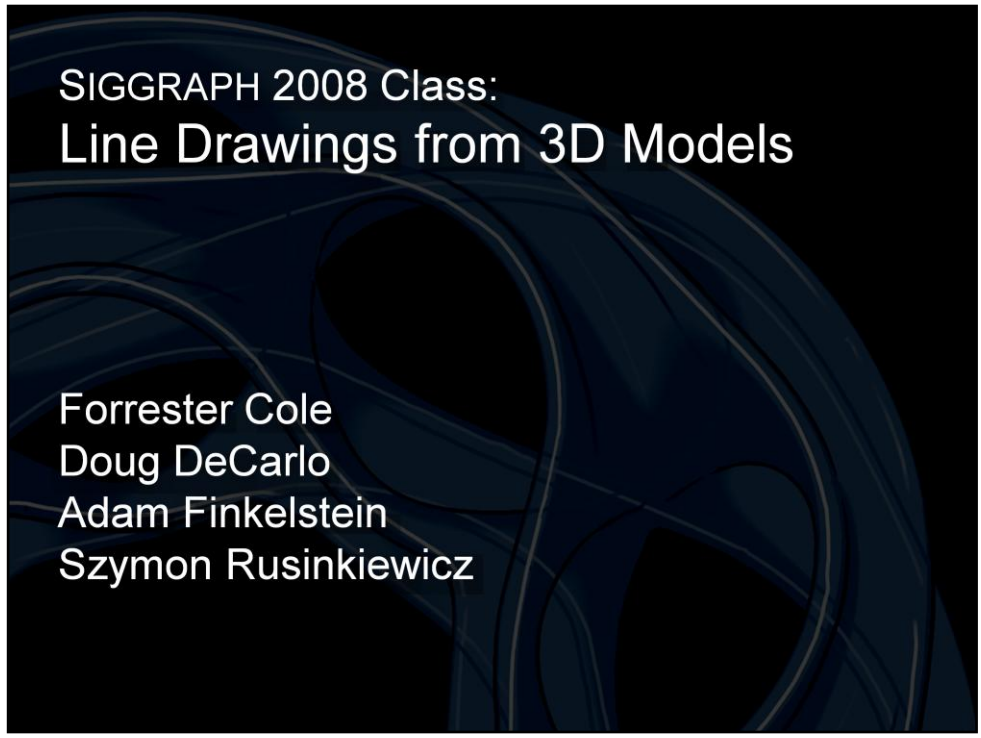
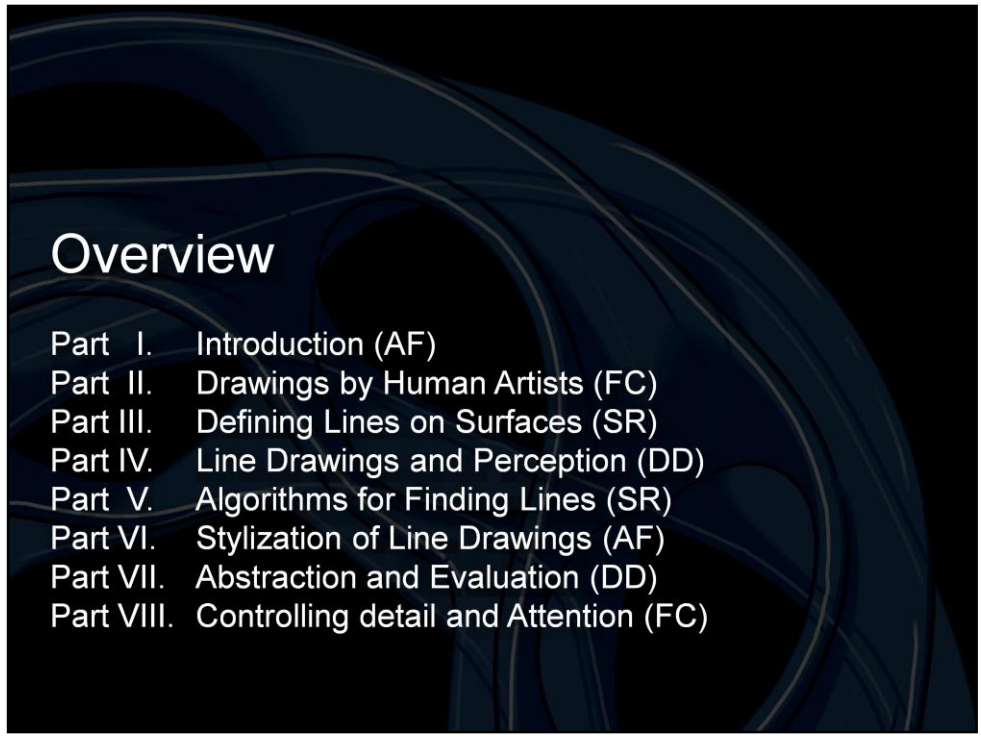
