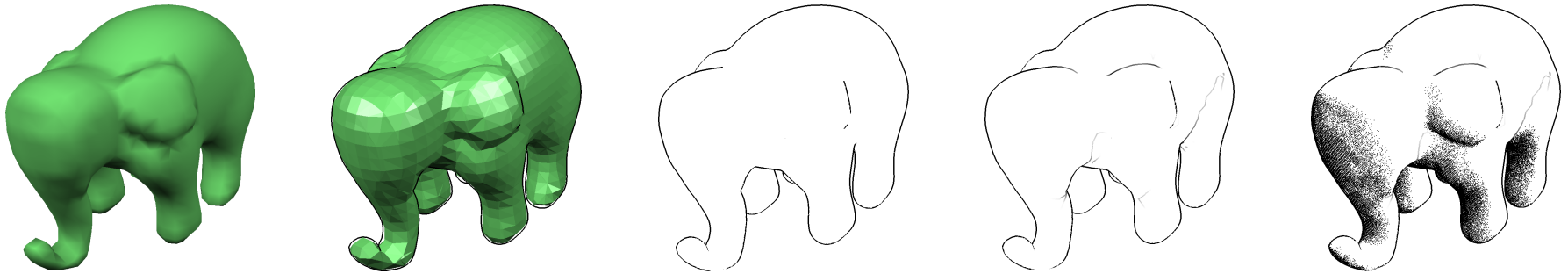

Interactive Pen-and-Ink Rendering for Implicit Surfaces

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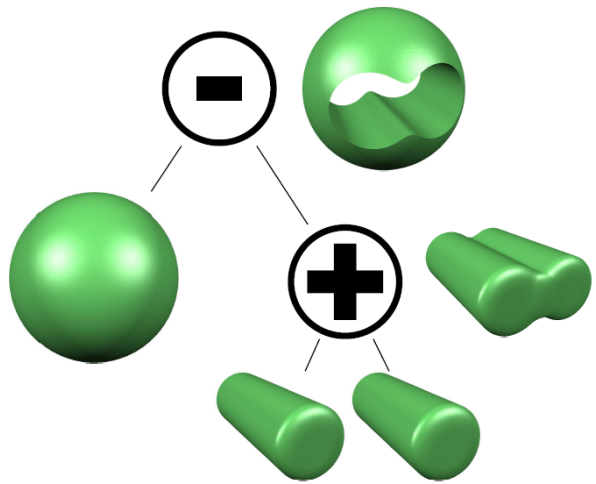
SIGGRAPH2006

Introduction: Implicit Surfaces

- many nice properties for shape modeling
  - CSG, blending, animation, non-linear editing, …
- major drawback: visualization
  - finding the surface to render: expensive!
  - problematic for interactive editing



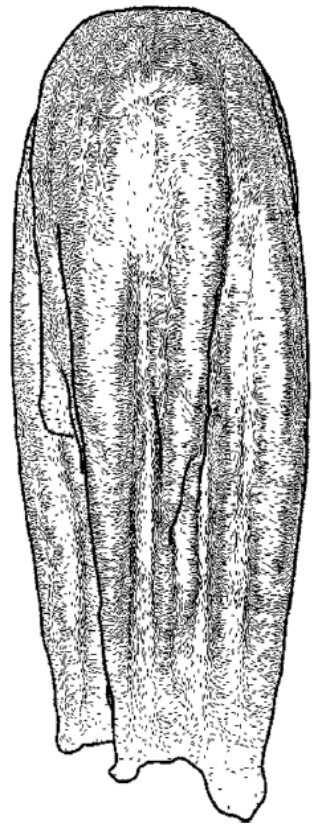
Implicit Surface Visualization

- ray-tracing
  - high quality but very slow
  - off-line only
- polygonization
  - coarse meshes interactively [Schmidt et al. 2005]
  - refinement expensive

courtesy of Erwin de Groot

What about NPR?

- non-photorealistic rendering
  - render “important” parts of the surface
  - less geometry → ***potentially*** faster
- pen-and-ink [Foster et al. 2005]
- excellent results but still slow
  - ray-tracing
  - surface-particle walks, etc.



