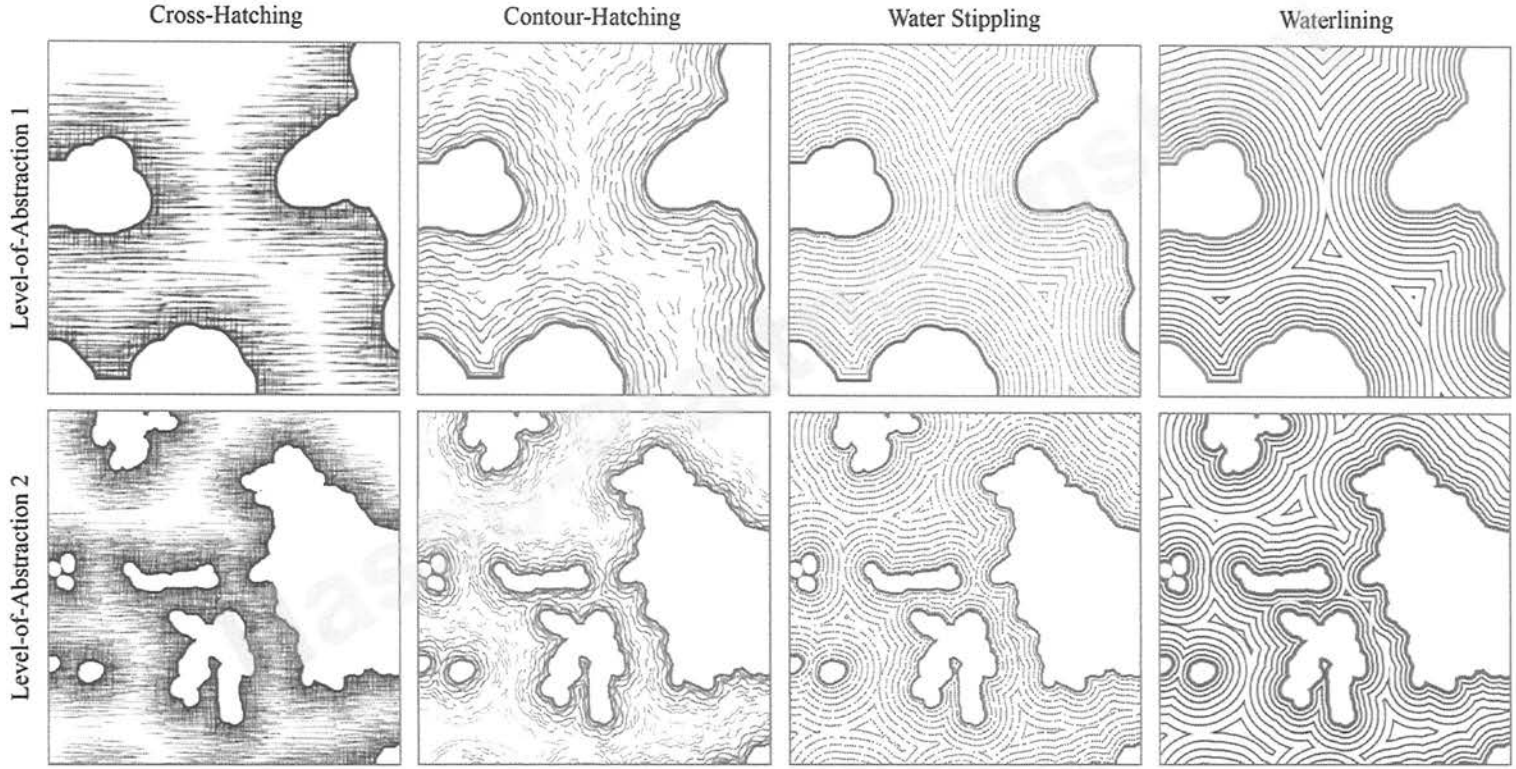
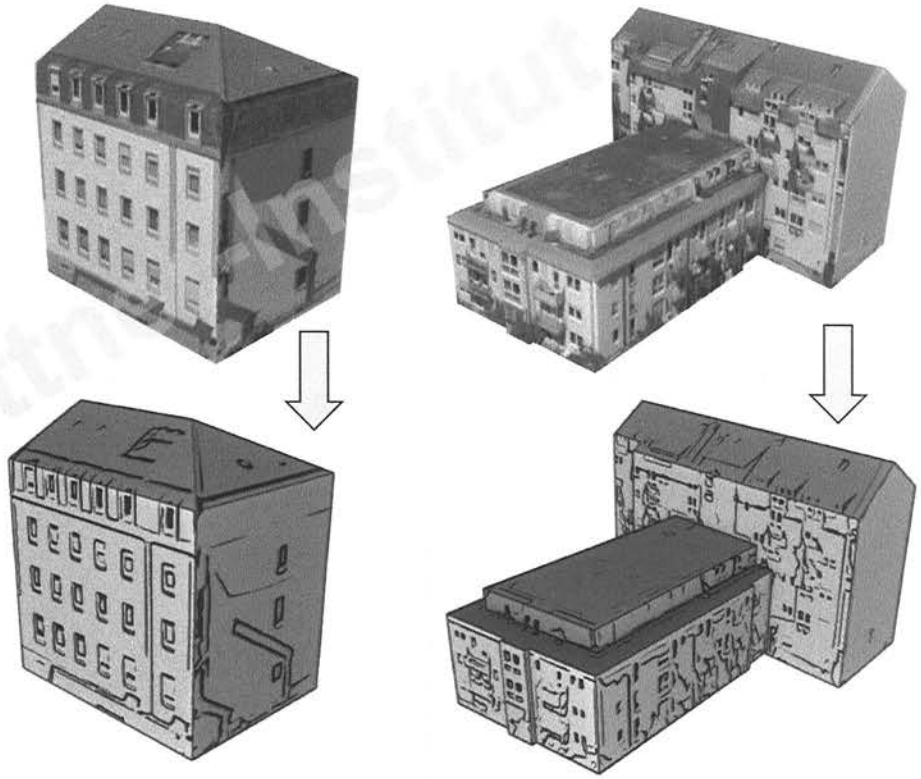