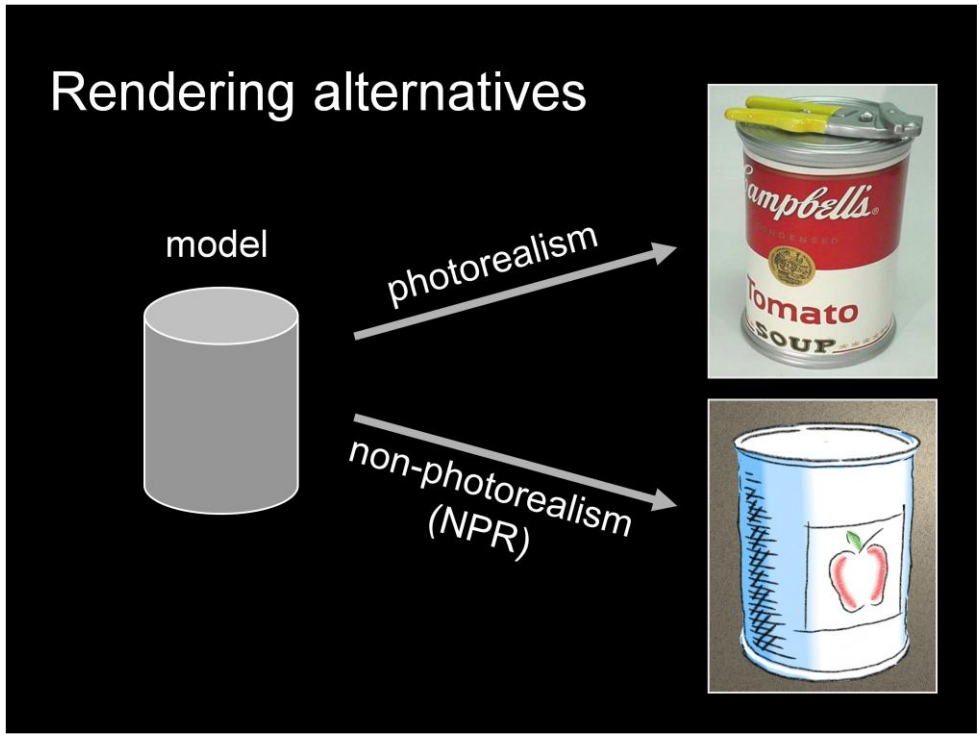

