

# Non-Photorealistic Rendering

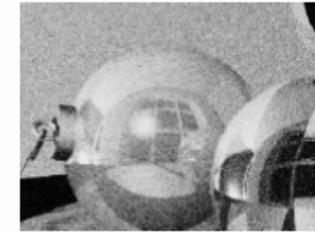
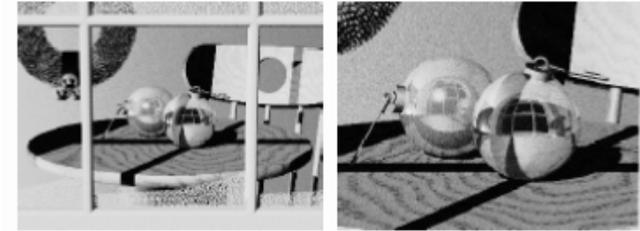
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CS 319

Advanced Topics in Computer Graphics

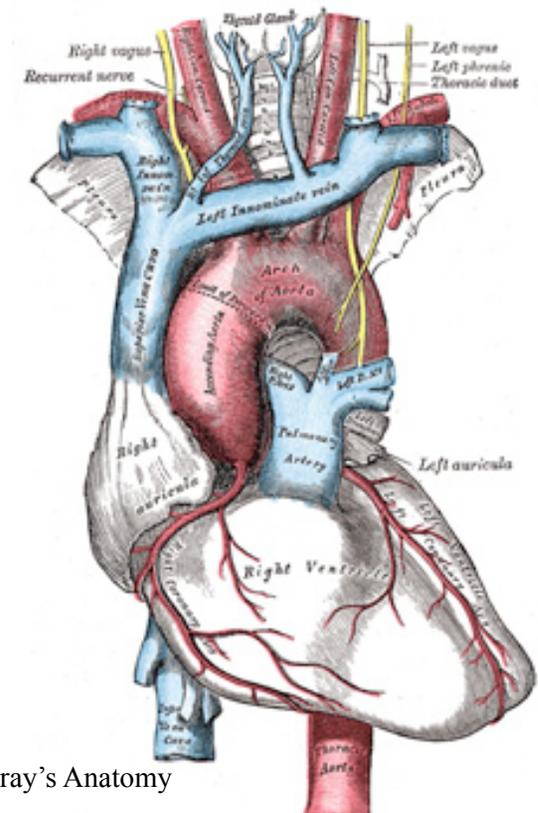
John C. Hart

# Whither Graphics?



What is our ultimate goal in computer graphics?

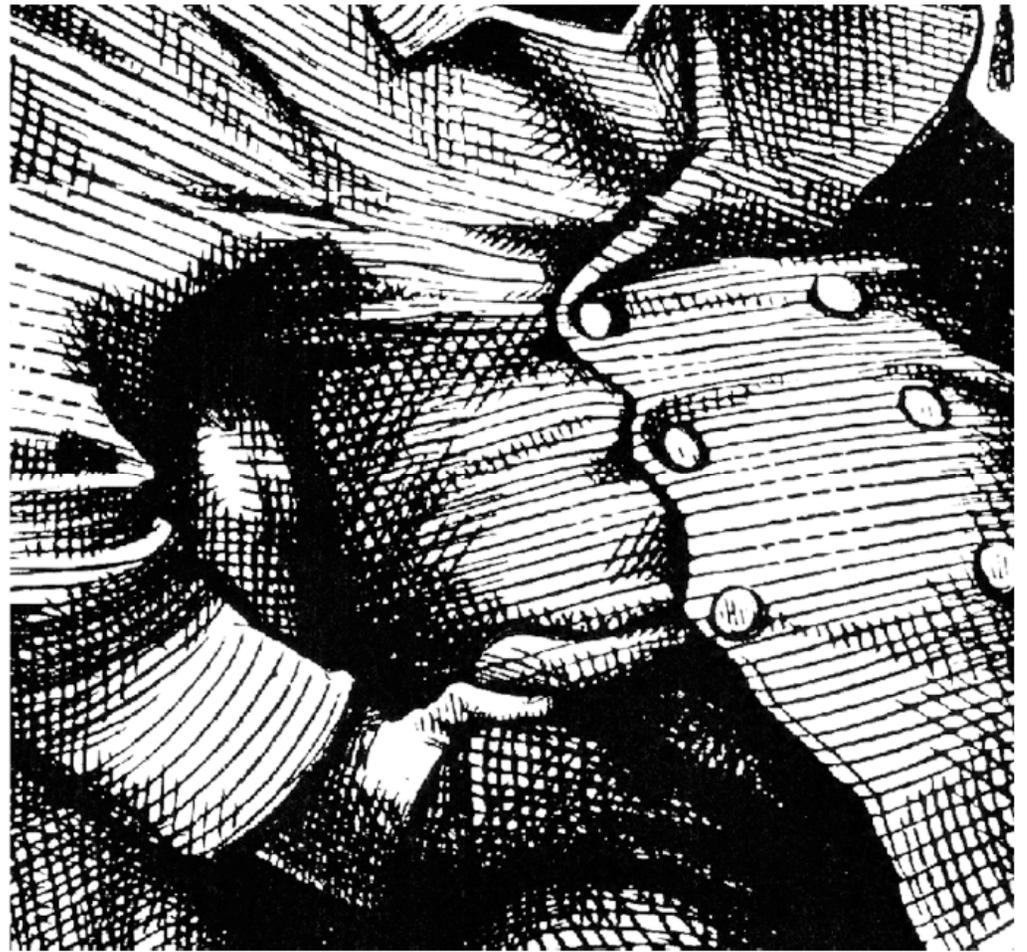
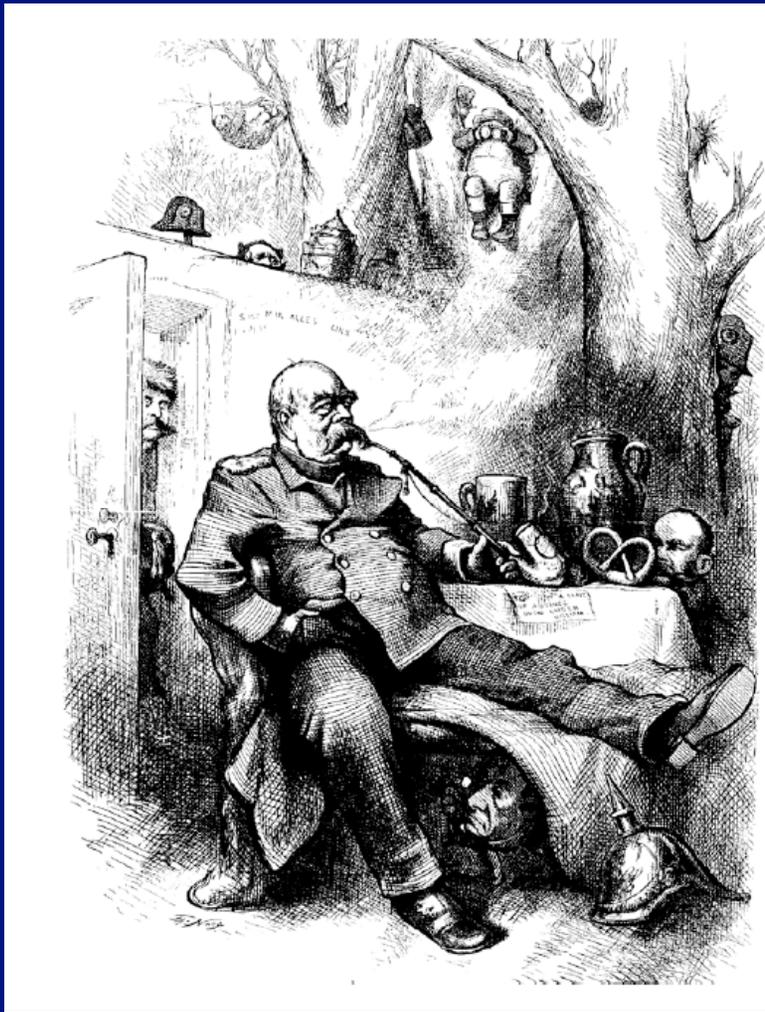
- Photorealism
  - Makes synthesized pictures appear like photographs of real objects
  - Includes distracting artifacts of the photographic process (e.g. depth of field, lens flare)
  - Breeds dishonesty
- Communication
  - Graphics is a high-bandwidth medium for transmitting information into the brain