5 Cartographic Rendering - Buildings

- Goals
  - Express „uncertainty“
  - Highlight structures and features
  - Reduce visual noise
  - Enable high compression rate for facade textures
- Dominant color tone detection on photorealistic facade textures
- Colorization according to dominant colors
- Edge detection on textures to integrate structural information in visualization



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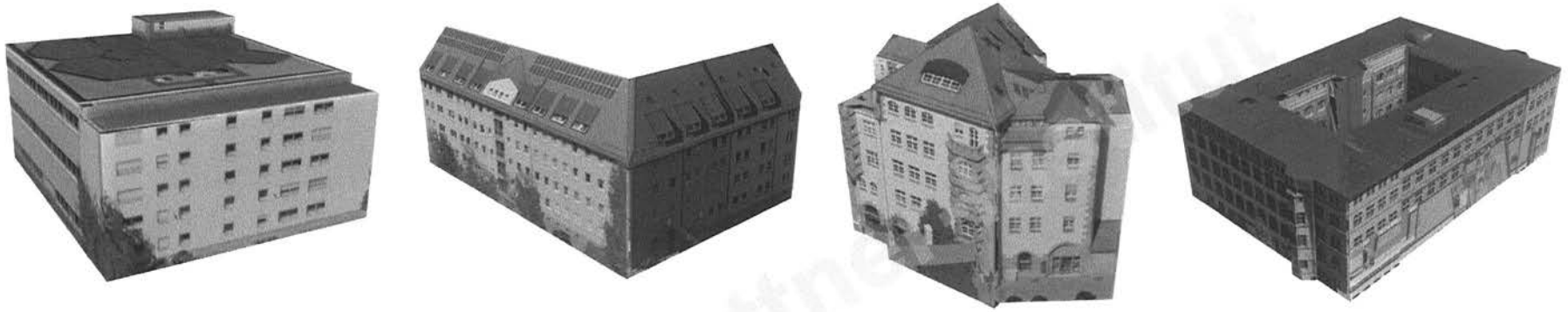
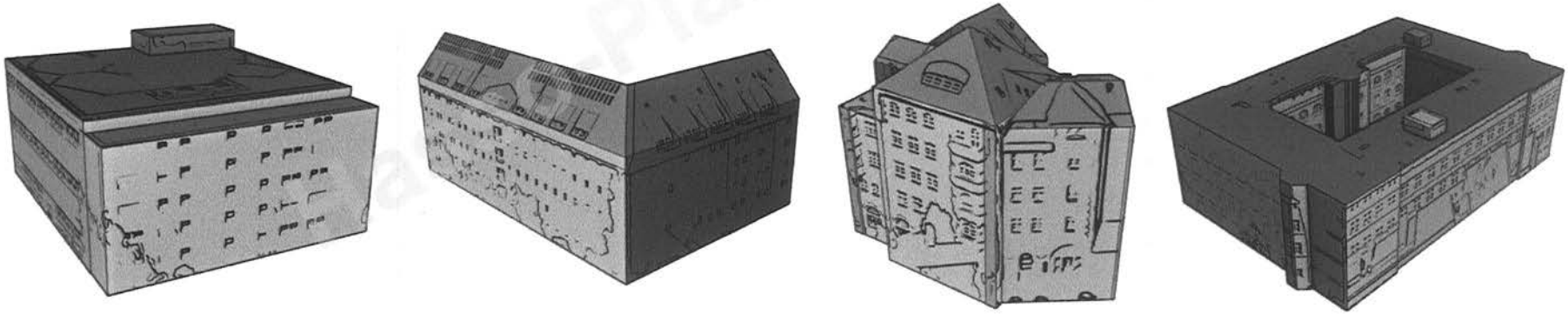
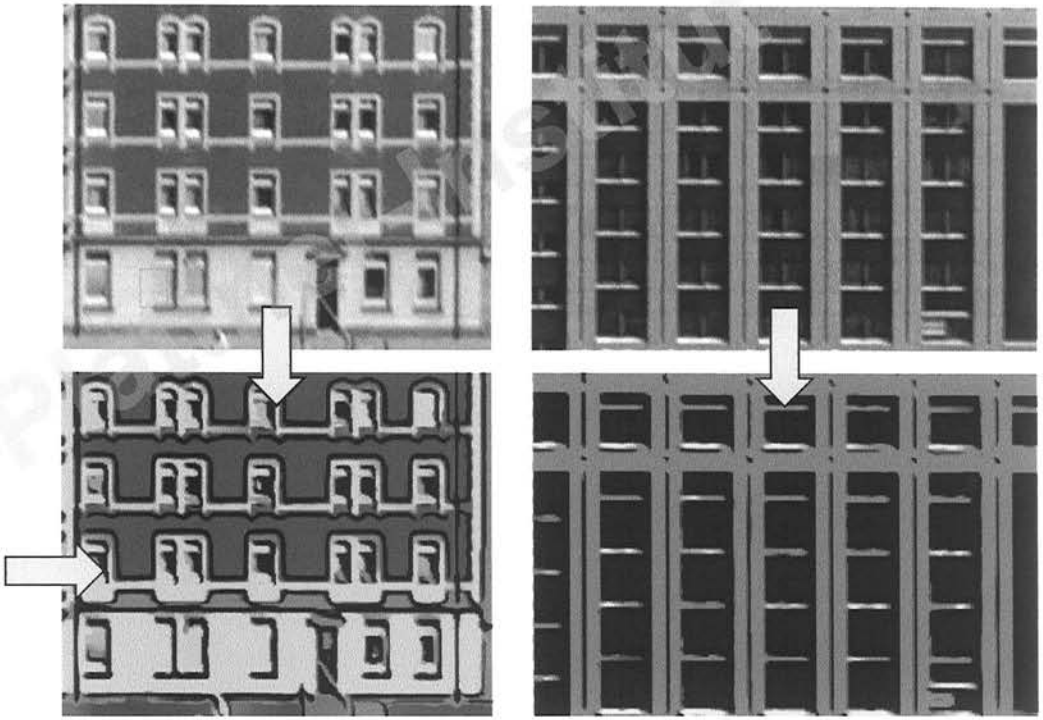




5 Cartographic Rendering - Buildings

- Colorization of Facades
- (Re-)colorize facade textures according to dominant colors
- Reduces color palette and visual noise, and improves feature contrasts in visualization
- Enables high compression rate for abstracted facade textures