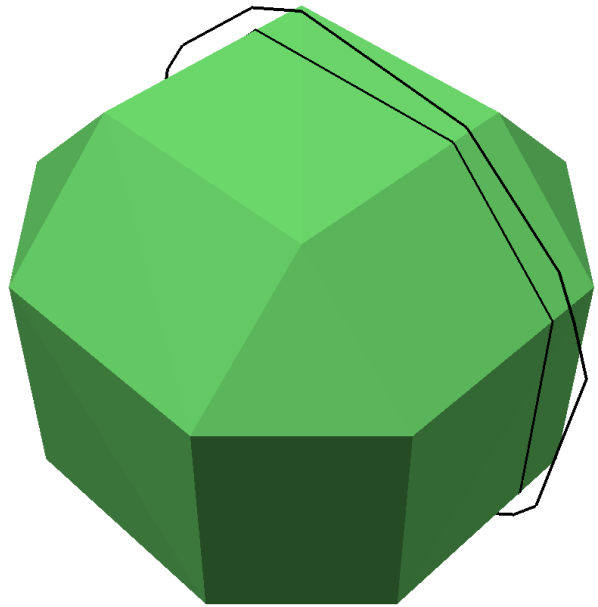
from [Foster et al. 2005], used with permission

Basic Idea of Our Approach for Fast Rendering of Implicit Surfaces

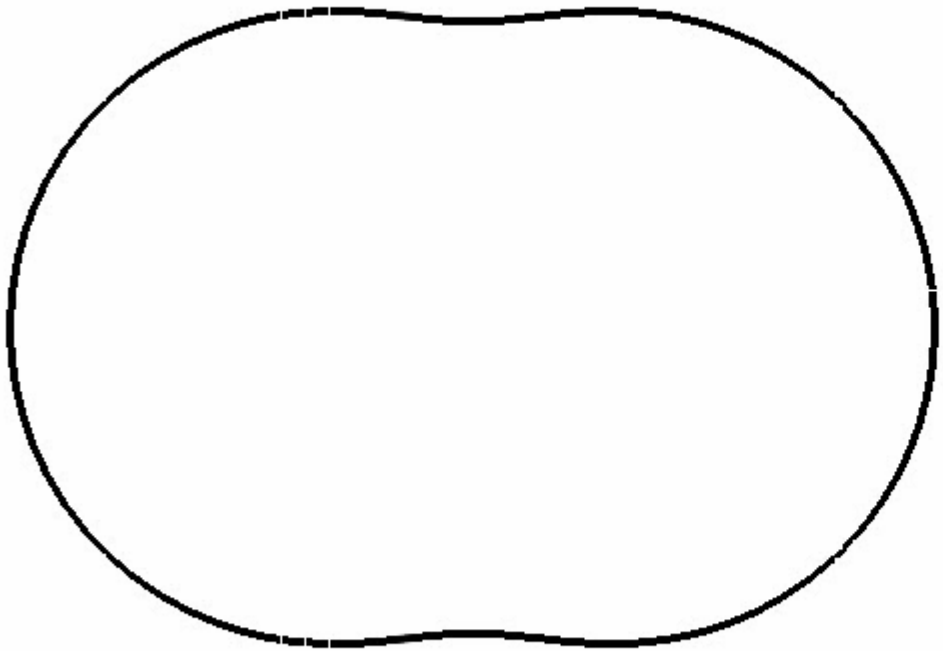
- use simplicity of polygonal NPR methods
- mesh provides sampling of implicit surface
- speed gains from using simple meshes
- goals:
  - approximate technique
  - high-quality rendering
  - dynamic meshes

Fast Approximate Implicit Silhouettes

- use coarse base iso-mesh
- compute sub-polygon silhouettes on that mesh
  [Hertzmann & Zorin 2000]
- project vertices to iso-surface using field gradient
- adaptively refine silhouette