Gray's Anatomy

# Non-photorealistic rendering

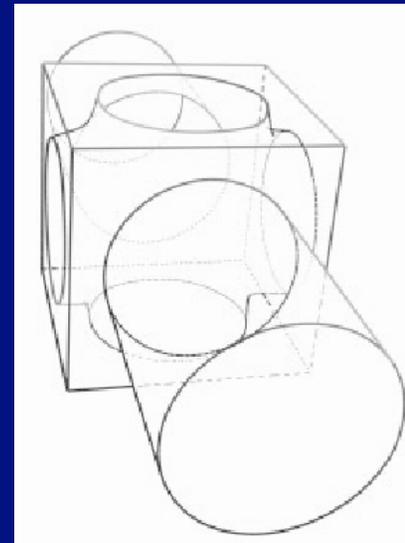
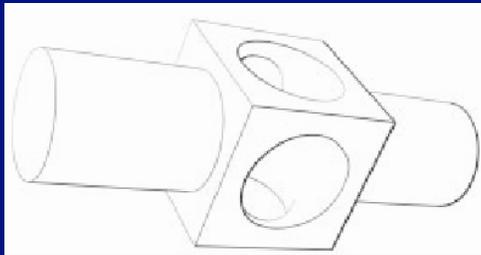
- Painterly rendering
  - pixels imitate brush strokes
- Illustrator like rendering
  - silhouettes
  - hatches
  - stipples



Cartoon by Thomas Nast, from Hertzmann+Zorin

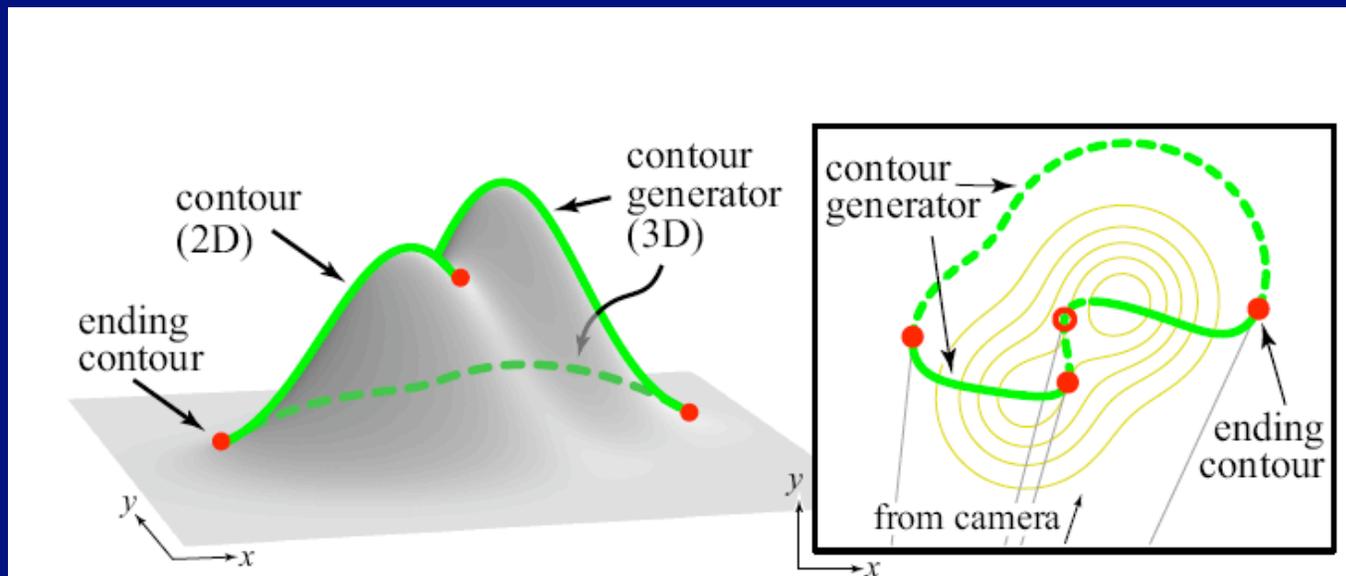
# Silhouettes

- Constructed by
  - edges shared by front and back-facing polygons
  - zero set of function
- include bounding contours