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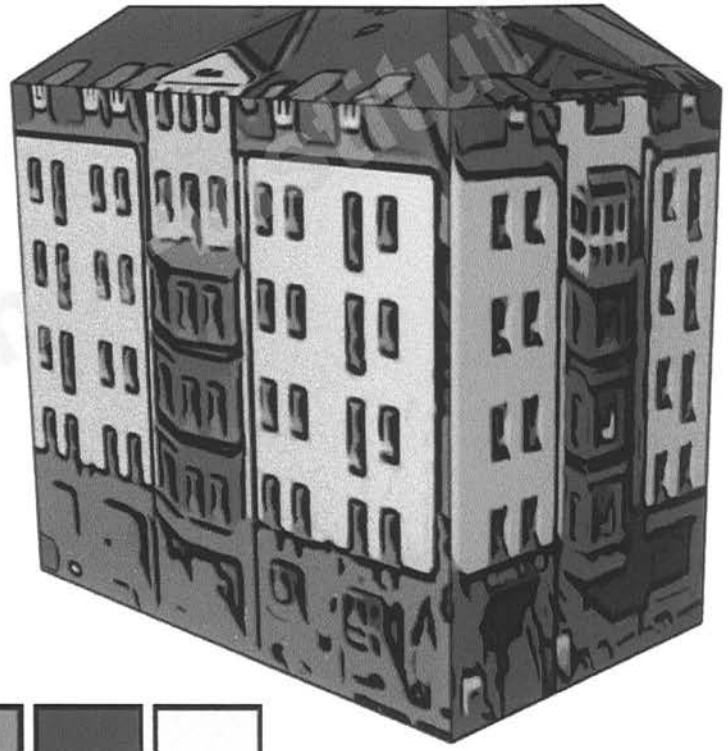

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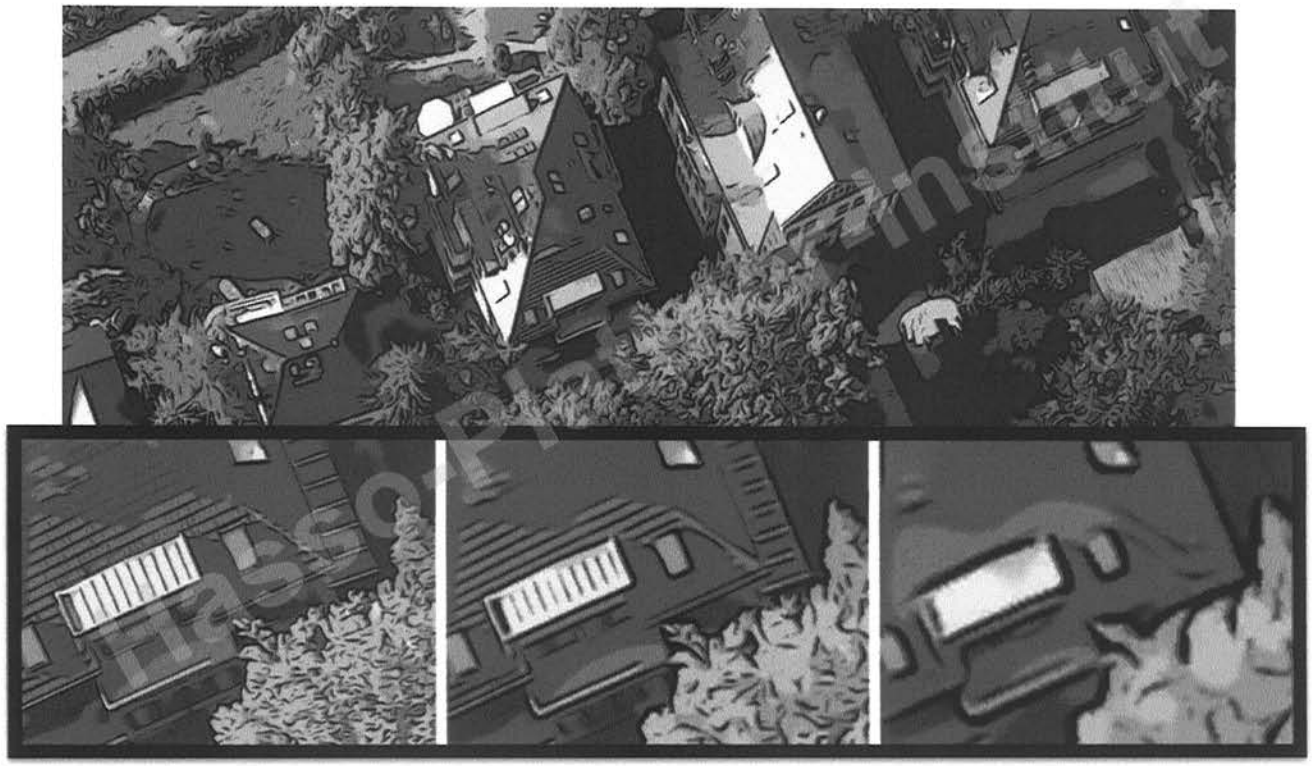

