

COS426

Non-photorealistic Rendering

Lee Markosian

Q: What is computer graphics about?

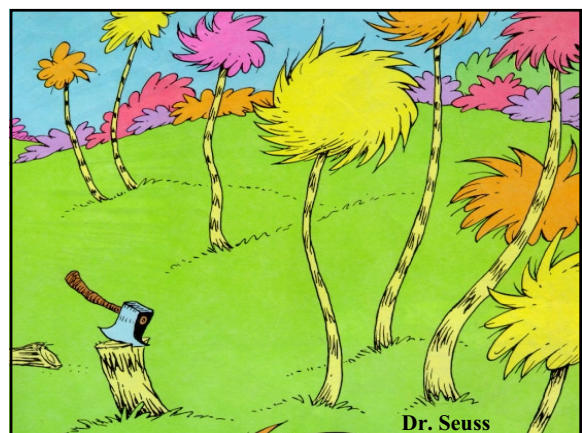
A: Providing tools to help human designers produce images that communicate visual information for some purpose.

Whether to use photorealism depends on the purpose of the image:

- Documentation
- Illustration
- Story-telling
- Expression

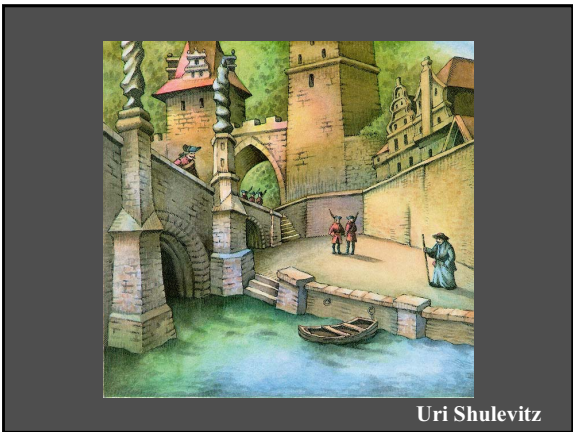
Qualities of hand-drawn images

- Many details left out
- Some details emphasized
- Stylization / abstraction
 - used to evoke complex things
- Recognizable individual style