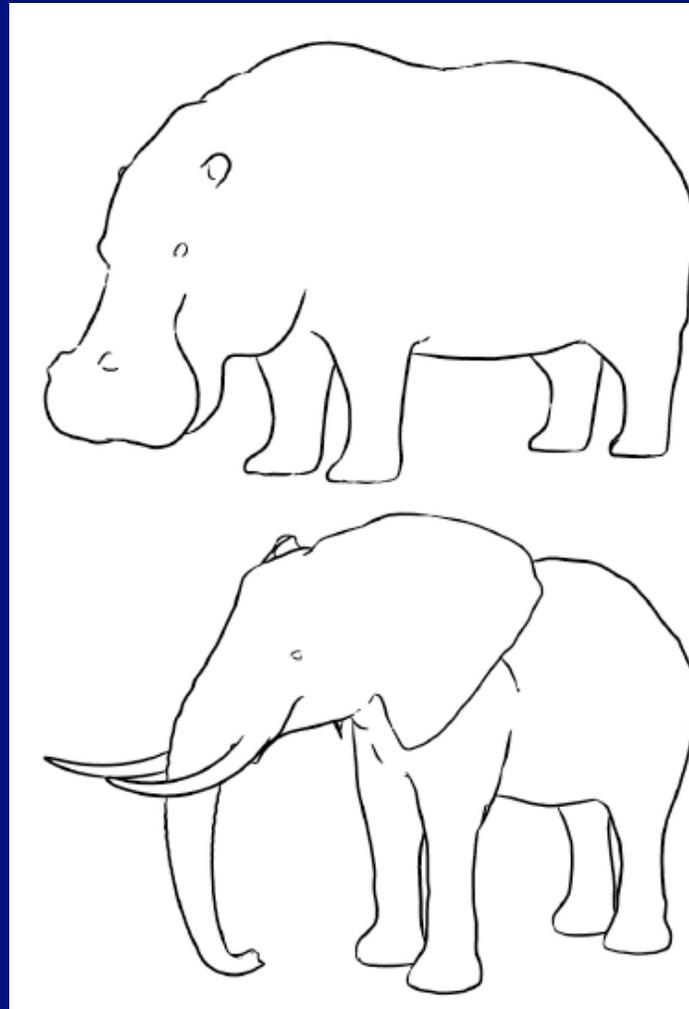


# Cusps

- Silhouettes need not be closed curves



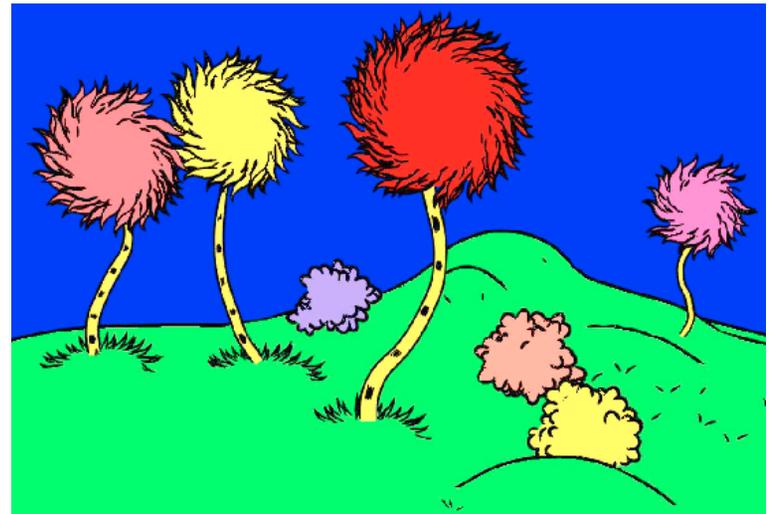
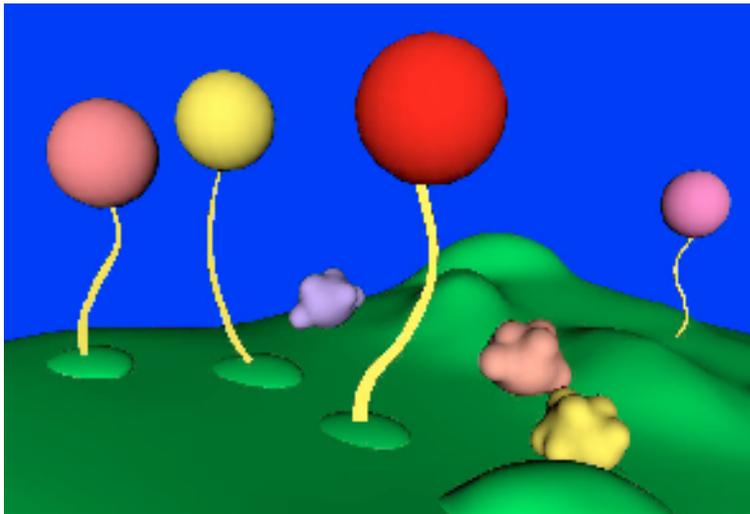
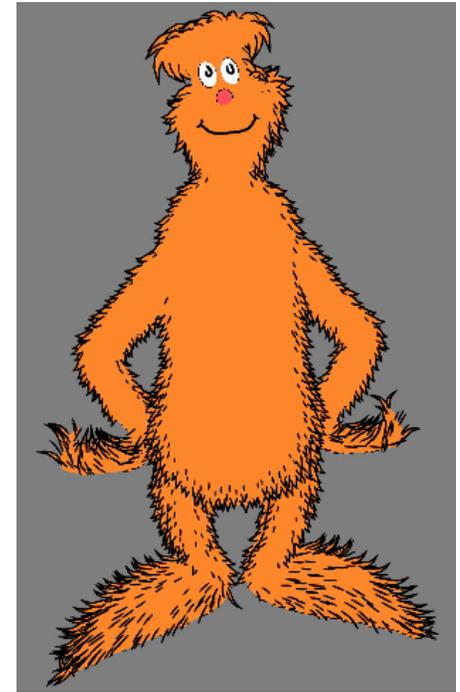
From DeCarlo et al