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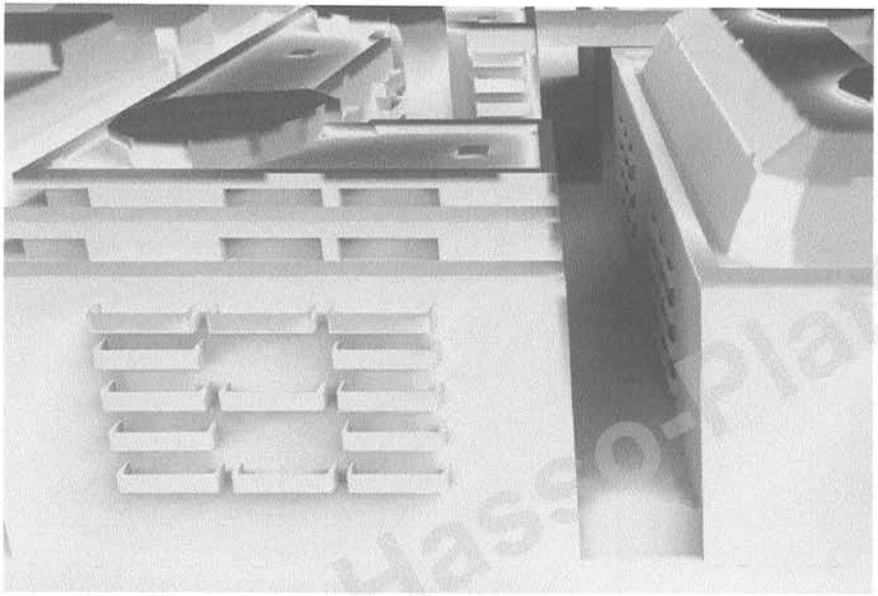