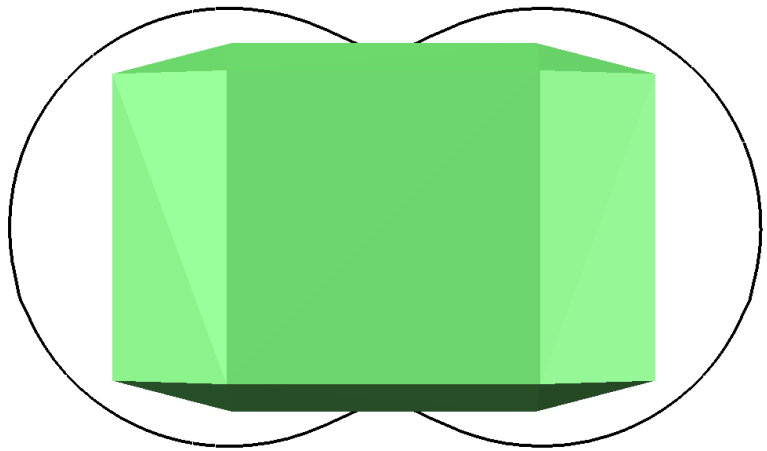
Fast Approximate Implicit Silhouettes

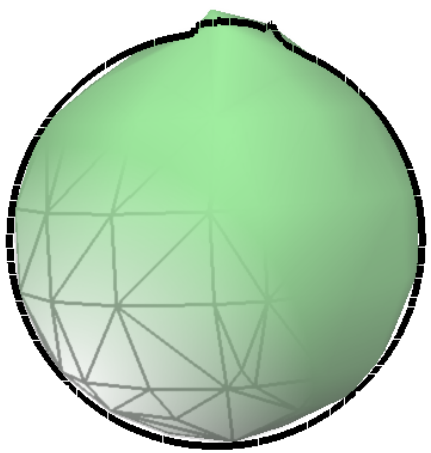


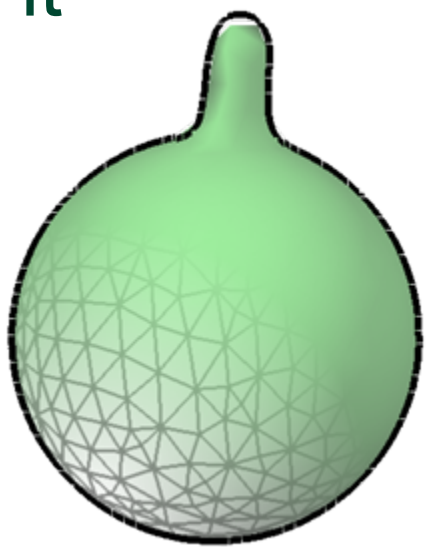
Silhouette Precision

- fairly coarse iso-mesh usable ...