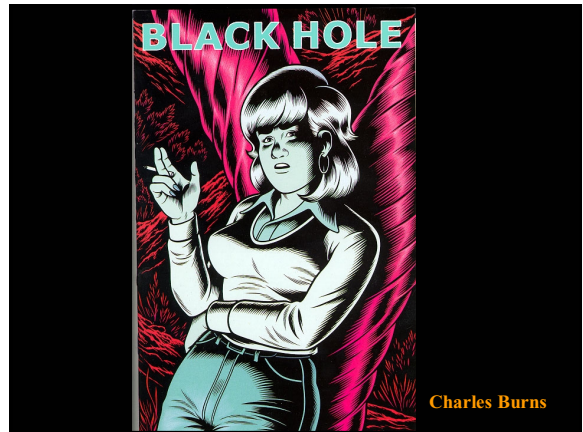




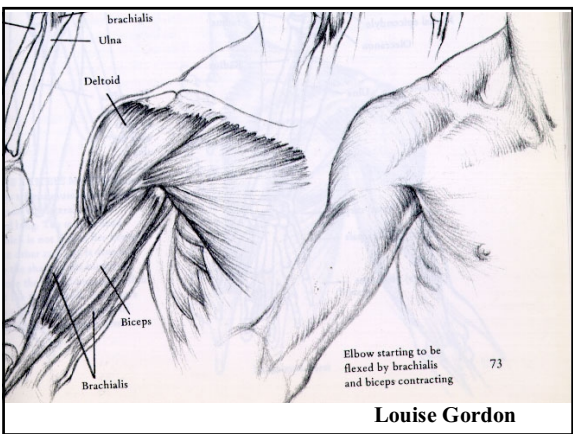
Monet



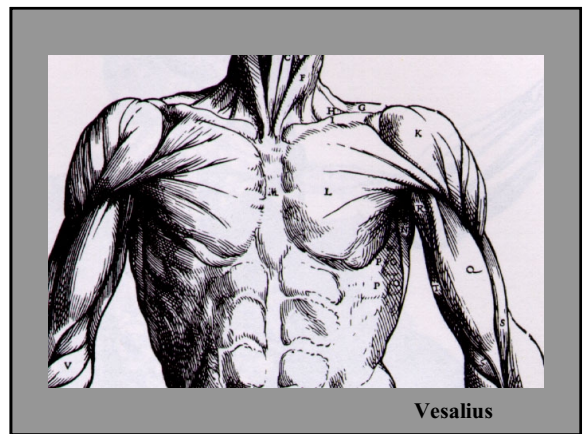
Uri Shulevitz



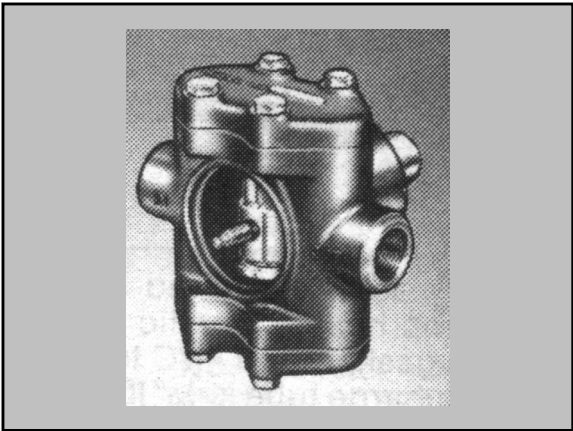
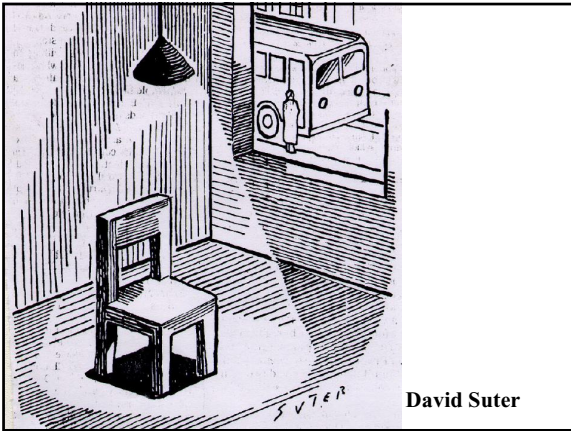
Charles Burns



Louise Gordon



Vesalius

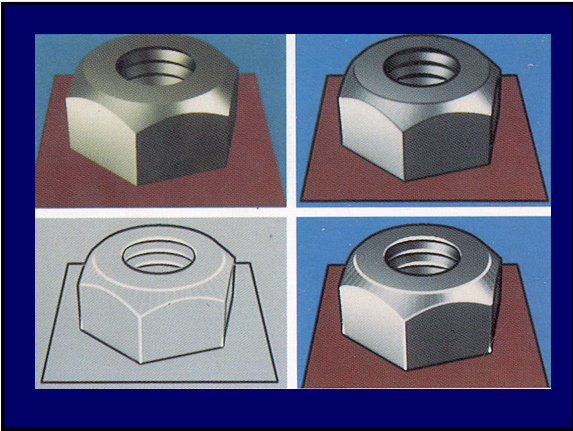
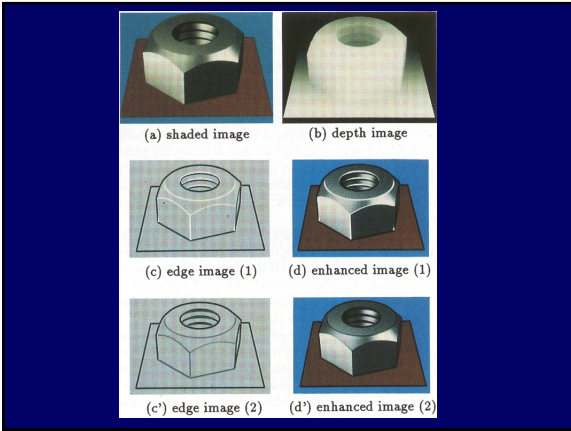