SIGGRAPH 2008 Class:
Line Drawings from 3D Models
Forrester Cole
Doug DeCarlo
Adam Finkelstein
Szymon Rusinkiewicz

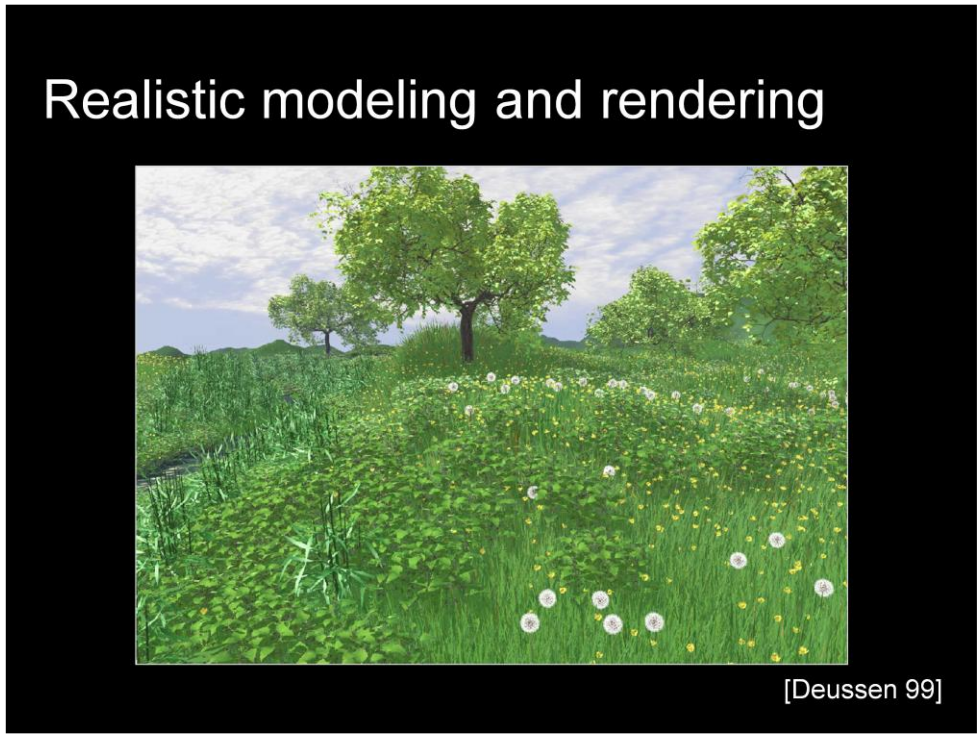

Overview
Part I. Introduction (AF)
Part II. Drawings by Human Artists (FC)
Part III. Defining Lines on Surfaces (SR)
Part IV. Line Drawings and Perception (DD)
Part V. Algorithms for Finding Lines (SR)
Part VI. Stylization of Line Drawings (AF)
Part VII. Abstraction and Evaluation (DD)
Part VIII. Controlling detail and Attention (FC)

We taught a similar course at Siggraph 2005, so it's natural for those of you who attended it to wonder what's new this time? Indeed, there is substantial overlap in this offering. However there have also been a number of advances in the field since then and we'll try to highlight this new material. In particular, there have been several new algorithms proposed recently for drawing lines from smooth 3D shapes. In addition, there have been some studies on how people make line drawings. Finally, there is the usual version 2.0 overhaul.