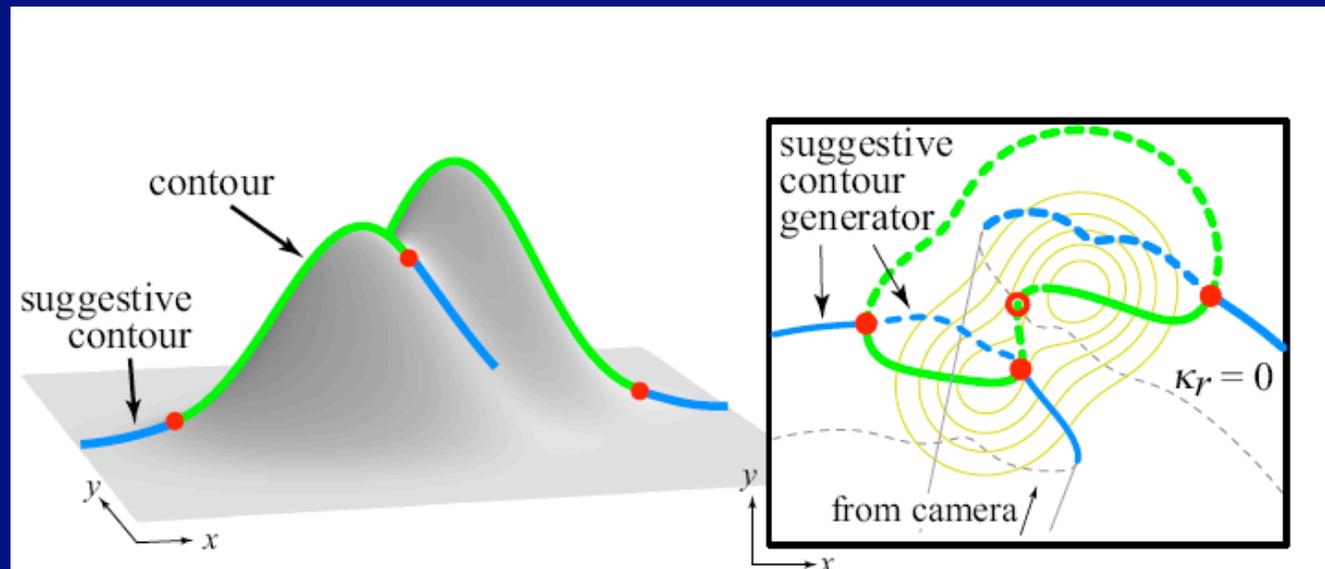
From DeCarlo et al

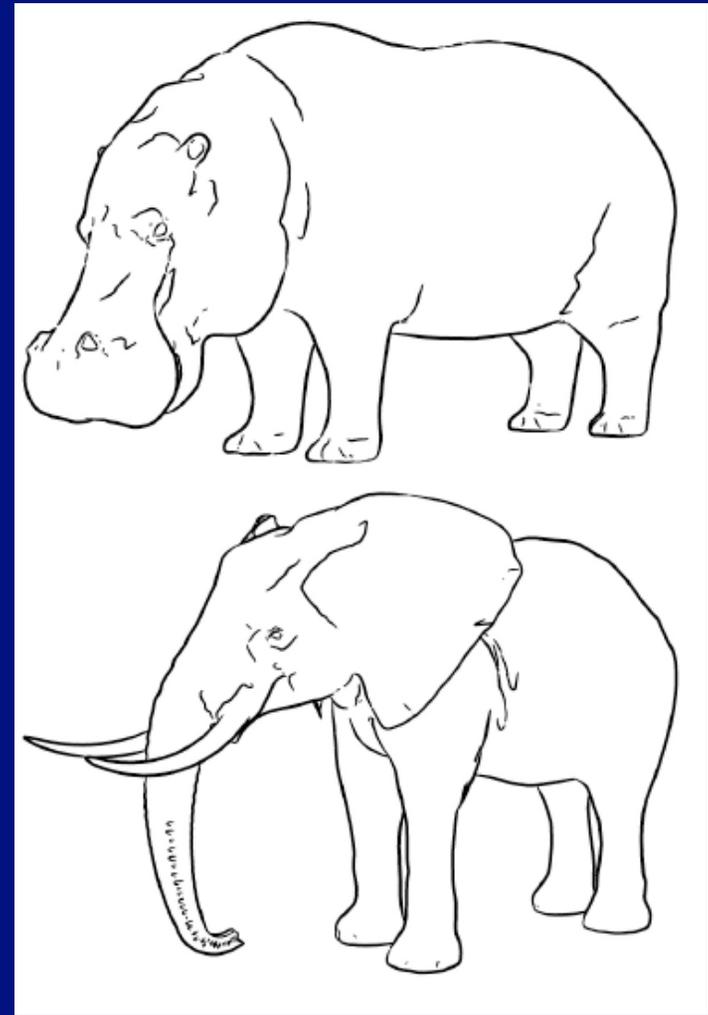
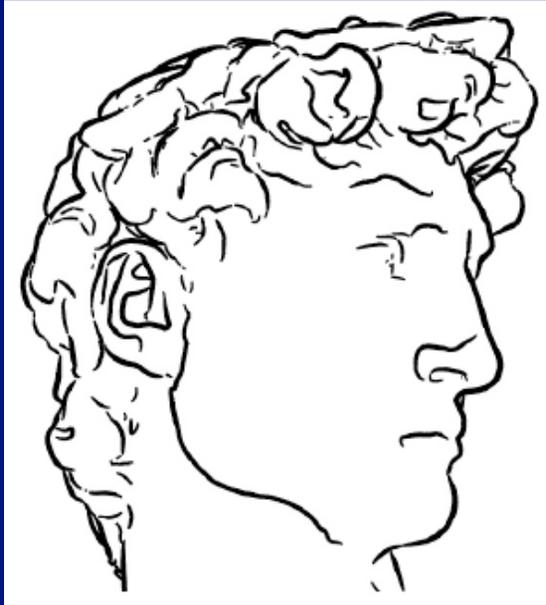
# Displacement Silhouettes

- Kowalski *et al.*, S99
- Add displacement texture to silhouette
- Texture controlled by  $N \cdot V$



# Suggestive contours



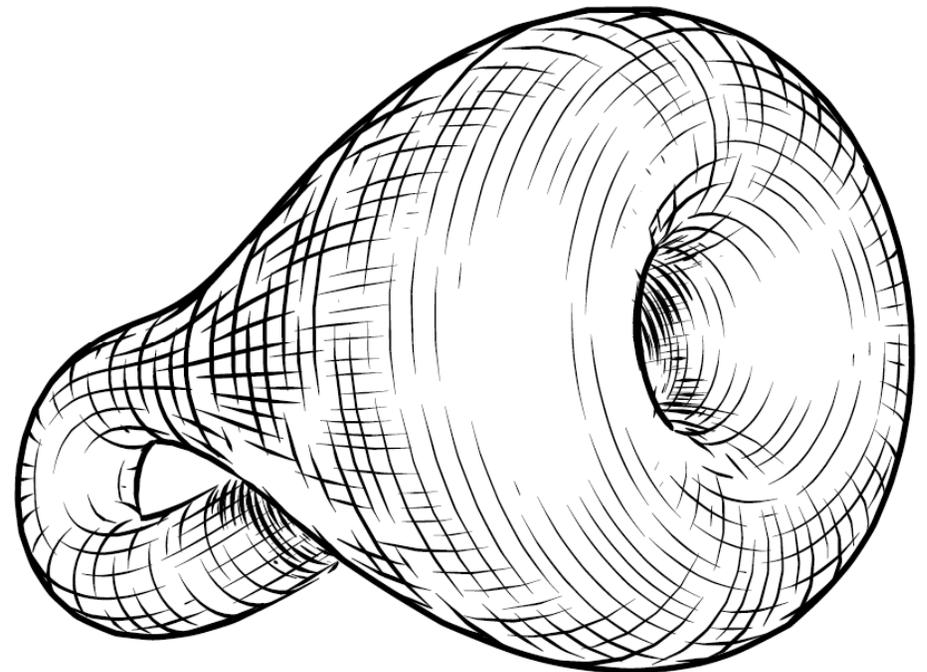


From DeCarlo et al

# Hatches

- Directions of curvature
- Driven by lighting values
- Undercuts emphasize dark spots