  ... as long as features are captured by it

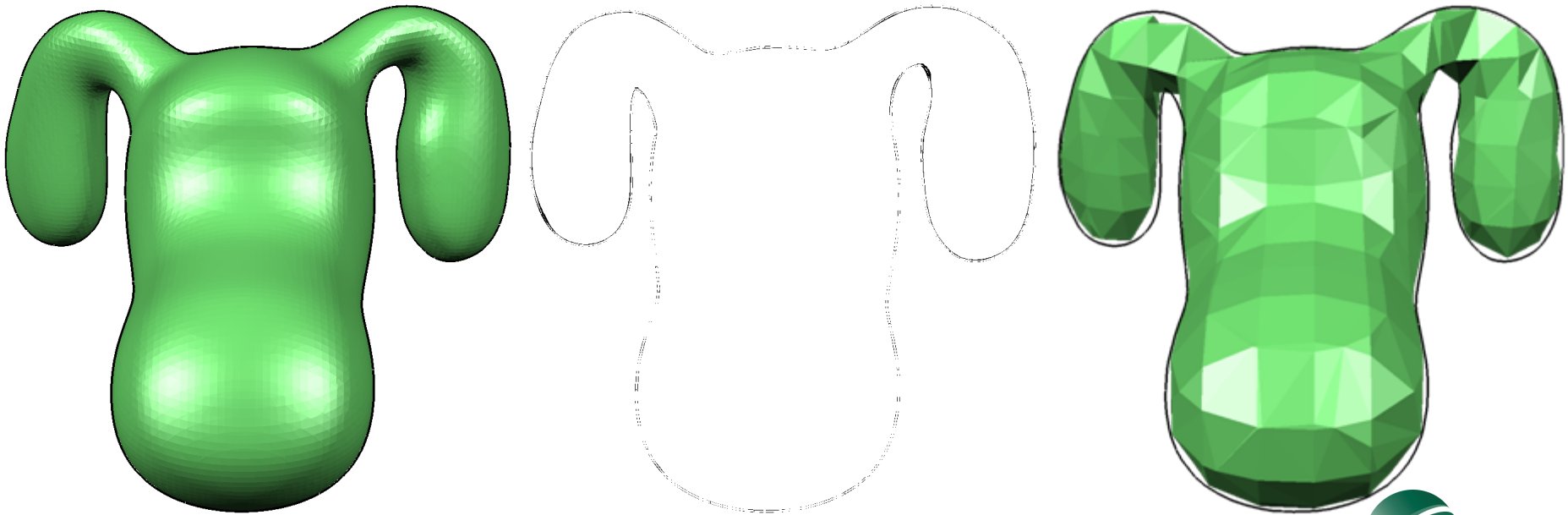






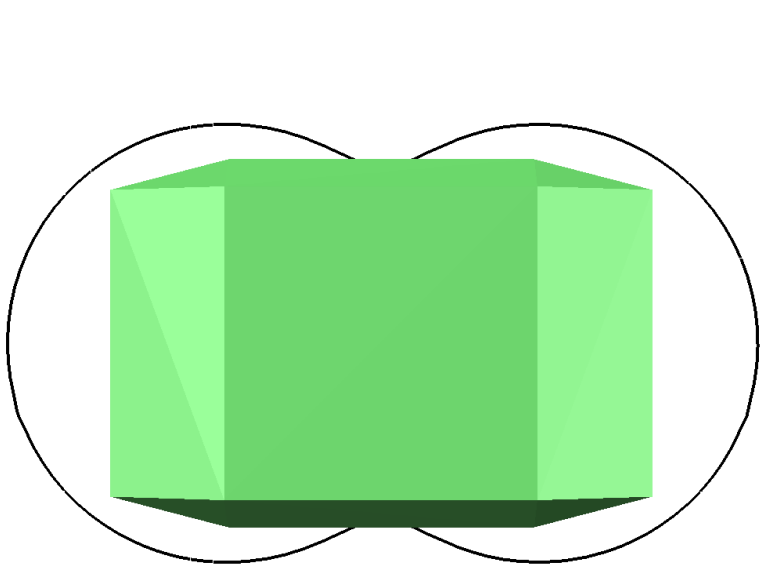
Silhouette Precision

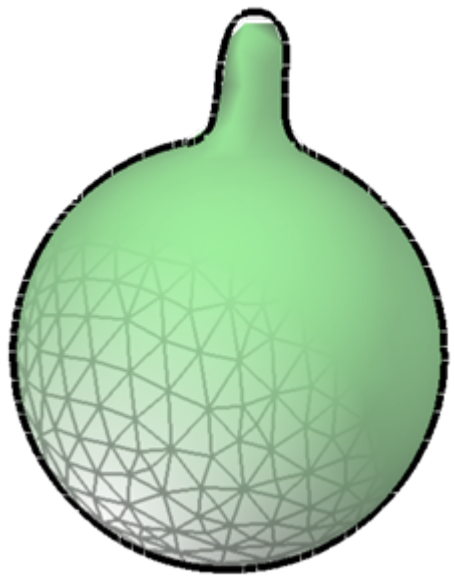
- high-res mesh silhouette vs. refined approximate silhouette of low-res mesh



Fast Approximate Implicit Silhouettes

- profit from simple mesh-based techniques
- fast for coarse meshes, even brute-force
- very few field evaluations necessary

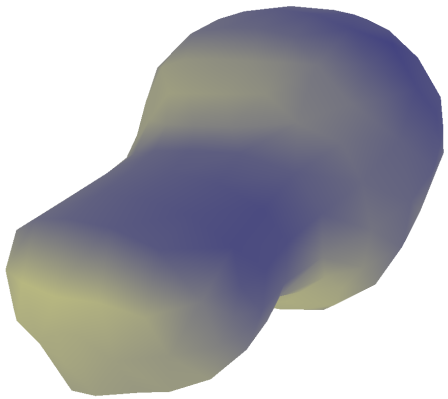




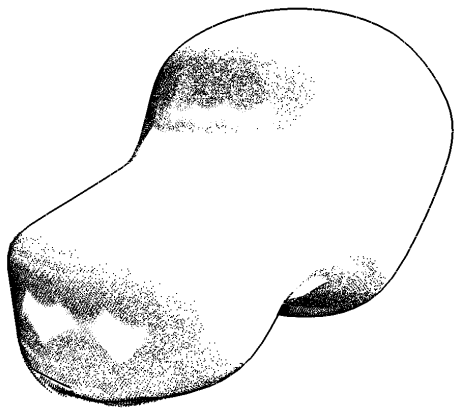
Hidden Line Removal

- previous techniques too slow or inaccurate
  - implicit surface ray-intersection: expensive
  - filling *z*-buffer with coarse mesh: inaccurate
  - particle/surfel technique [Foster et al. 2005]: slow
- distribute points on coarse mesh triangles
- project them to implicit surface
- render small tangent disk into *z*-buffer