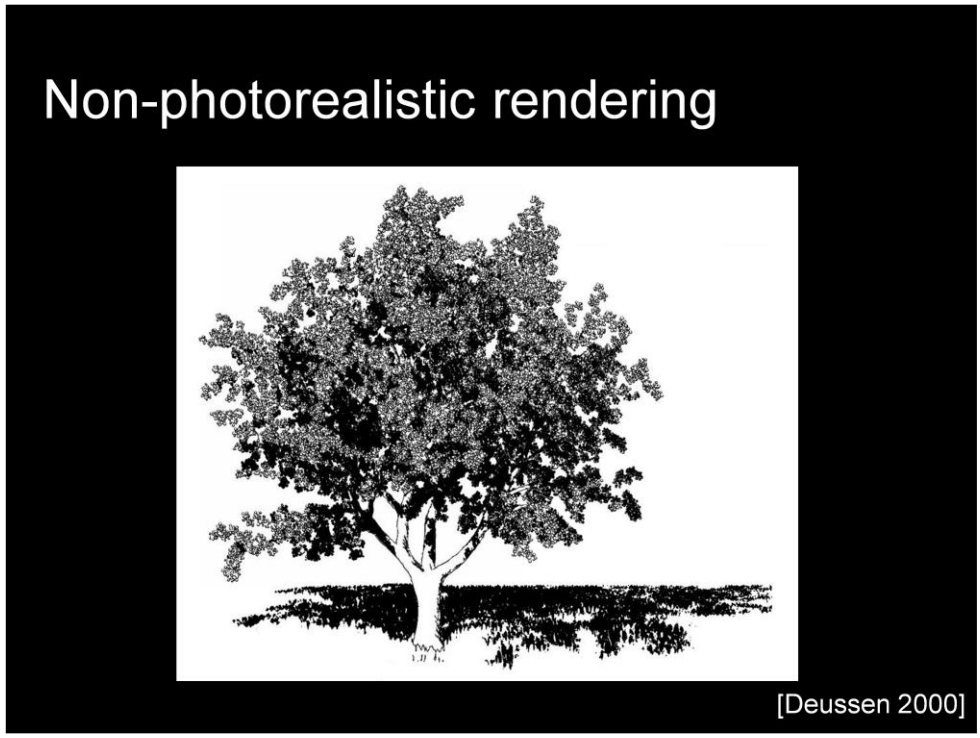


When it comes to making pictures with computer graphics there are a couple alternatives. Most traditional work in computer graphics has been striving towards realistic imagery. One reason is that it provides a way to accurately simulate our experiences in the real world. There is a terrible cost to this, unfortunately, which is that you have to get all the details just right, which imposes a great burden on the modeler.

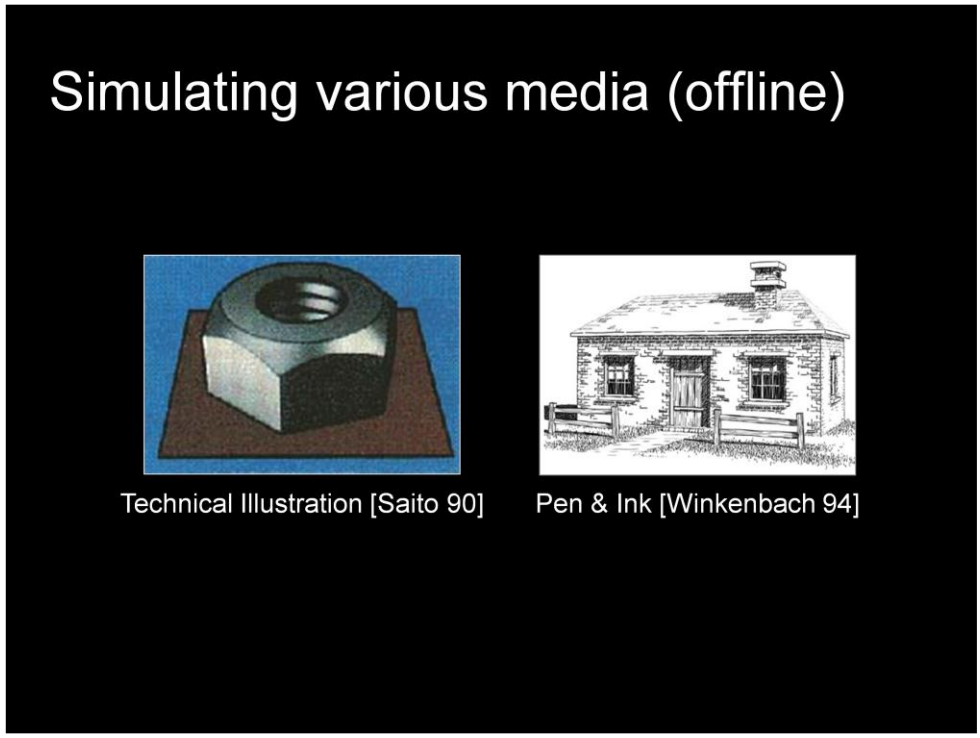
Fortunately there is an alternative. There is a branch of computer graphics that has been looking for more than a dozen years at how can we exploit principles of abstraction known to artists for many centuries to avoid having to worry about a myriad of perhaps unnecessary details.



