Painterly Rendering
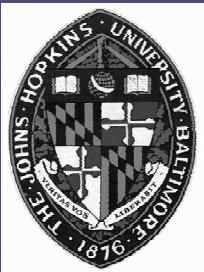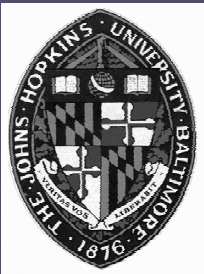
Types of Computer Painting

Physical simulation

- User applies strokes

- Computer simulates media (e.g. watercolor on paper)

Automatic painting

- User provides input image or 3D model and painting parameters
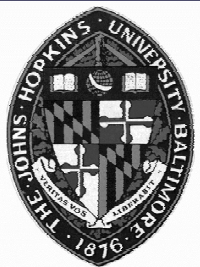
- Computer generates all strokes

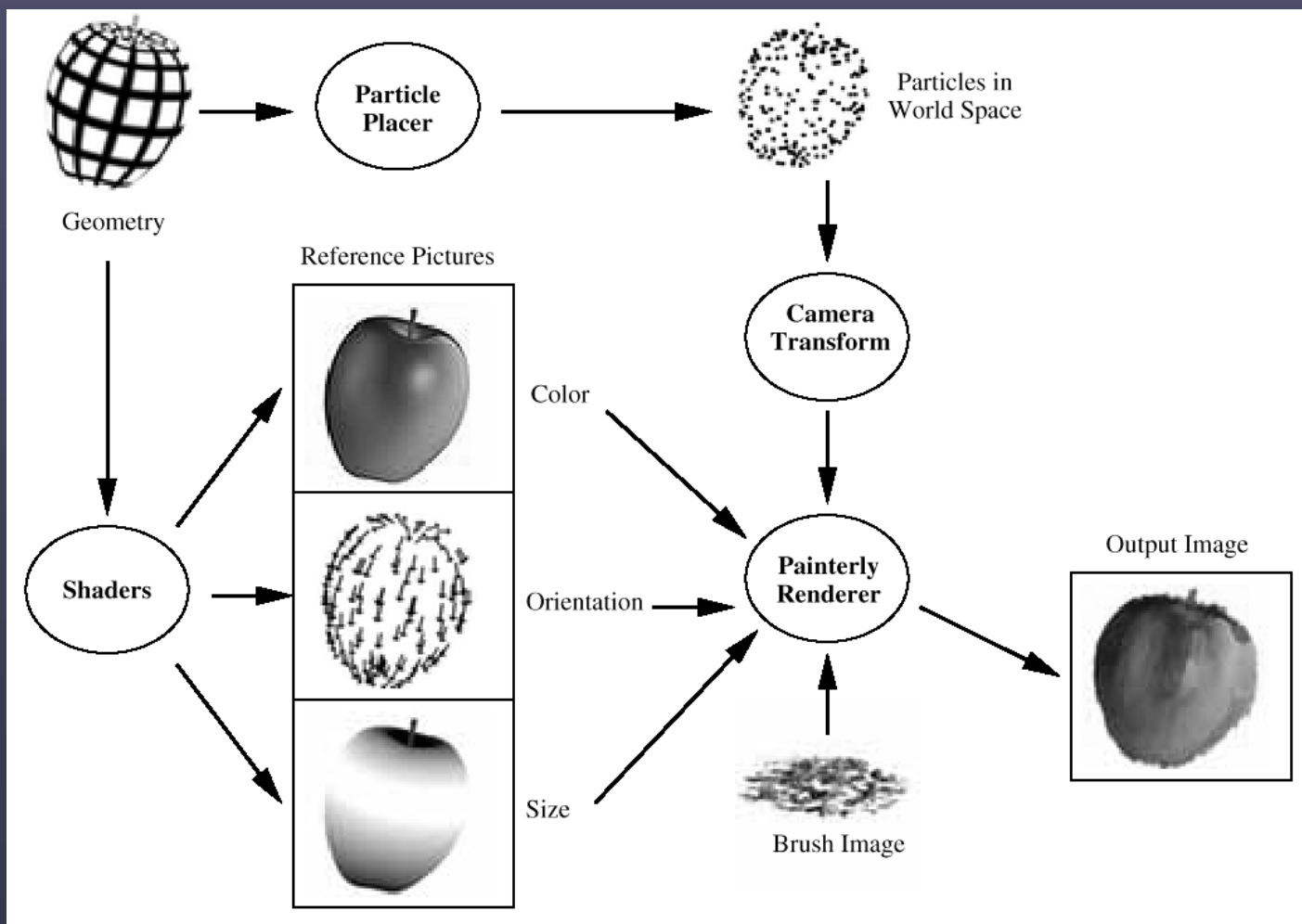# Two Painterly Rendering Systems

"Painterly Rendering for Animation"

- Meier, *SIGGRAPH 96*

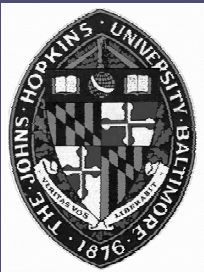"Painterly Rendering with Curved Brush Strokes of Multiple Sizes"

- Hertzmann, *SIGGRAPH 98*

Painterly Rendering Pipeline

from Meier, "Painterly Rendering for Animation, *Proceedings of SIGGRAPH 96*, page 480.
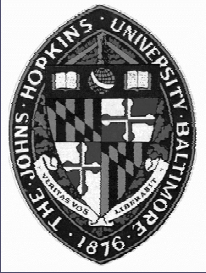
Basic Approach

Algorithm

- Surface particles placed in world space
- Reference images rendered
- Each particle becomes a screen-space stroke

Features

- Greater temporal coherence than purely screen-space approaches
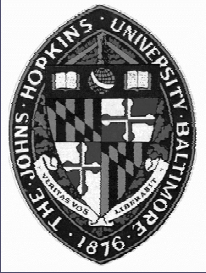- More natural style than purely geometry (texture-mapped) approaches

Particle Generation

Compute area of surface primitives

Randomly particles on primitives
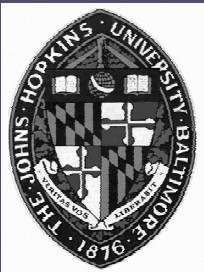
- **number proportional to area**

Reference Images

Used to determine stroke attributes

- color

- orientation

- size

- many others possible

Rendered with programmable shaders

Stroke Rendering

Particle transformed to screen-space

Stroke parameters from reference images

- **perturbed according to user-specified variation**

Brush image rendered according to stroke parameters

- **oblong brush shapes work best**
- **grayscale brushes typically sufficient**
    - **color brush textures may be used to modify particle colors**
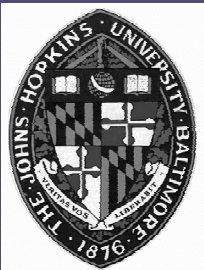
Example - Haystacks