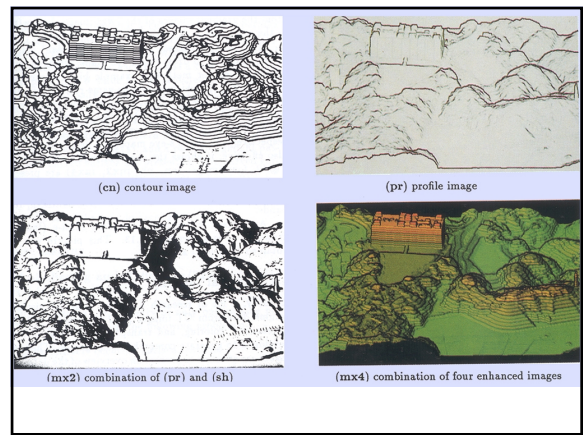
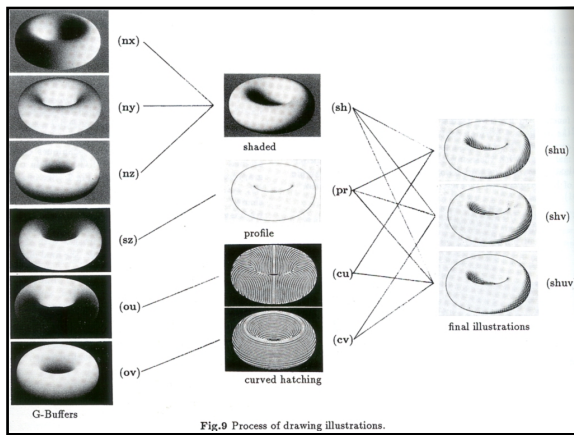
Outline

- Technical illustration
- Pen & Ink
- Painterly rendering for animation
- Cartoonish rendering

Technical illustration

- Saito and Takahashi, Siggraph 90
- Purpose: render 3D models in styles that are more “comprehensible”
- Method:
 - Render various intermediate images
 - Do image-processing operations on them
 - Combine the results



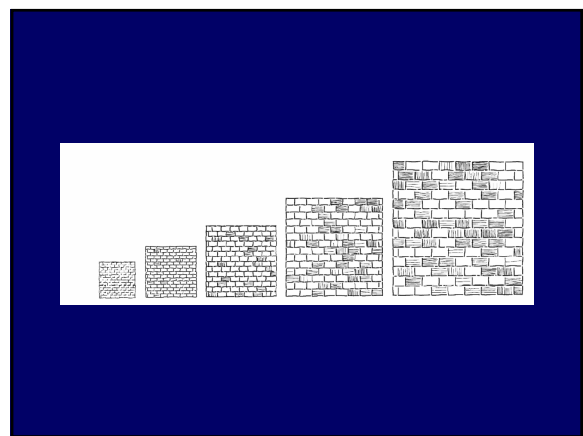
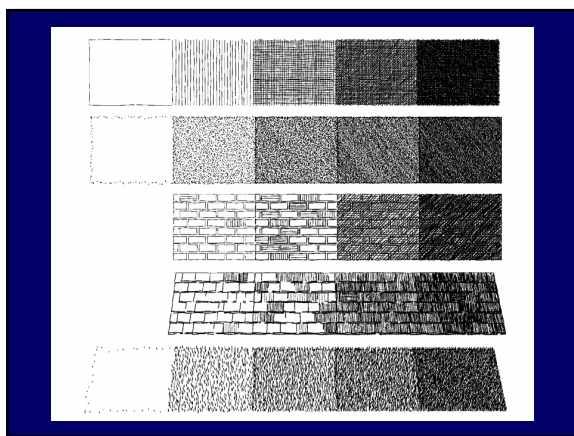