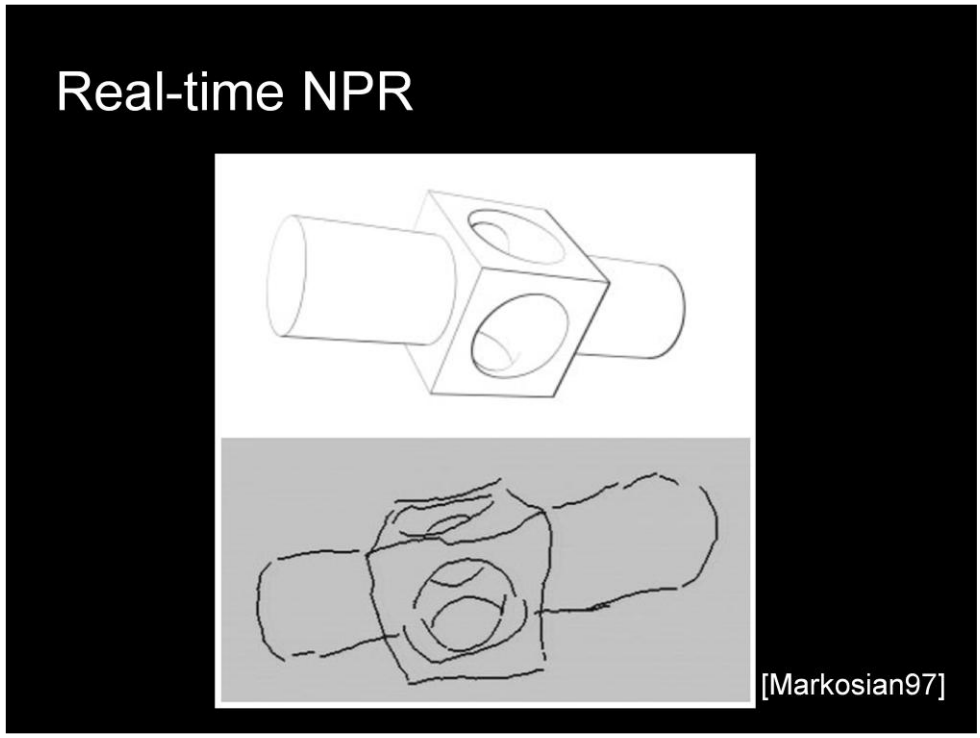
Here is a rendering of a realistic outdoor scene due to Deussen and others. It highlights the tradeoff that I was just mentioning. The model is extremely complex -- the number of polygons would not fit in the memory of most computers today, let alone those of 1999 when it was created.



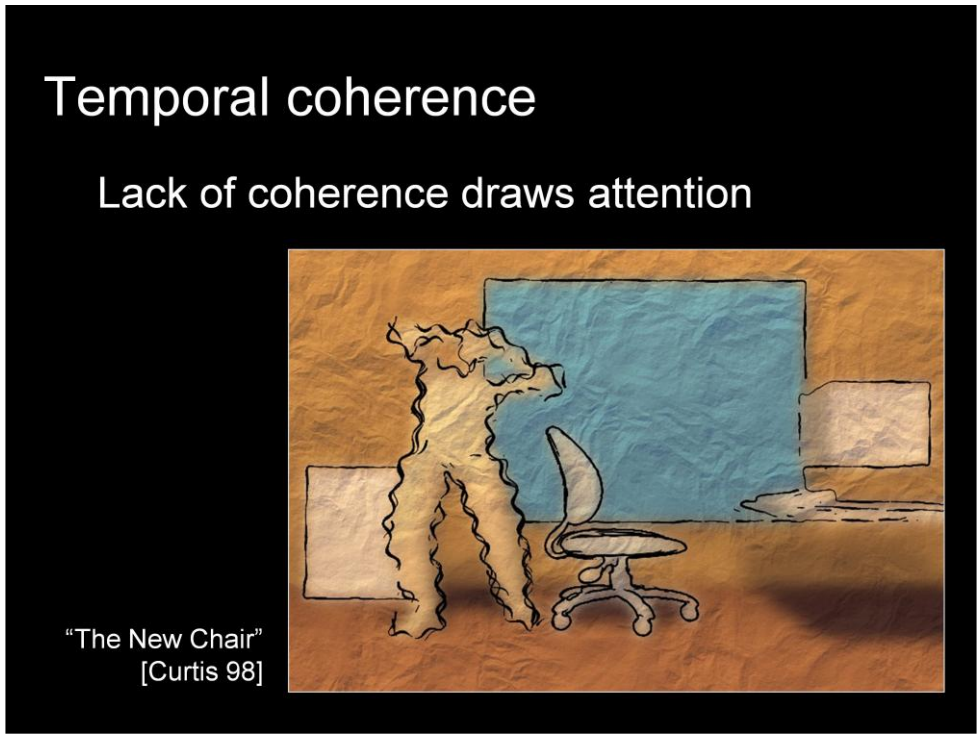
Here is a different rendering of an outdoor scene by Deussen and others. Obviously, there is a lot less complexity there, and yet depending on the application it may be just as appropriate for conveying a particular sense of a place.