Haystacks *without* random parameter perturbation

Similar view *with* random parameter perturbation

from Meier, "Painterly Rendering for Animation, *Proceedings of SIGGRAPH 96*, pages 481 and 478.
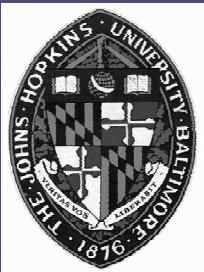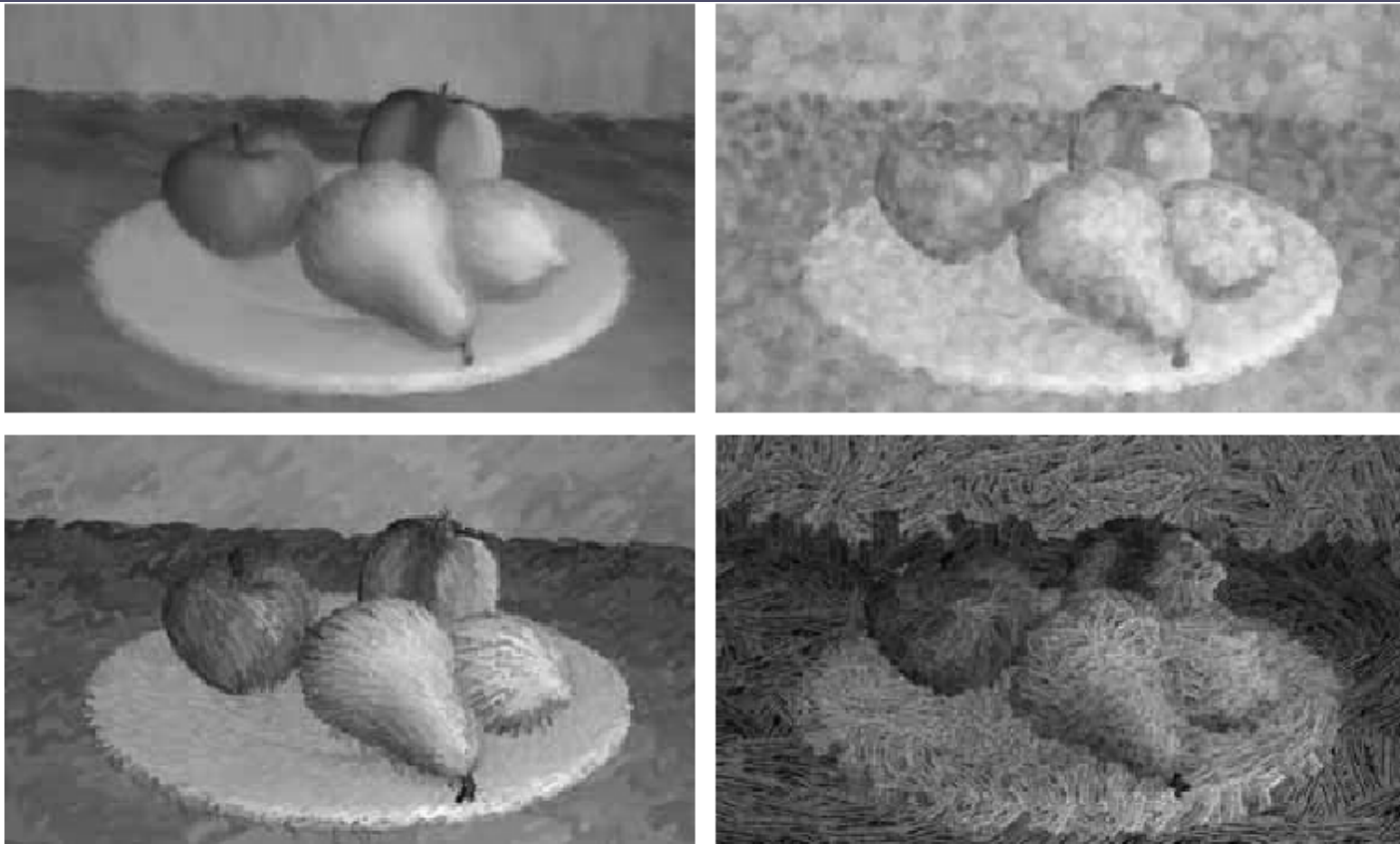
Example - fruit

Figure 5: **Four styles of painterly rendered fruit.** By choosing different brush images and painting parameters, we have created four different looks from the same set of reference pictures. The upper left image has the soft, blended quality of a pastel painting. The pointillistic version, in the upper right, remaps the original saturations and values from the color reference picture to a new range. A squiggle brush image and increased hue variation were used to create marker-style strokes in the lower left image. The brush used to create the lower right contained some opaque black that helps to create a woodcut print style.

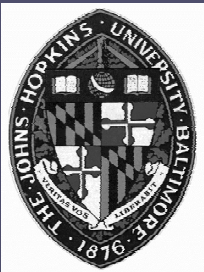from Meier, "Painterly Rendering for Animation, *Proceedings of SIGGRAPH 96*, page 481.