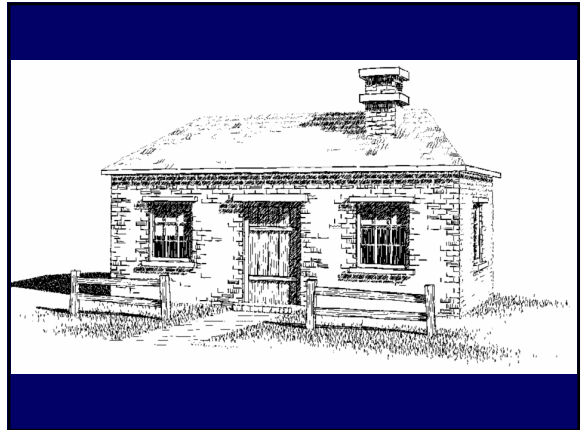
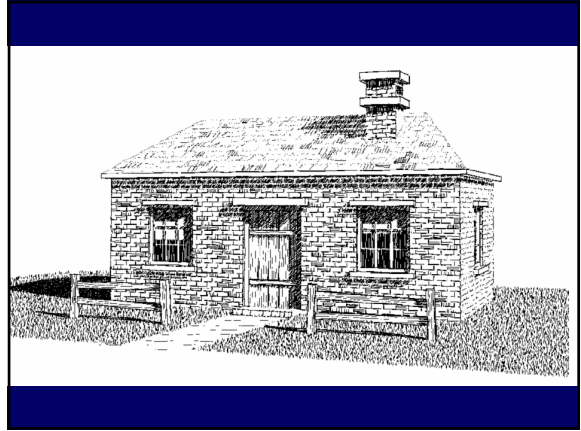
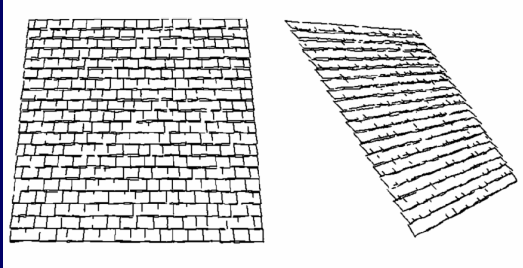
Problem

- Parameters need careful tuning for good results

Pen and Ink

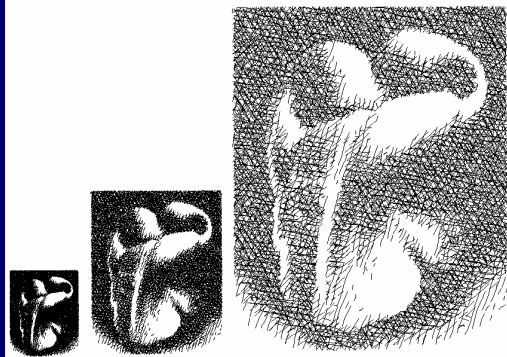
- Winkenbach and Salesin, Siggraph 94
- Purpose: render 3D models as pen & ink drawings
- Method:
 - annotate model with procedural “textures”
 - Render tonal “reference image”
 - Use it to guide pen and ink textures