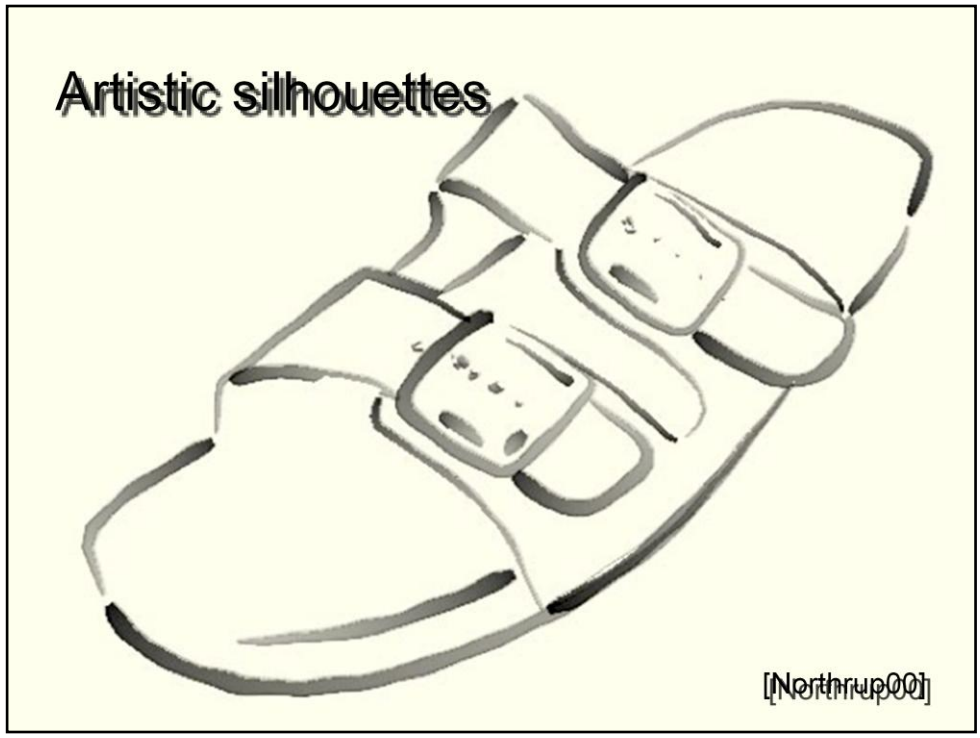
In the 1990s, NPR emerged as an alternative to photorealism. Research efforts largely focused on ways to simulate various media such as technical illustration or pen-and-ink. The goal was to make an image that was believably created by hand in one of these traditional media. These systems were mostly-automatic: the program attempted to mimic what an artist/illustrator might do. As in the traditional media, line drawing played a key role. These methods were largely offline, meaning you wait and after a while you get an image.



In the late 90's Markosian showed that stylized line drawings could be generated in real time, responding to changes in camera.