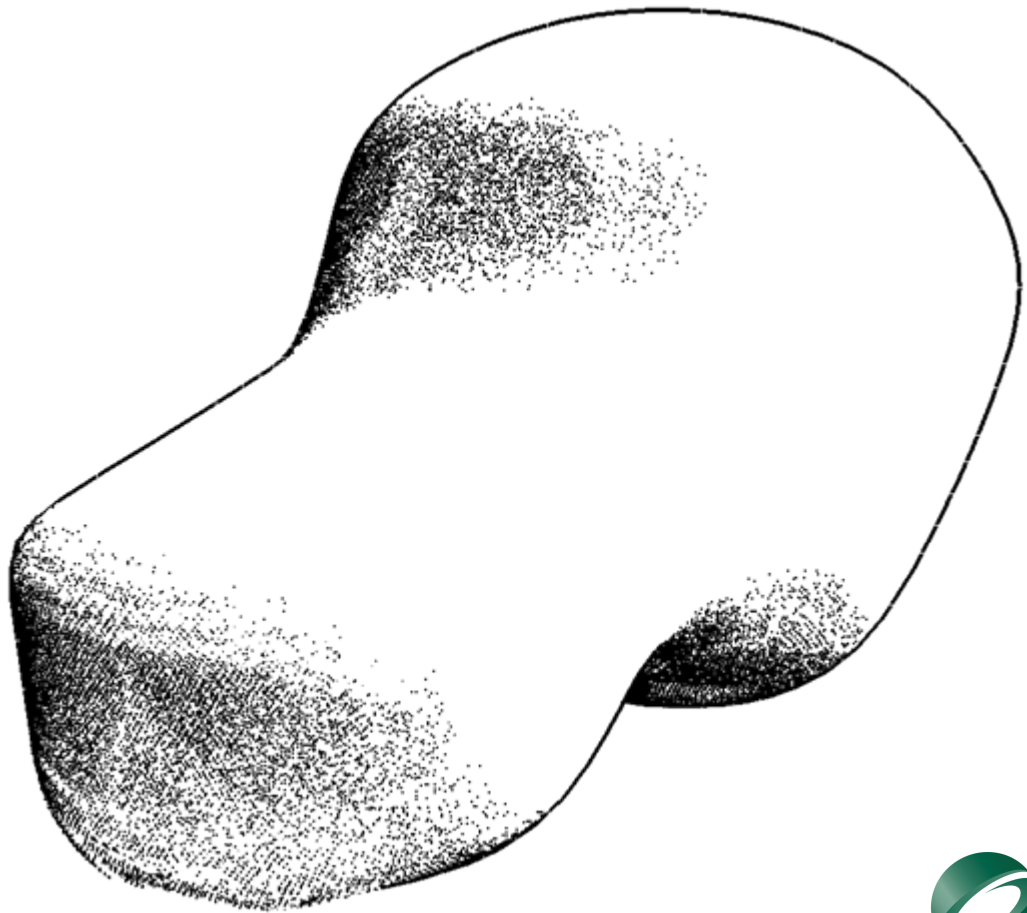
Hidden Line Removal



lo-res mesh



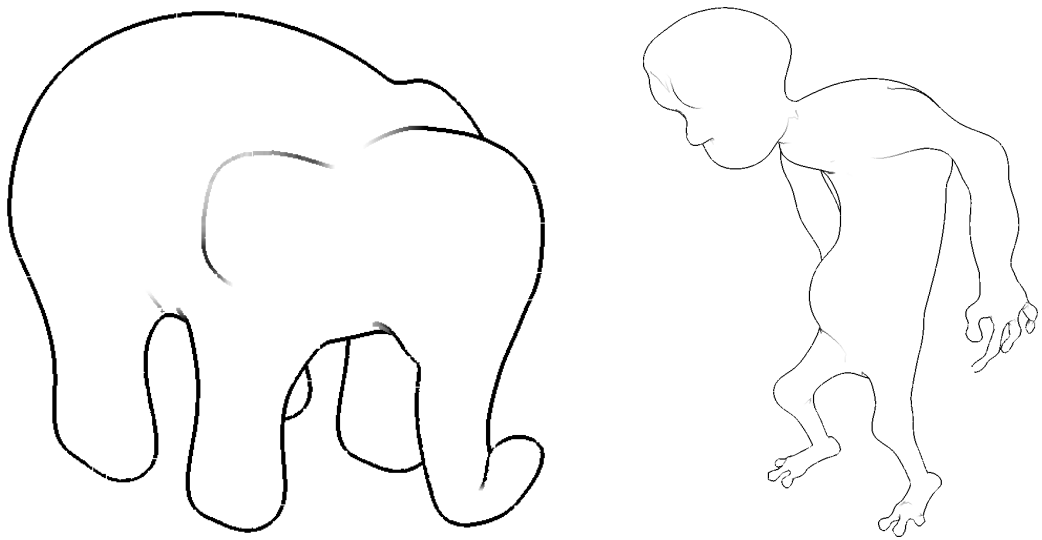
lo-res mesh HLR



lo-res surfel disc HLR

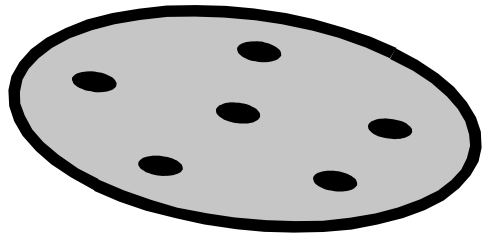
Suggestive Contours

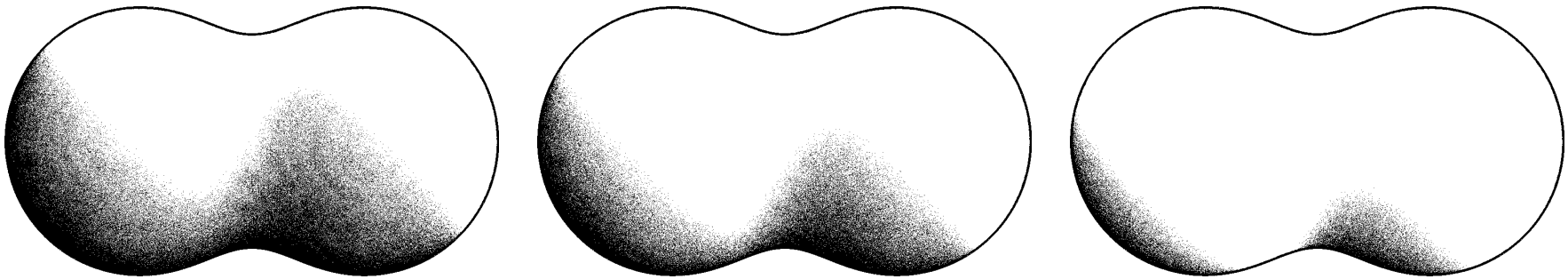
- view-dependent non-silhouette feature lines