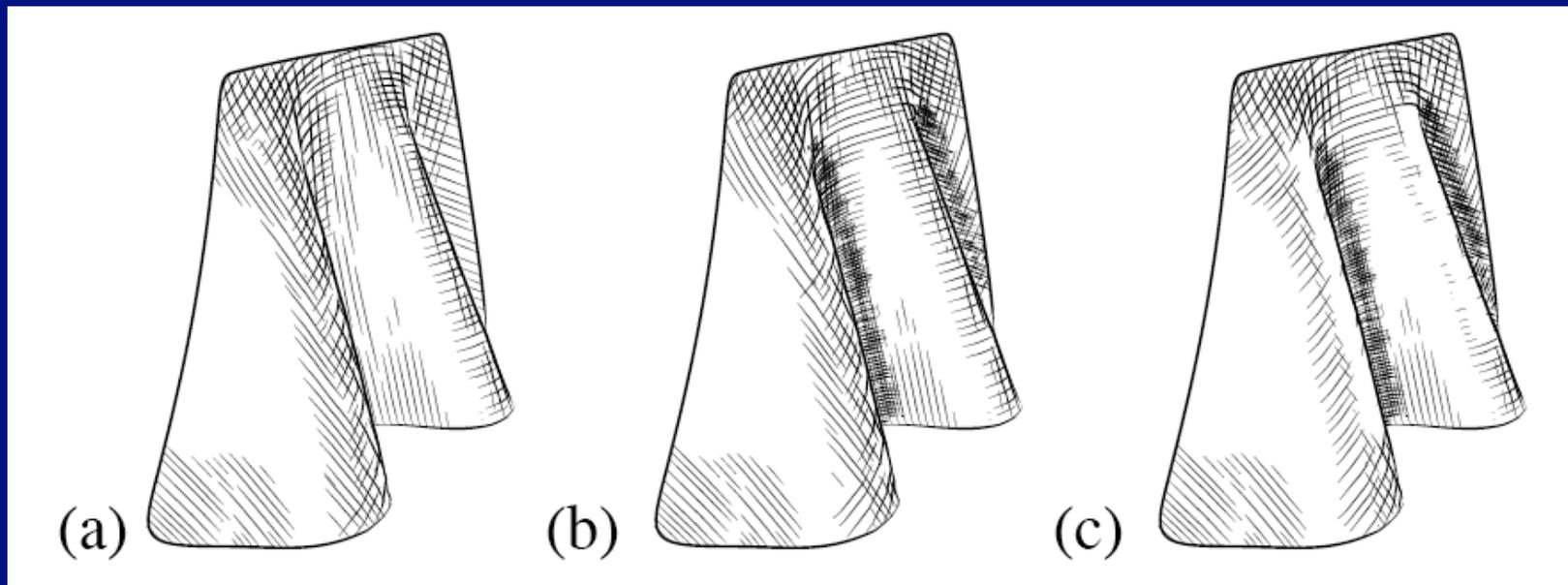
Hertzmann+Zorin



Basic hatch densities

Undercuts emphasize shadows

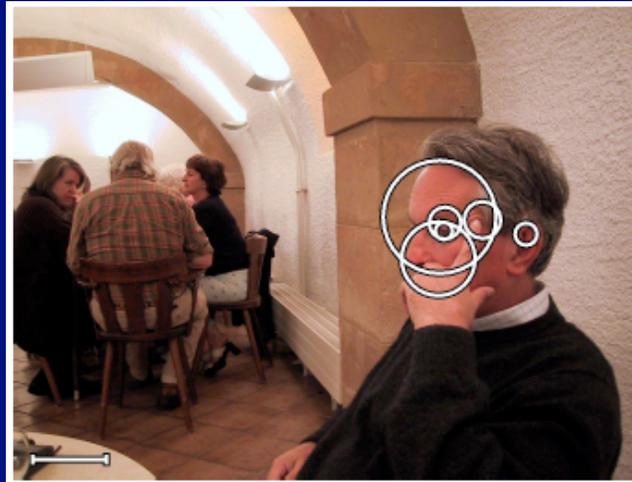
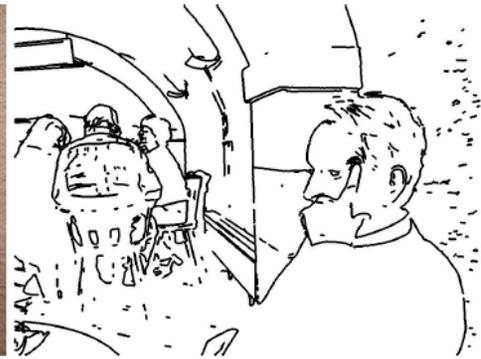
Mach bands give highlights



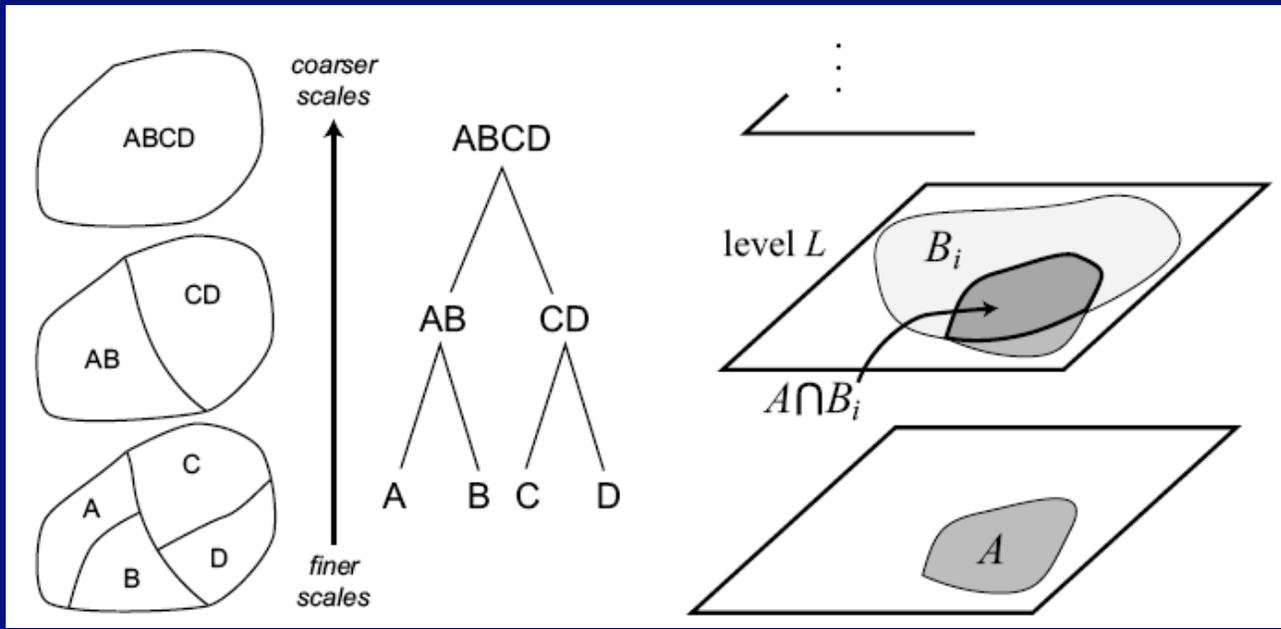
Hertzmann+Zorin

# Stylization and abstraction

- Render images with high detail at “important” bits, low detail elsewhere
- Need
  - hierarchy of detail
  - model of what’s important