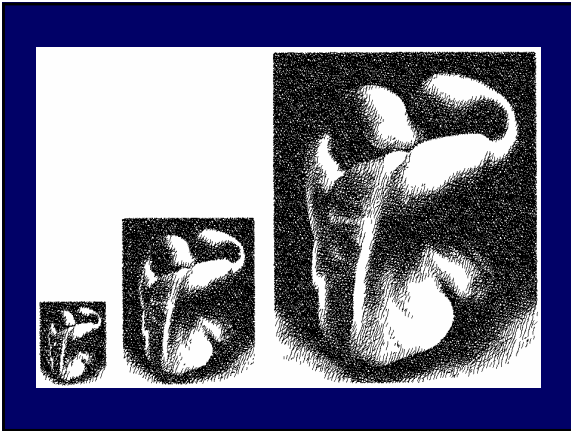




Pen and Ink

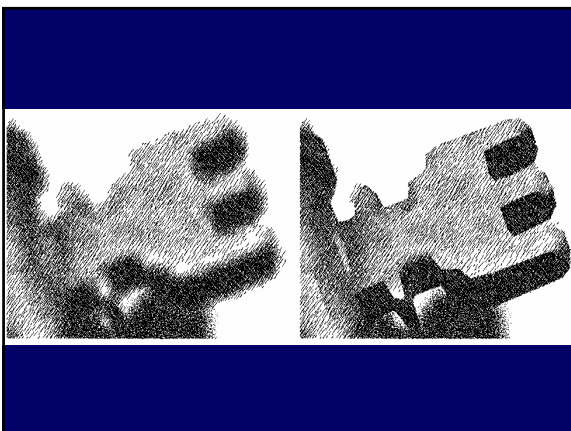
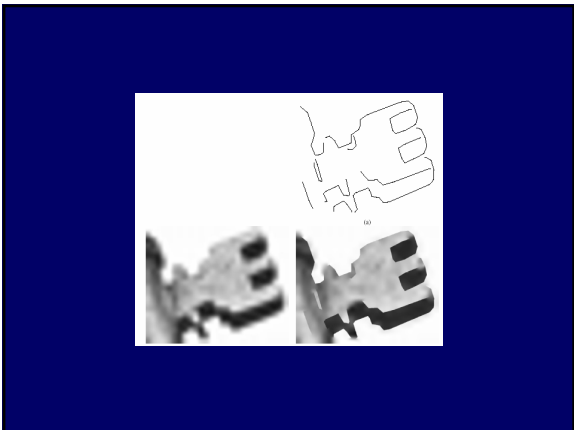
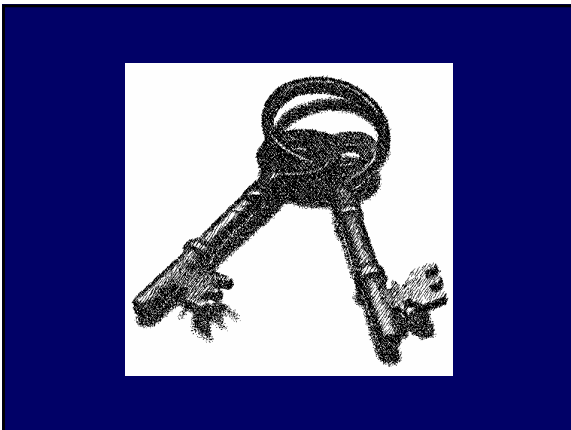
- Salisbury, Anderson, Lischinski and Salesin, Siggraph 96
- Purpose: define a scale-independent representation for pen & ink images





Salisbury et al., cont'd

- Method:
 - Store lo-res greyscale image annotated with discontinuities
 - filter greyscale image to desired size, run stroke generation algorithm on it

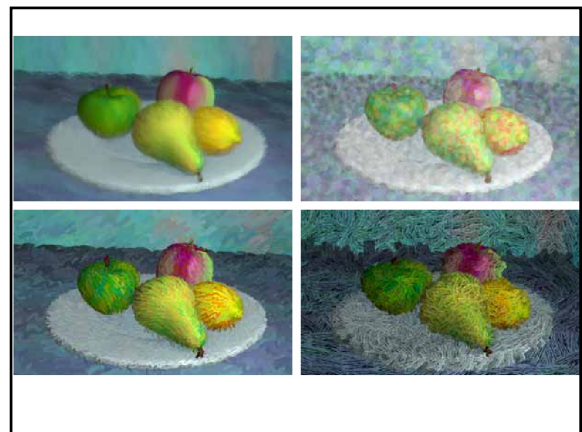
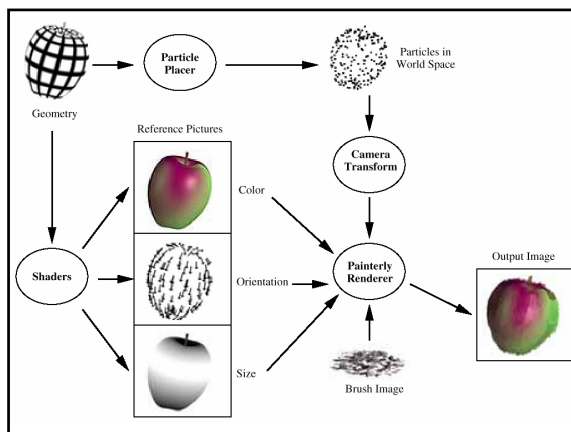
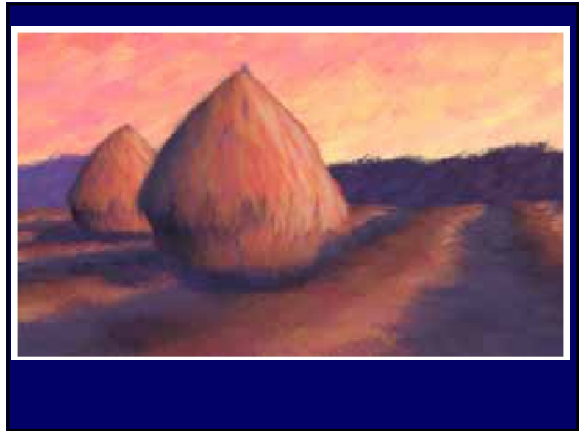


Problems

- Only produces still images
 - Would not provide temporal coherence
- What's the application?