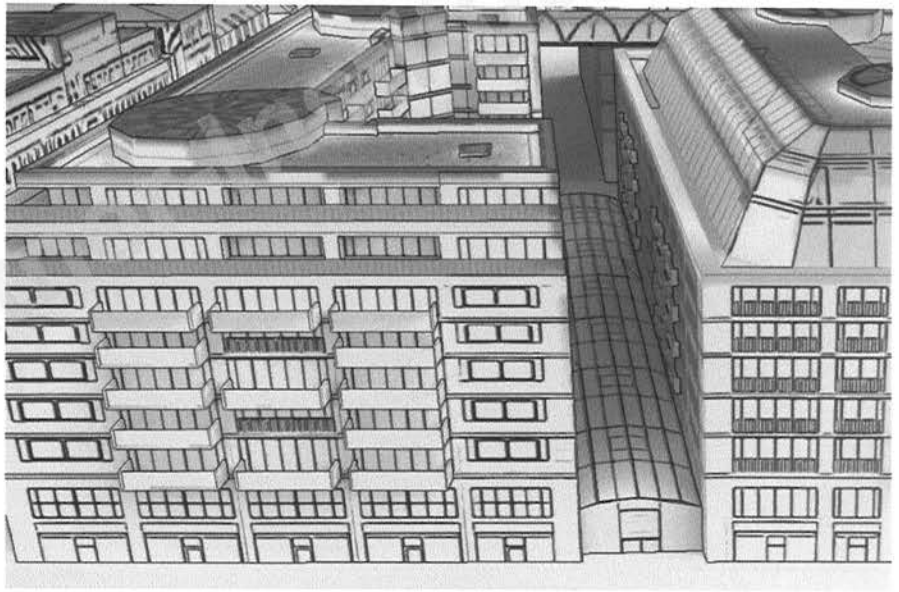
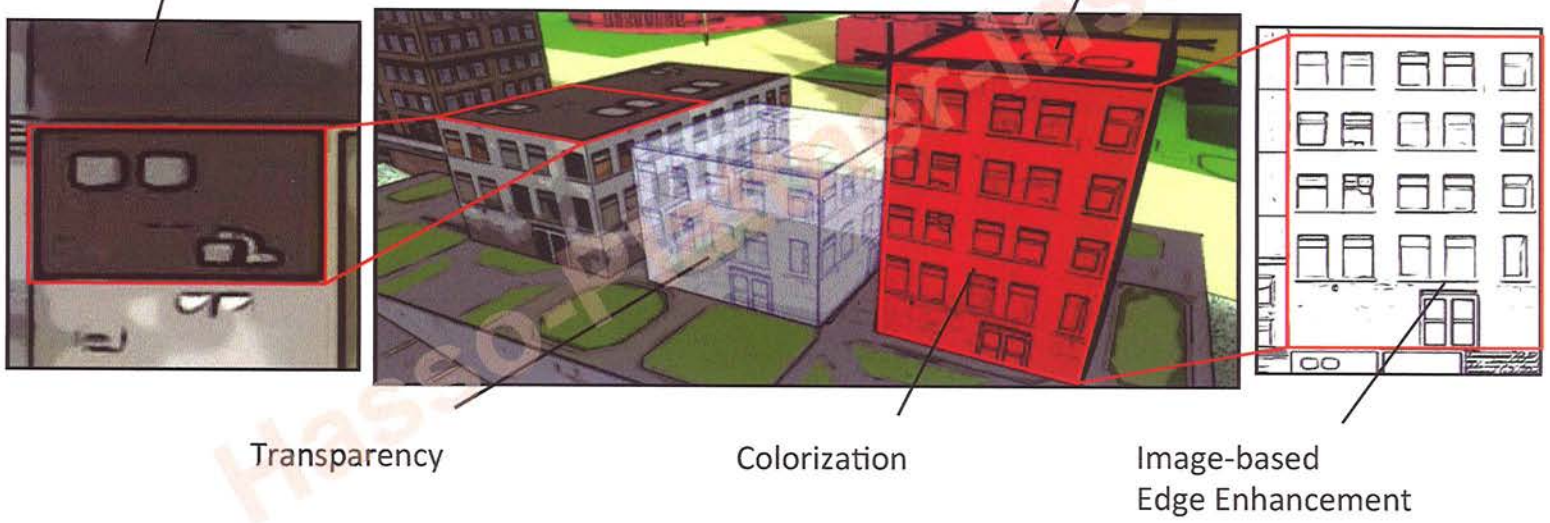