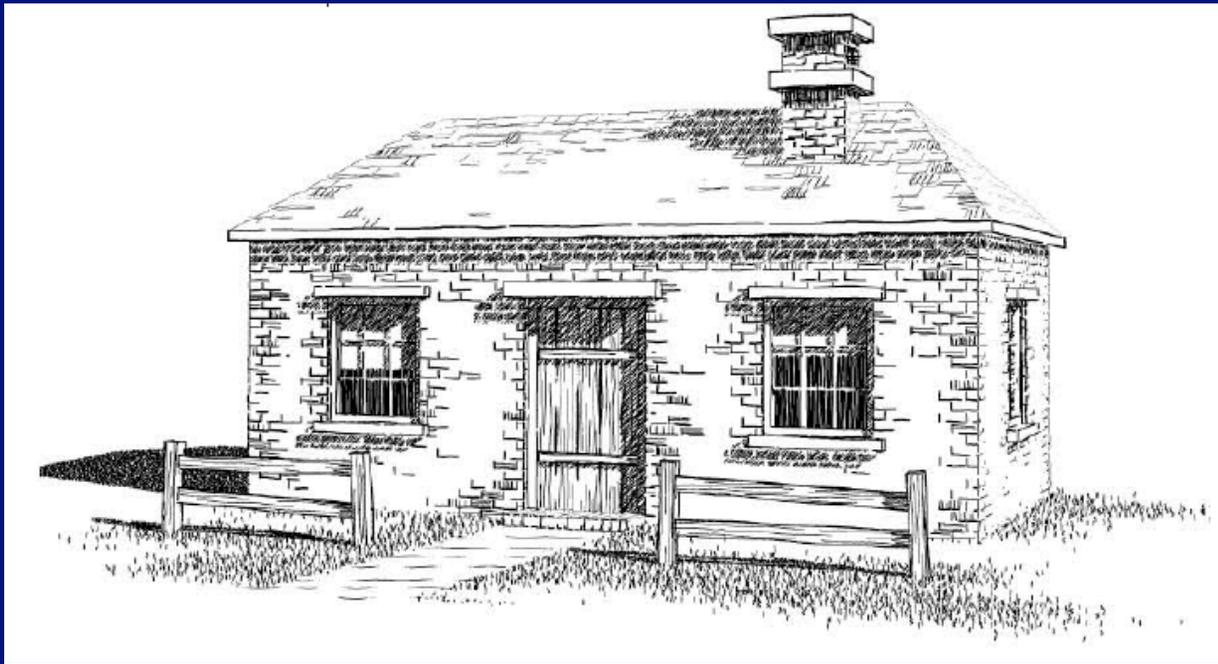
DeCarlo+Santella



DeCarlo+Santella





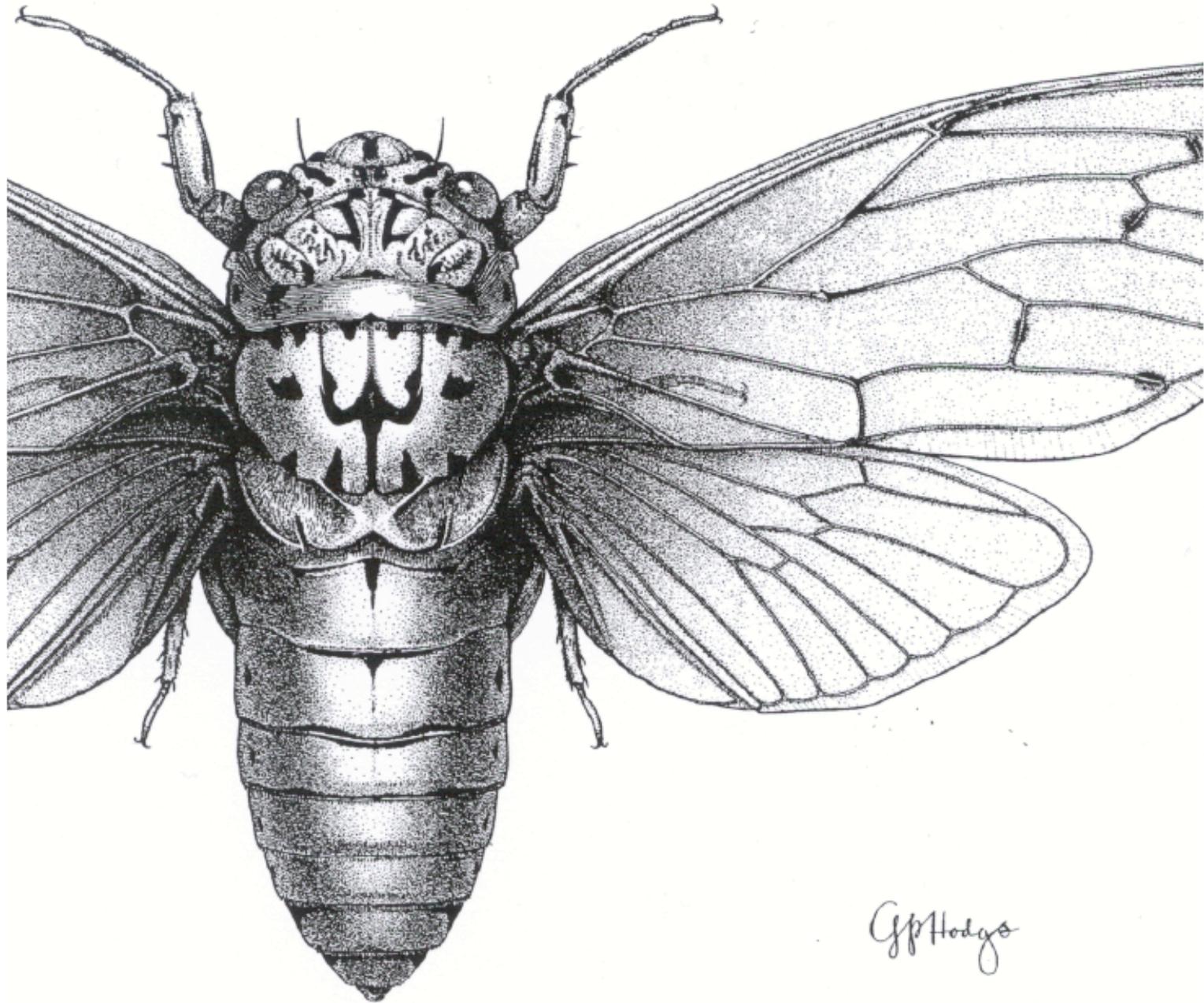


Winkenbach and Salesin



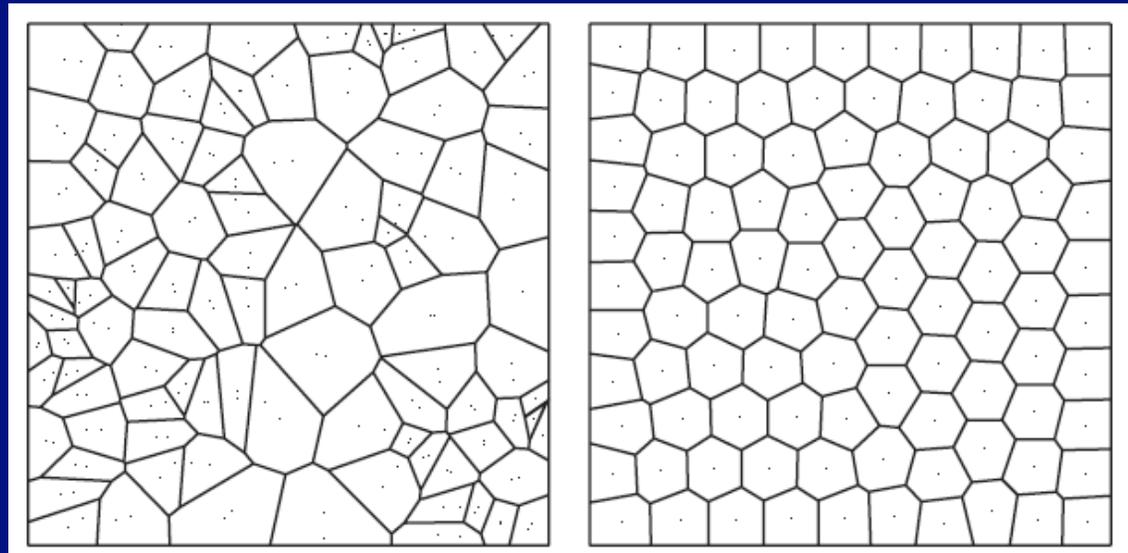


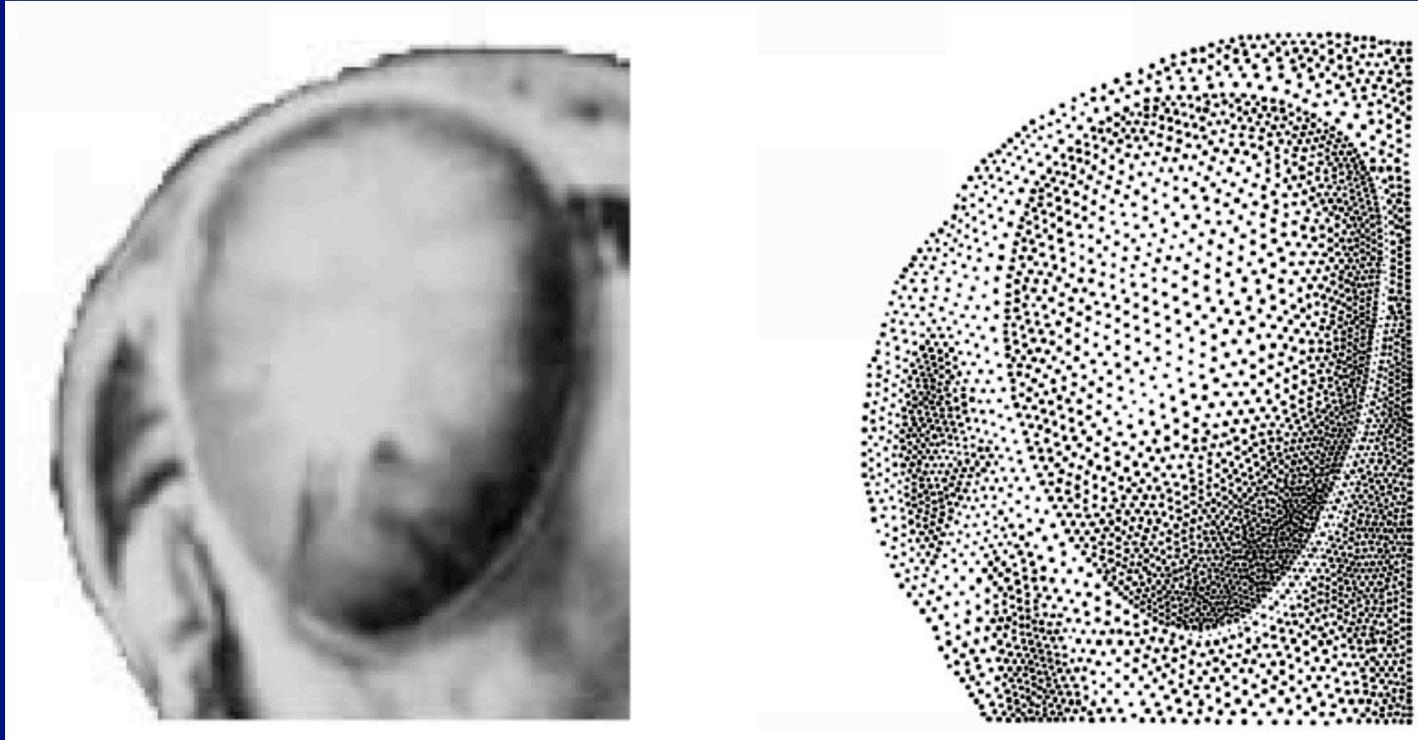