Painterly rendering

- Meier, Siggraph 96
- Problem: produce animations in a “painterly” style with temporal coherence of strokes
- Method:
 - Populate surfaces with stroke “particles”
 - Render with the help of reference images



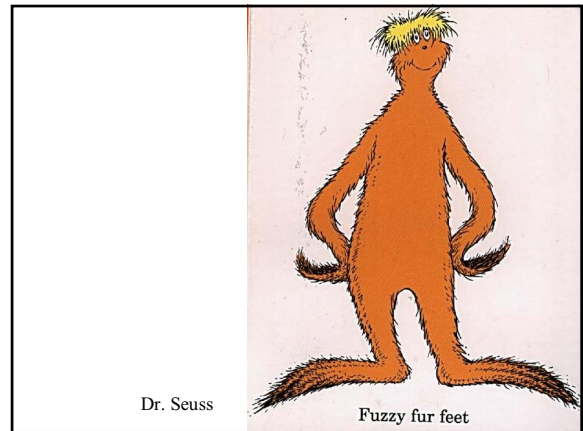
video

Problem

- Particles have fixed distribution
 - Need prescribed camera path

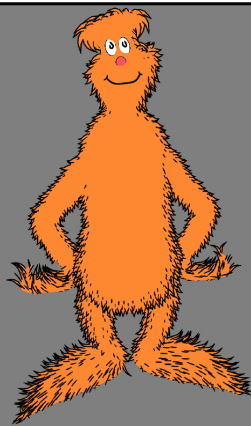
Cartoonish rendering

- Kowalski, Markosian, Northrup, Holden, Bourdev, Hughes, Siggraph 99
- Problem: render scenes like those truffula trees I showed you earlier
- Method:
 - Populate scene with detail elements “graftals”
 - Render with the help of reference images



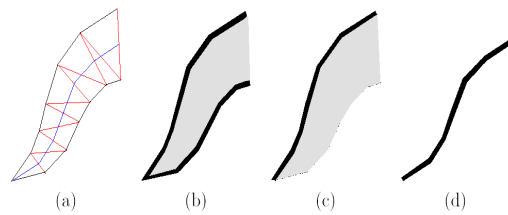
Graftal textures

Detail elements (graftals)
generated as needed



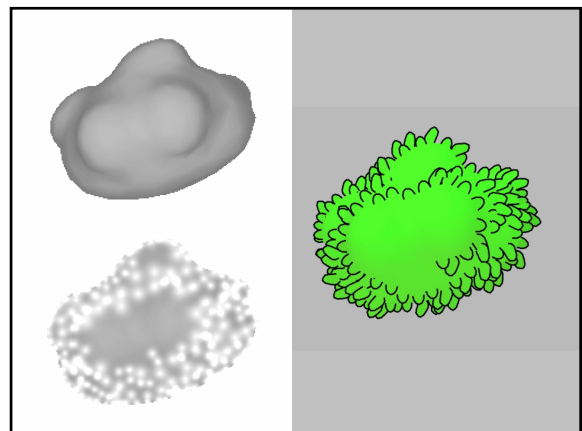
Graftals

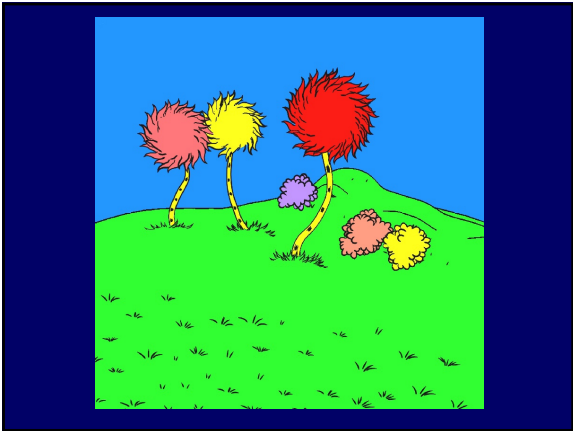
- Oriented in local frame
- Can choose level of detail



Needed for placement of graftals:

- Primarily at silhouettes (e.g.)
- Controlled *screen-space* density
- Placement on surfaces
- Persistence of graftals

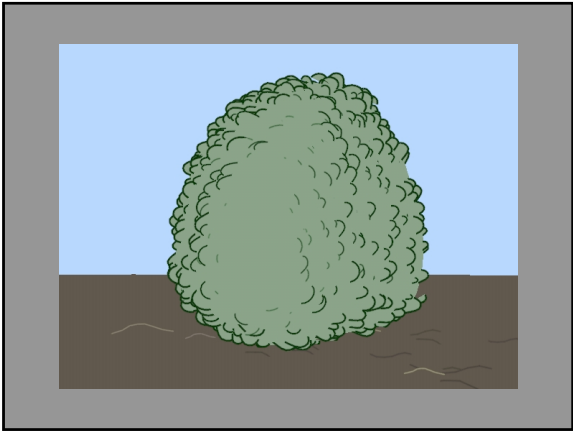




video

- ### Problems
- Temporal incoherence
 - Hard to author new scenes
 - You have to write C code

- ### Static graftals
- Markosian, Kowalski, Meier, Northrup, Holden, Hughes, NPAR 00
 - Problem: improve temporal coherence
 - Method:
 - Graftals are fixed on surfaces
 - Draw with view-dependent LOD

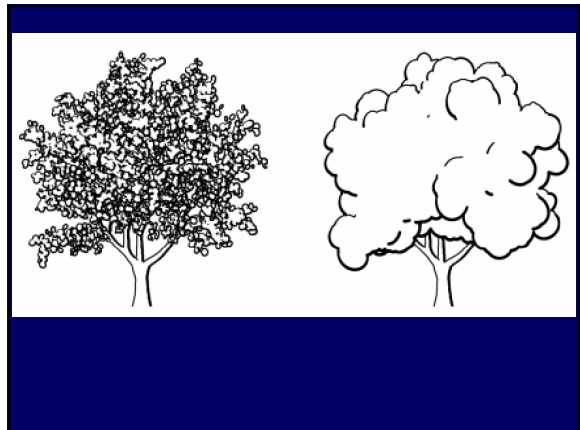
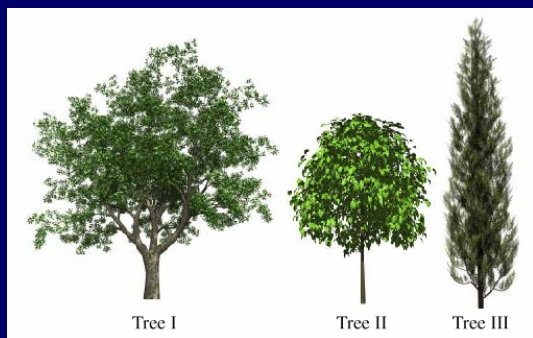


Problems

- Still hard to author scenes
 - You have to edit text files
- LOD handling too restrictive