- radial curvature $k_r = 0$ [DeCarlo et al. 2003]
- finite differences method w/o third derivatives



Surface Stippling

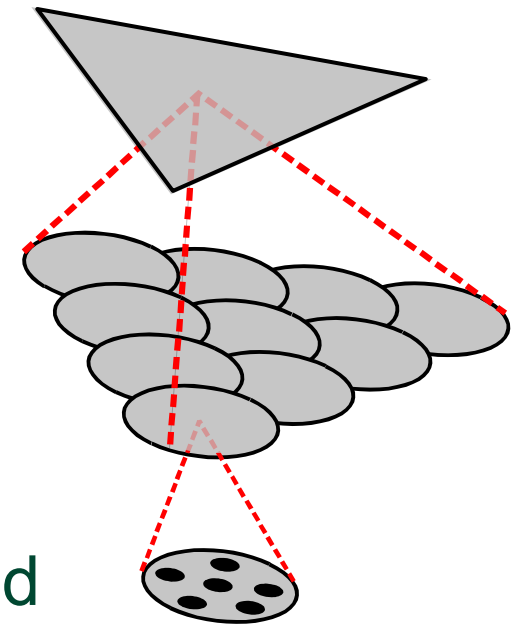
- re-use surfel disks from HLR
  - *k* stipple points per disk
  - illumination regions following [Foster et al. 2005]