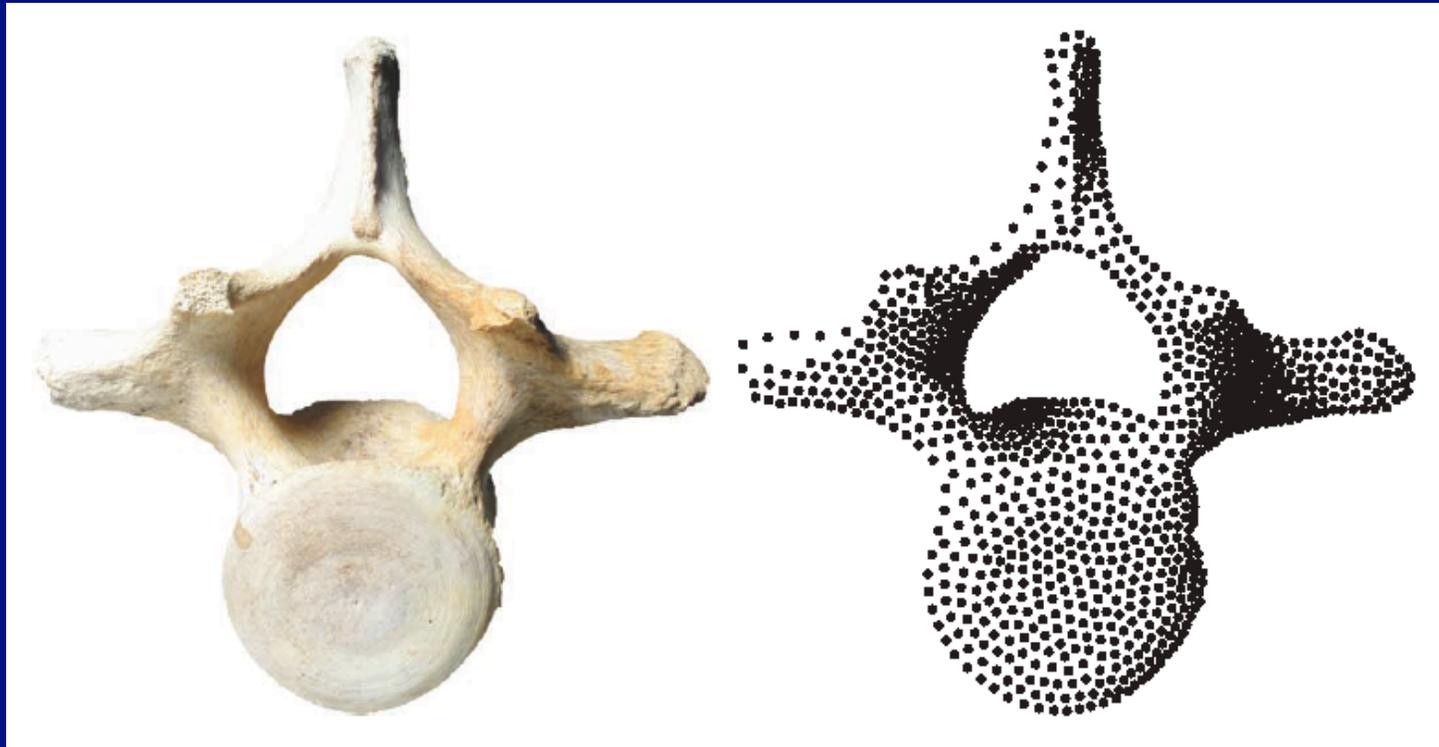
# Stippling

- Stipple size/density conveys shading
- Algorithm:
  - Obtain evenly spaced centers with Lloyd's method
  - size/density proportional to average grey level in cell