Pen & Ink: trees

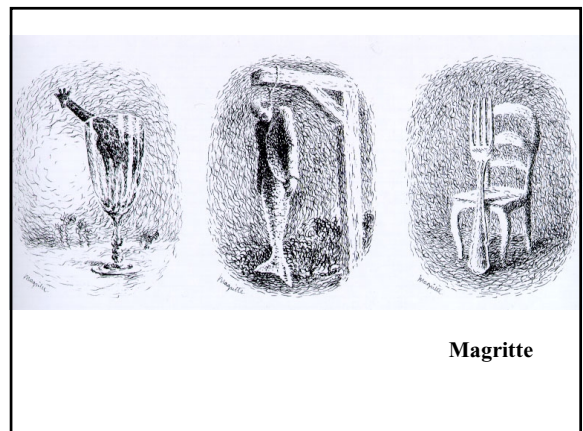
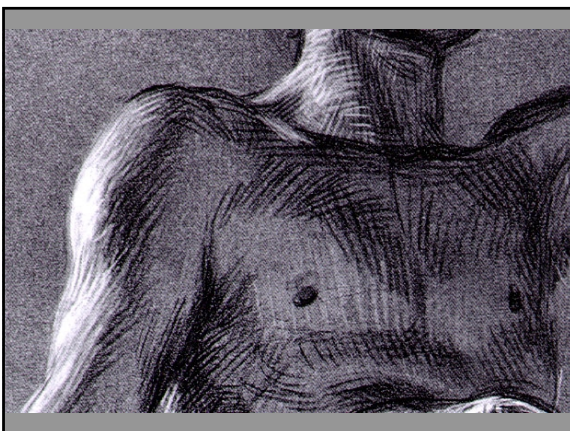
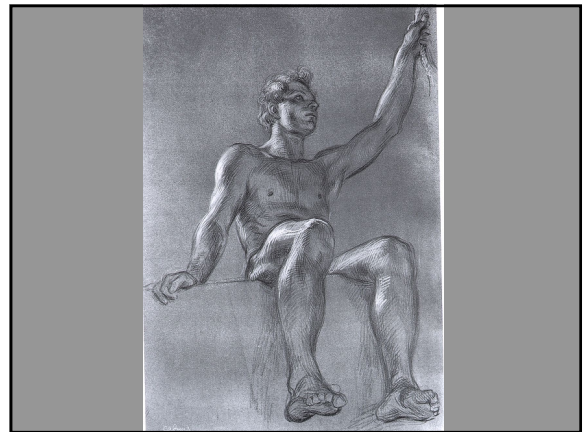
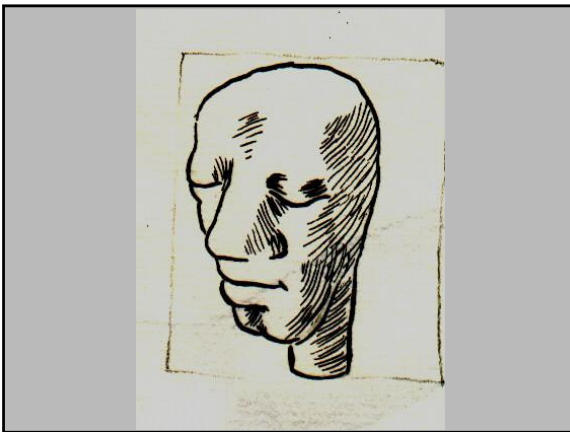
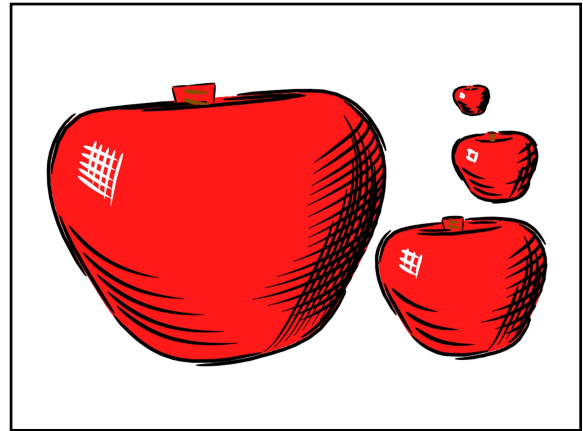
- Deussen and Strothotte, Siggraph 00
- Problem: temporally coherent pen and ink rendering of trees
- Method:
 - Draw leaf entities w/ controlled size/abstraction
 - Do image processing on depth buffer

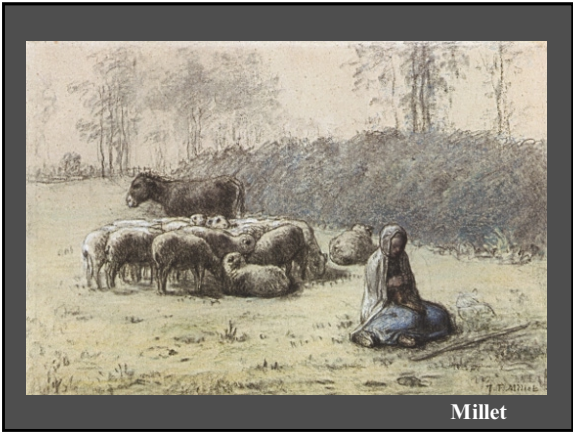


video

The future

- More rendering algorithms
- Better tools (UI)
 - NPR images need this especially
- Prediction: big advances in our ability to model stylized characters (people) are coming
- Reason: the content creators will demand it





Millet