Solar Potential

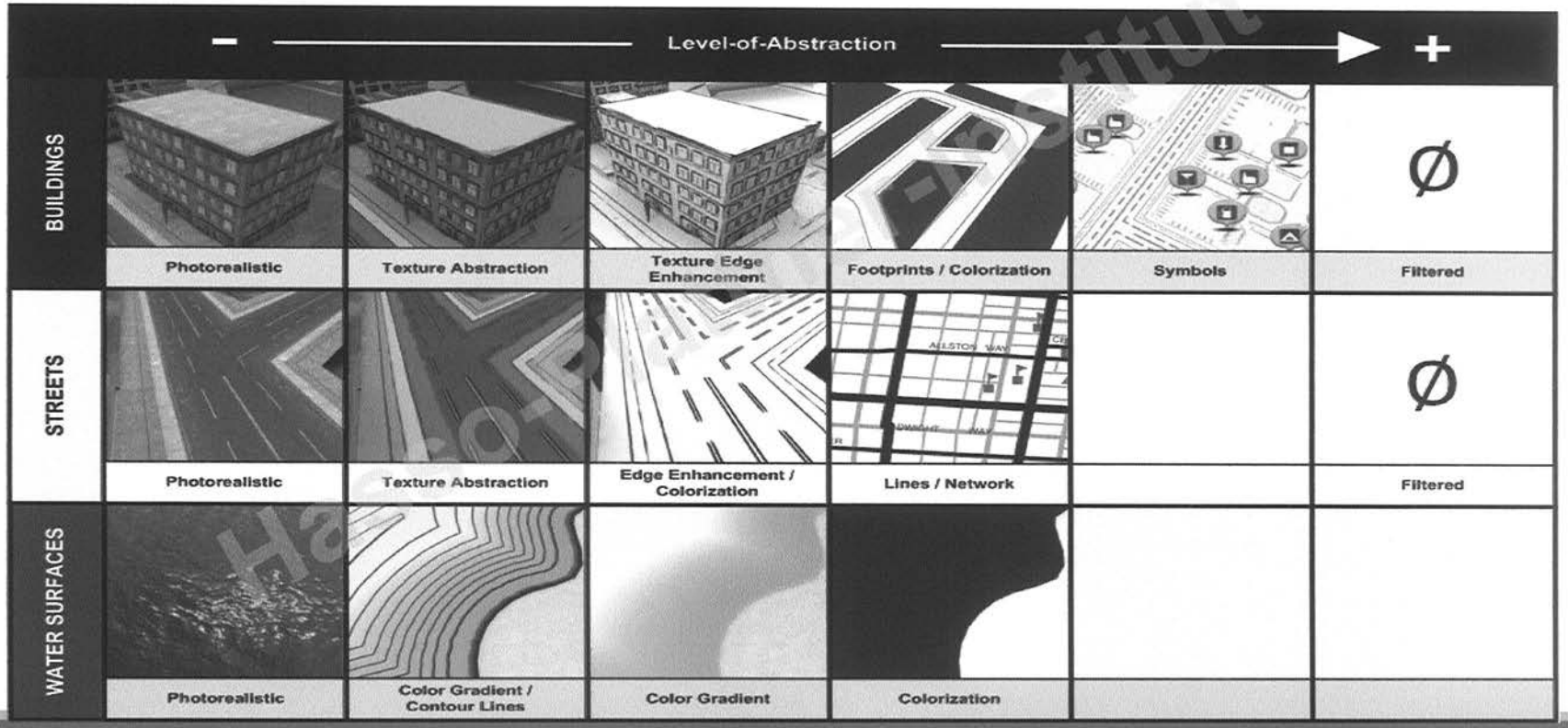


Solar Potential + Difference of Gaussians

5 Cartographic Rendering



5 Cartographic Rendering System



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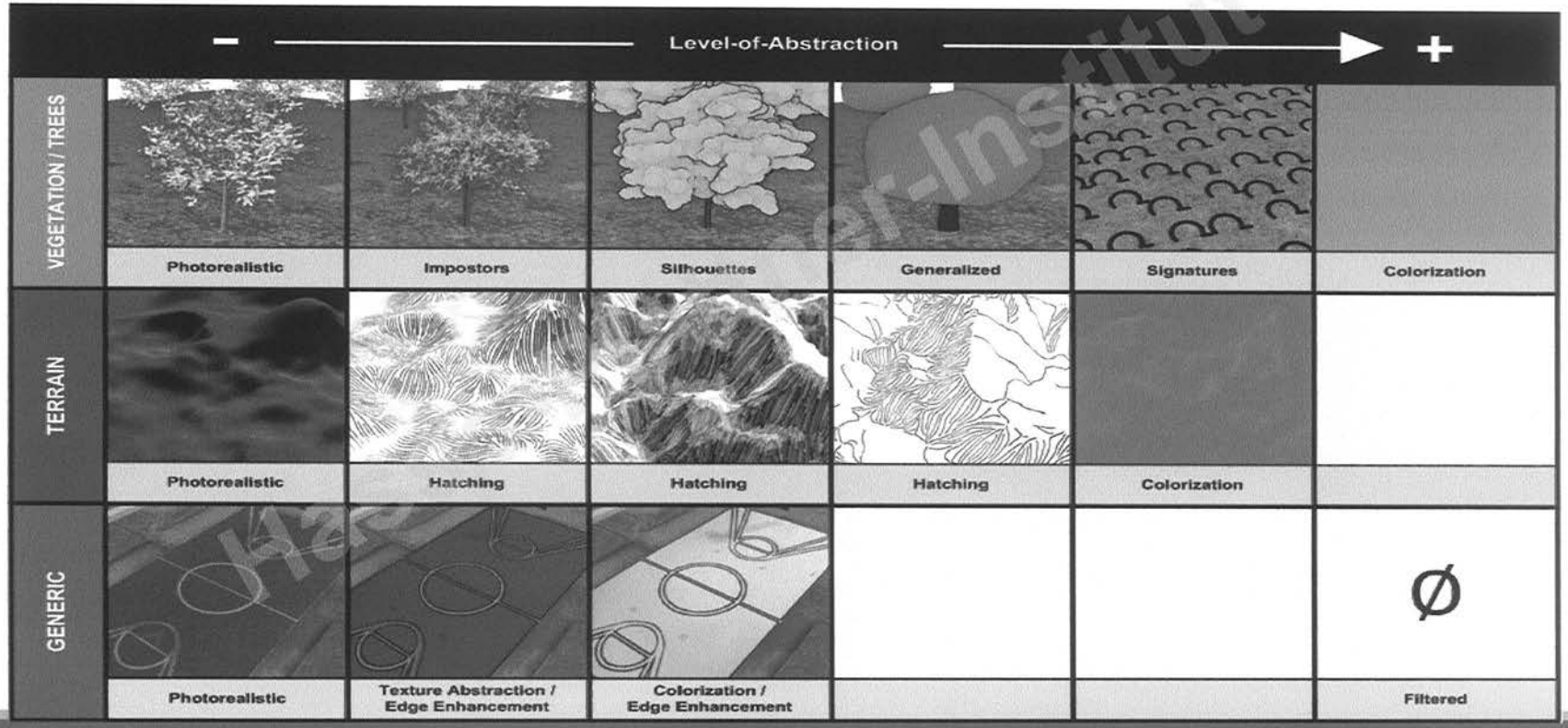
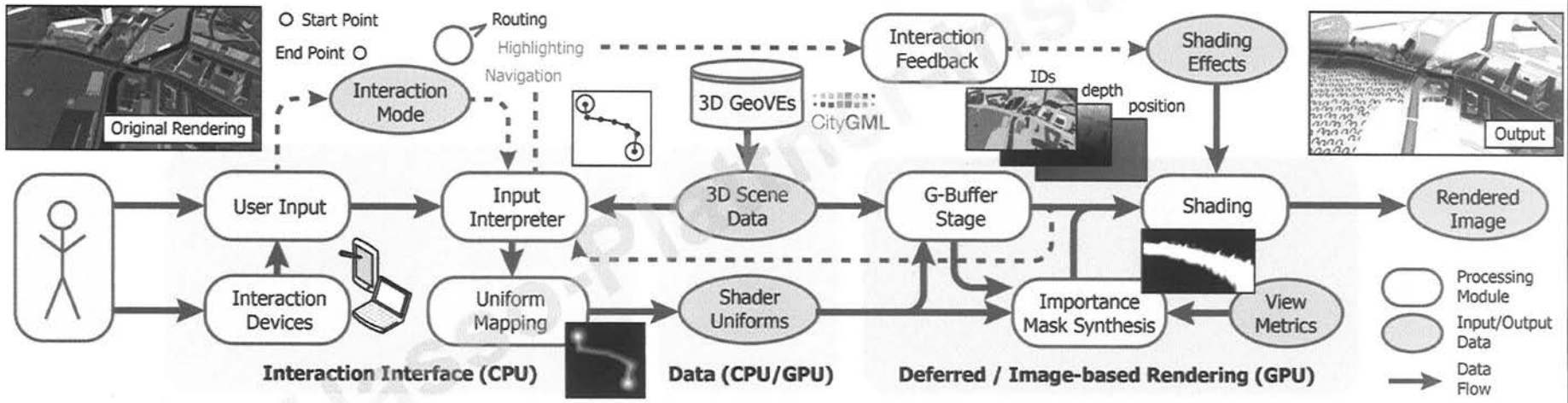


5 Cartographic Rendering Implementation



6 Example: Illustrative Maps

(City of Nuremberg, M. Merian, Topographia Germaniae, Edition Topographia Franconiae, 1642)

6 Example: Illustrative Maps

Conclusions

- Rapid progress in capacity, programmability, and availability of computer graphics (GPUs) enables specific graphics solutions for interactive cartographic information display
- Abstraction is supported by a large number of „nonphotorealistic“ or „illustrative“ rendering techniques
- Abstraction is a key element for design and implementation of such future map-based/map-related services and applications
- Abstraction does not automatically solve the many issues with 3D geospatial data visualization (e.g., details, orientation, navigation, information clutter, ...)

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www.motionintelligence.net www.digitalmasterpieces.com