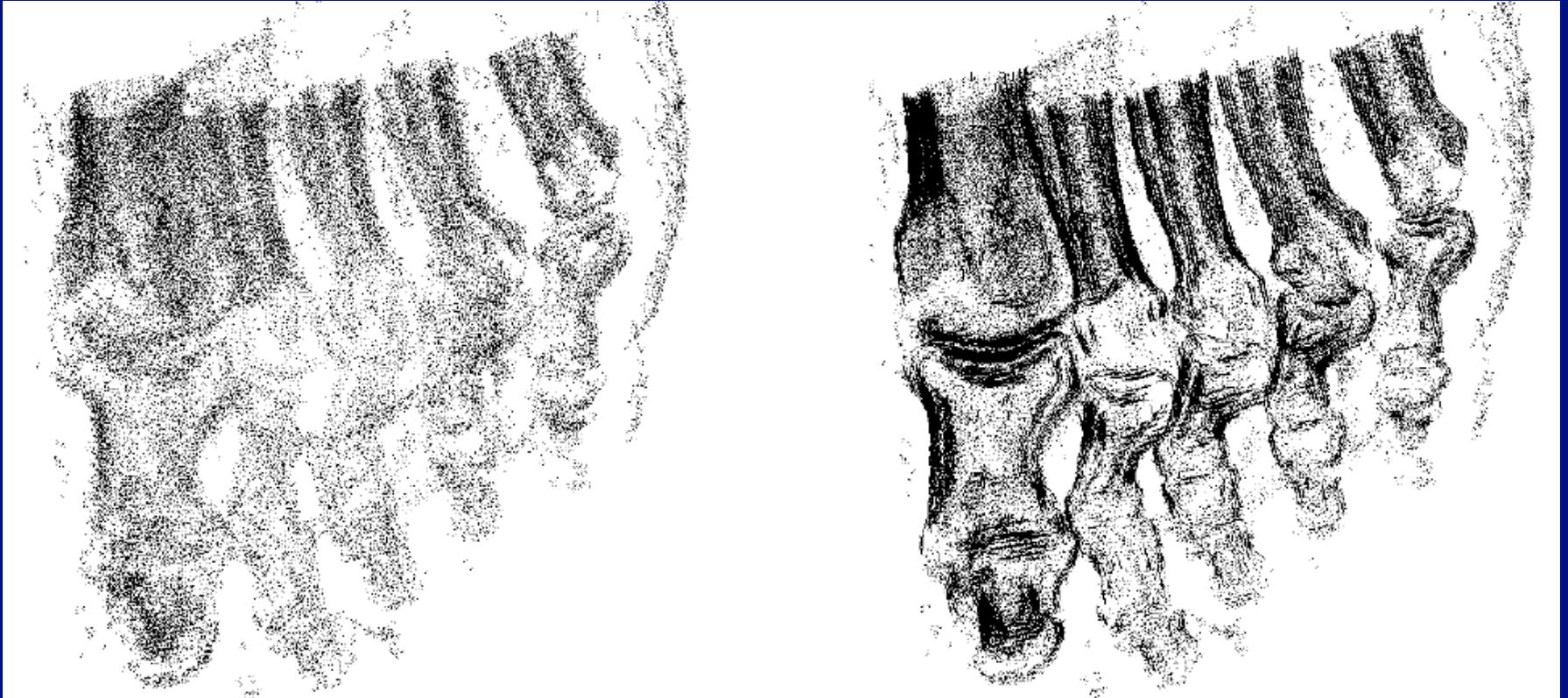




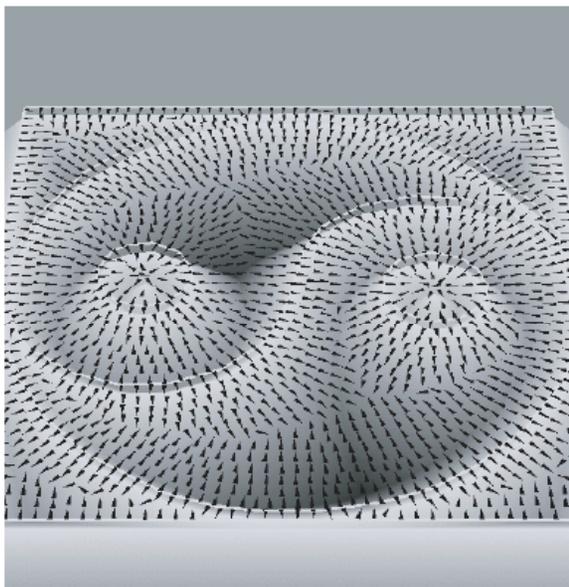
Deussen et al



Secord, from Hertzmann



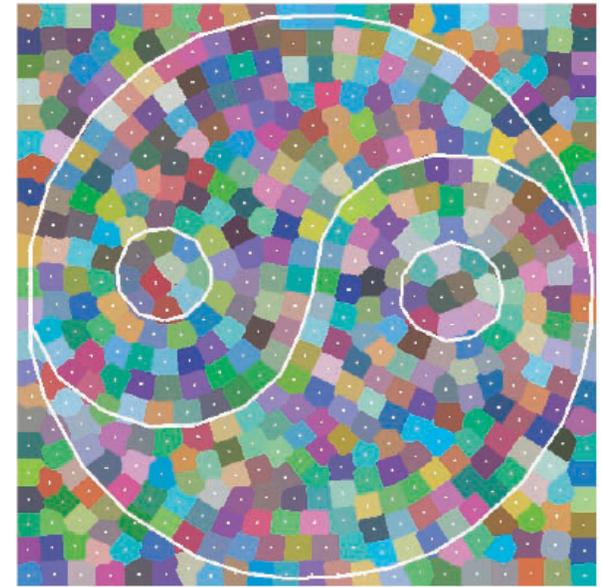
Lu



(a)

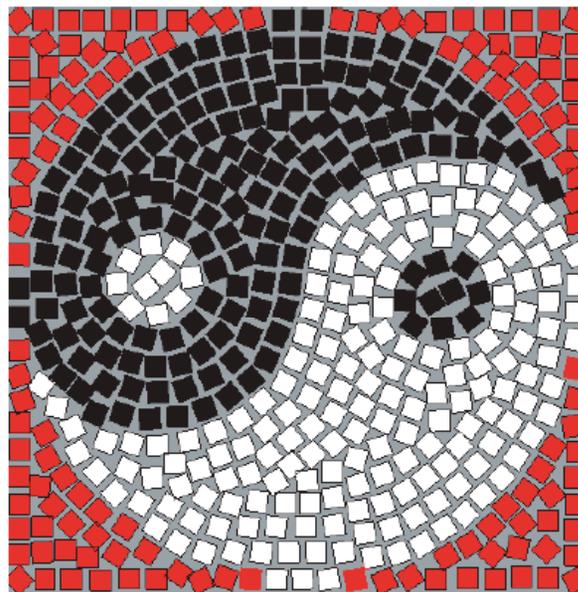


(b)

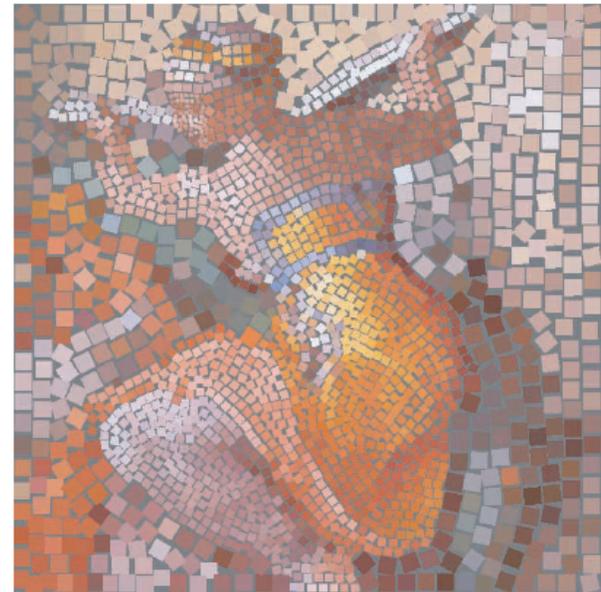


(c)

**6** Tile mosaic results from Hausner.<sup>14</sup> (a) Perspective view of the vector field used for the yin-yang example. The vector field was generated from the height field shown. (b) Initial Voronoi diagram of randomly placed points. (c) Final tiling. Edges shown in white are excluded from the optimization. (d) Rendered tiling, using colors from a source image. (e) Tiling of a Lybian Sibyl image.



(d)



(e)

Courtesy of Alejo Hausner



Haerberli, from Hertzmann