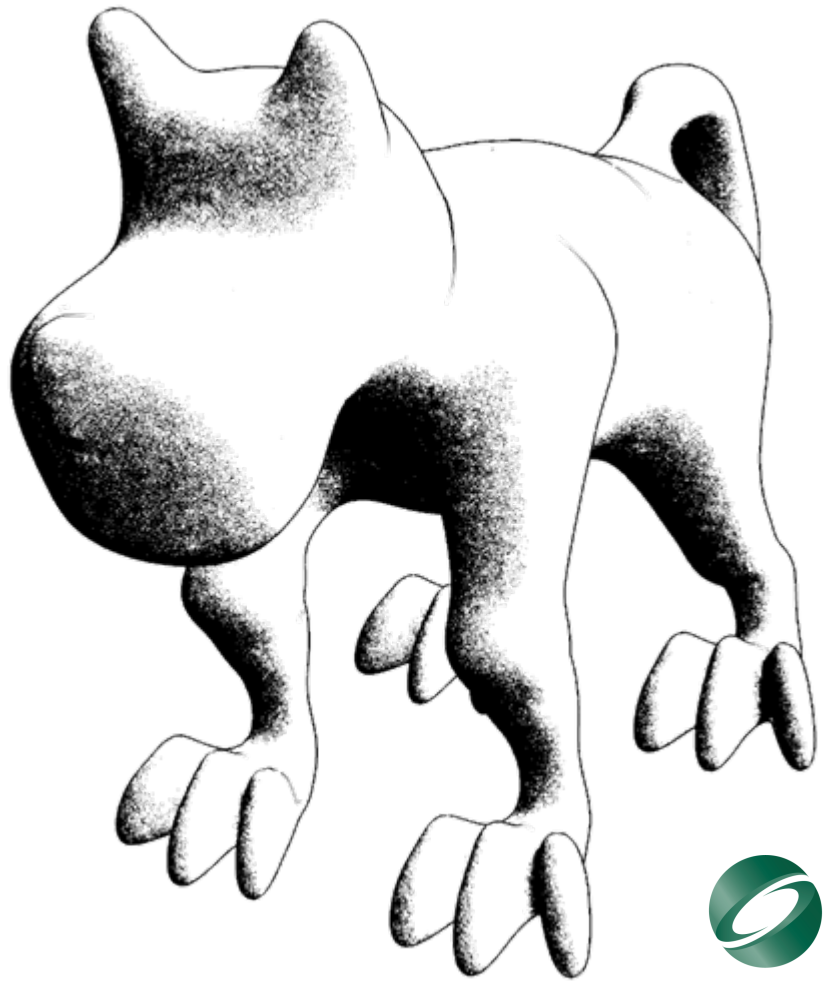


Geometry Hierarchy

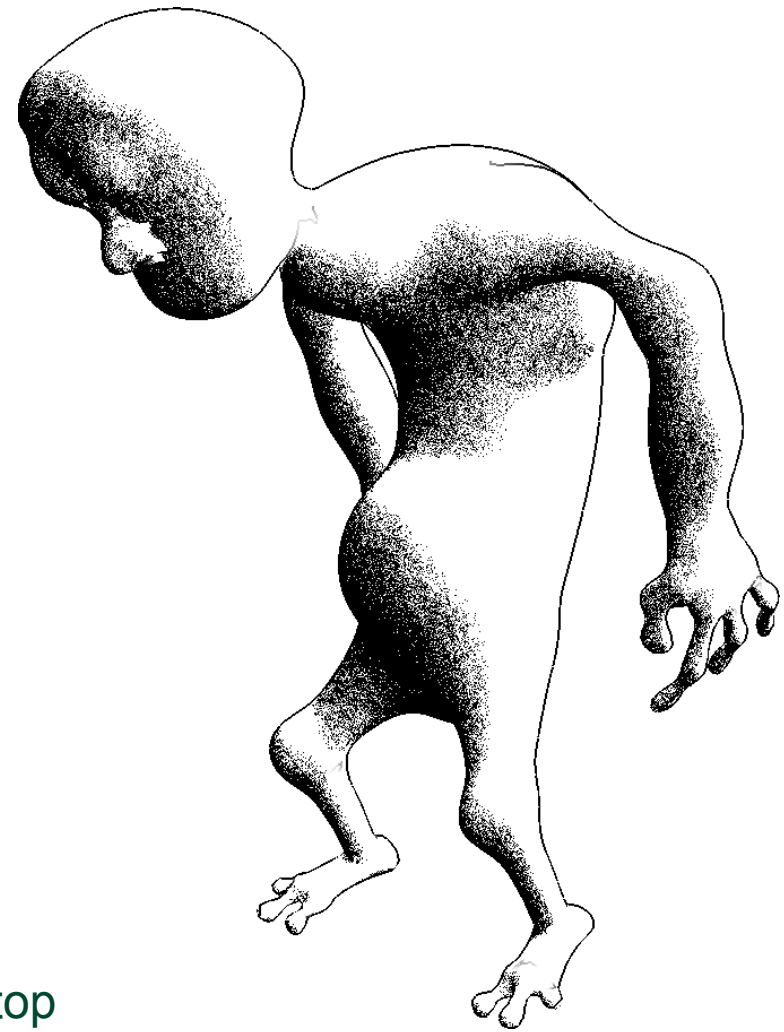
- triangles → discs → stipple points
- visibility culling
  - at each level of hierarchy
  - back-face & illumination culling
- dynamic geometry generation
  - expand hierarchy only when required
  - minimizes setup time for dynamic surfaces