Layered Approach

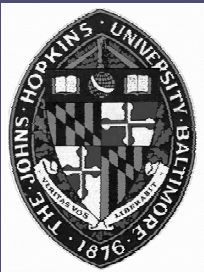Similar objects rendered together

Dissimilar objects often rendered as separate layers and composited later

- Large strokes intrude less onto nearby objects

Video (or .mov movie files)

Meier, "Painterly Rendering for Animation", *Proceedings of SIGGRAPH 96.*
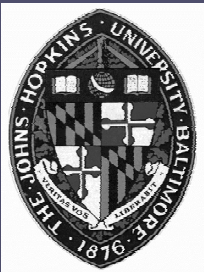
Hertzmann's Approach

Apply to color images with no 3D model information

Allow longer, curved brush strokes

- makes different styles possible

Multiple rendering passes

- larger strokes first
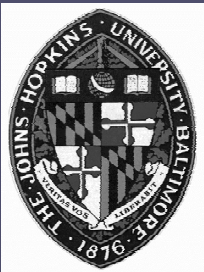
- add detail with smaller strokes

Stroke Description

Constant color per stroke

B-spline path

Constant radius circle (or other shape)

swept along path

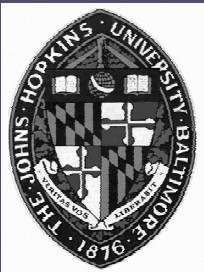Applied in layers, with opacity control

Building Up Layers

Start with large strokes

Each pass reduces stroke size

New strokes placed according to error

metric of current painting

Painting a Layer

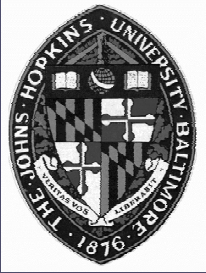Select stroke size for layer

Blur input image

Start strokes within uniform grid cells

Start each stroke at point of maximum error within grid cell

Walk perpendicular to image gradient to place control points

Render strokes in random order as circles along cubic B-spline path

Style Parameters

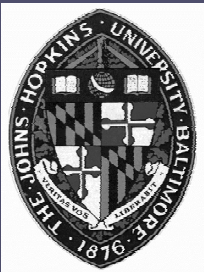Approximation threshold

Brush sizes

Curvature filter

Blur Factor

Min/Max stroke lengths

Opacity

Grid size

Color jitter

Example Styles

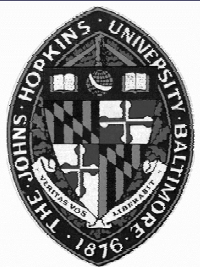"Impressionist"

"Expressionist"

- long strokes, color value jitter

"Colorist Wash"

- transparency, RGB color jitter

"Pointillist"

- densely placed circles, random hue and saturation

Example - adding passes

Figure 2: Painting with three brushes. (a) A source image. (b) The first layer of a painting, after painting with a circular brush of radius 8. (c) The image after painting with a brush of radius 4. (d) The final image, after painting with a brush of size 2. Note that brush strokes from earlier layers are still visible in the painting.

from Herzmann, "Painterly Rendering with Curved Brush Strokes of Multiple Sizes, *Proceedings of SIGGRAPH 98*, page 456.
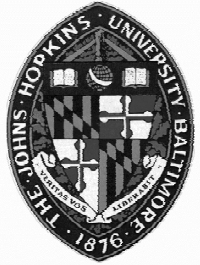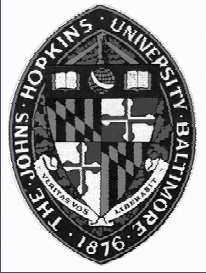
Example - styles

Three styles: impressionist, expressionist, colorist wash

from Herzmann, "Painterly Rendering with Curved Brush Strokes of Multiple Sizes, *Proceedings of SIGGRAPH 98*, page 460.

Video

Hertzmann, "Painterly Rendering with Curved Brushe Strokes of Multiple Sizes", *Proceedings of SIGGRAPH 98.*