Example: Lines + Stippling

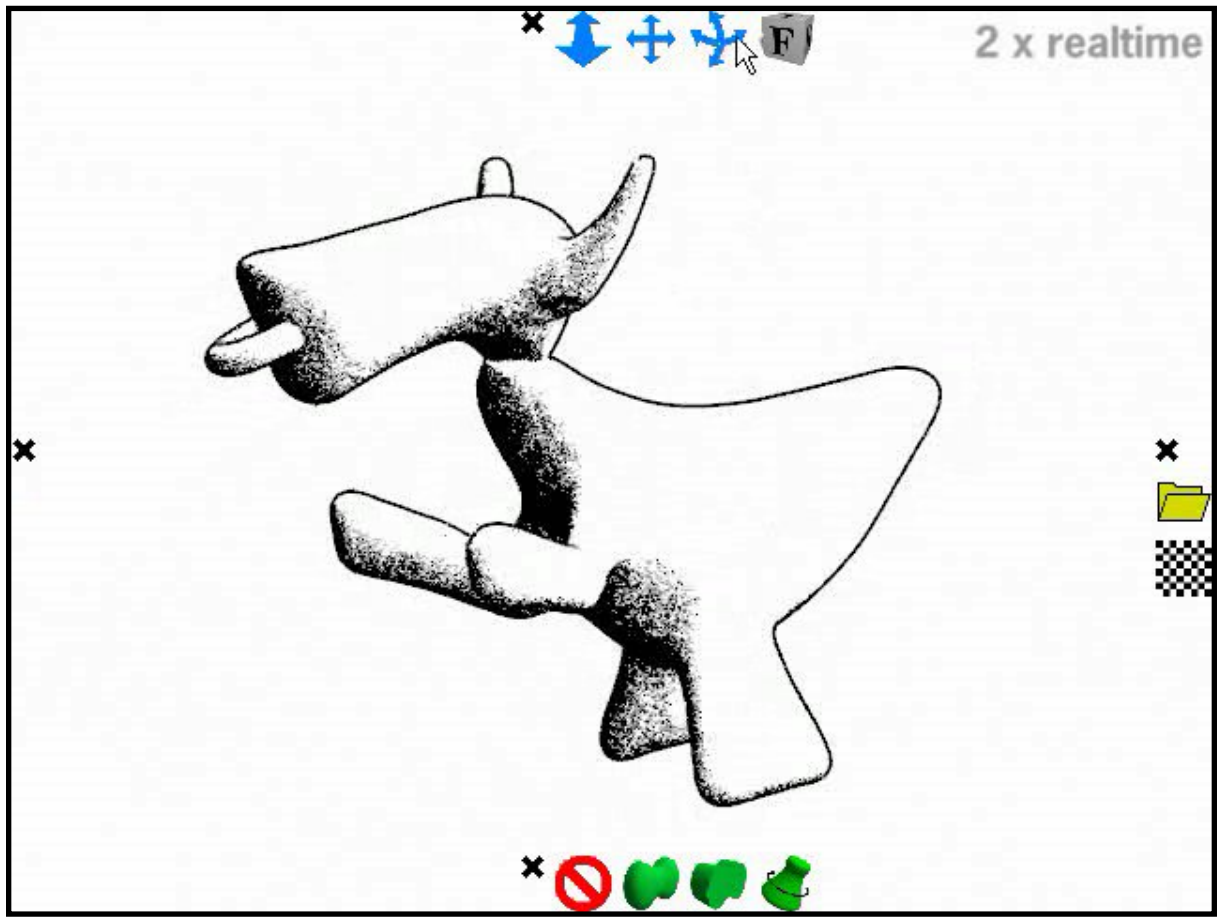


Performance: Video



machine:
1.6 GHz Centrino laptop

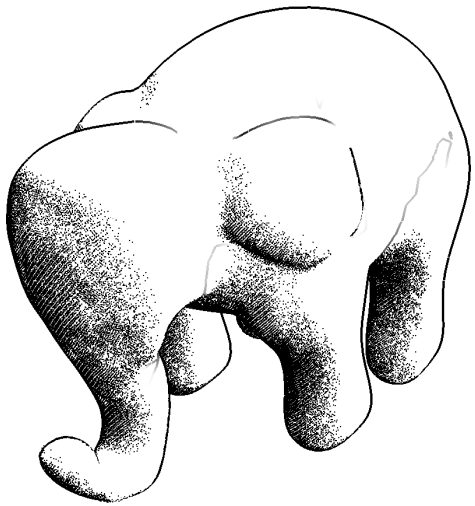
Video: Interactive Session

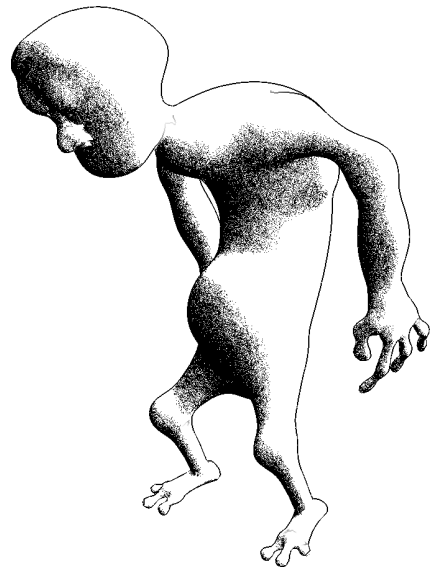


Contributions

- fast & efficient approximate silhouette extraction for implicit surfaces
- extended to suggestive contours & stippling
- faster than extraction of detailed iso-surface
- application: interactive modeling
- also works for other surfaces (e.g., NURBS)

Thanks for your attention!





download demo at:
http://www.unknownroad.com/shapeshop/

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