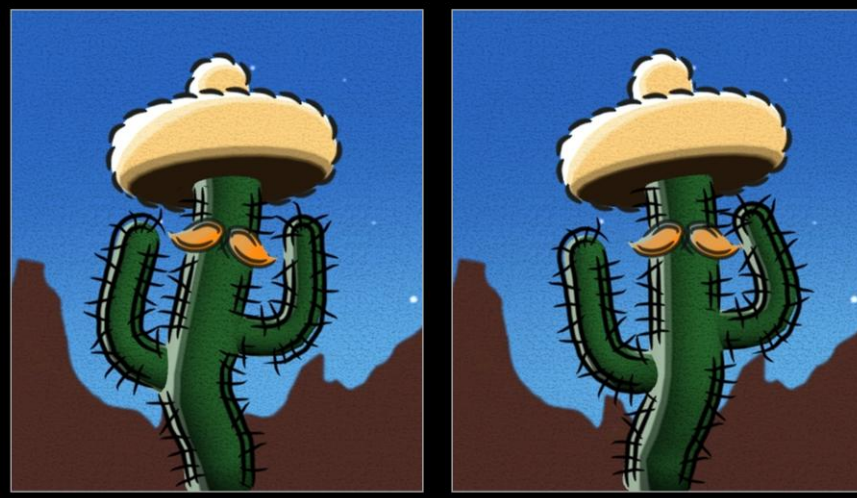


We can also use non-photorealism to guide the viewer's eye towards important features in a scene and away from unimportant fixtures. So, for example here, by using lines that have a crazy temporal quality, Curtis gave the standing figure a very energetic quality that draws your eye.



Northrup and Markosian continued to work on temporal coherence and line stylization, producing imagery like this in real time by the beginning of this decade.

Coherent stylized silhouettes



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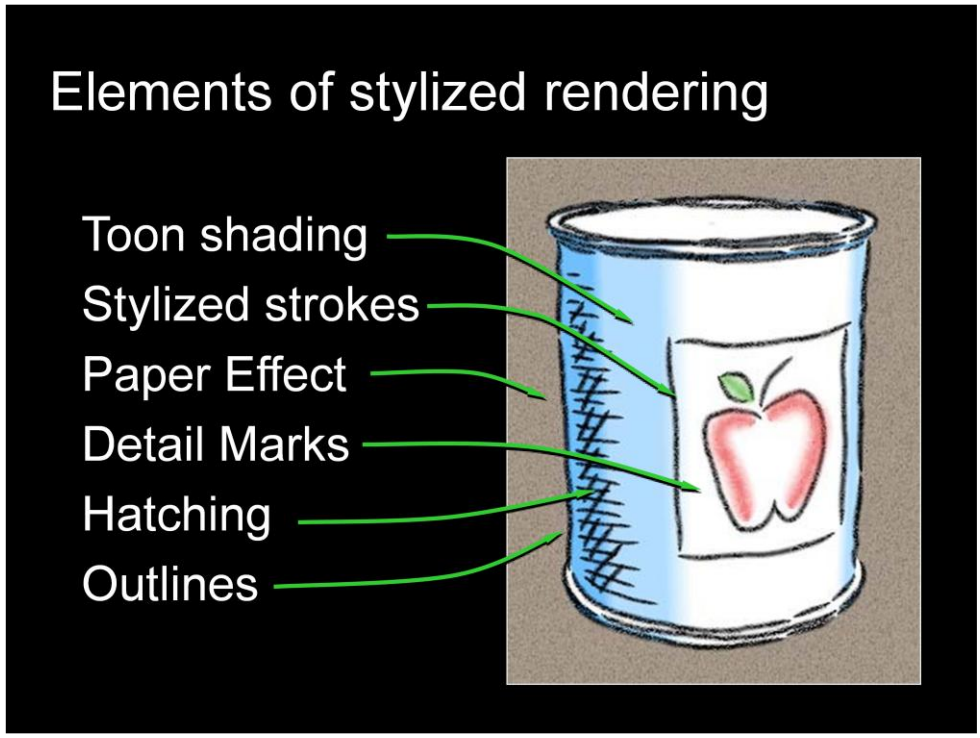
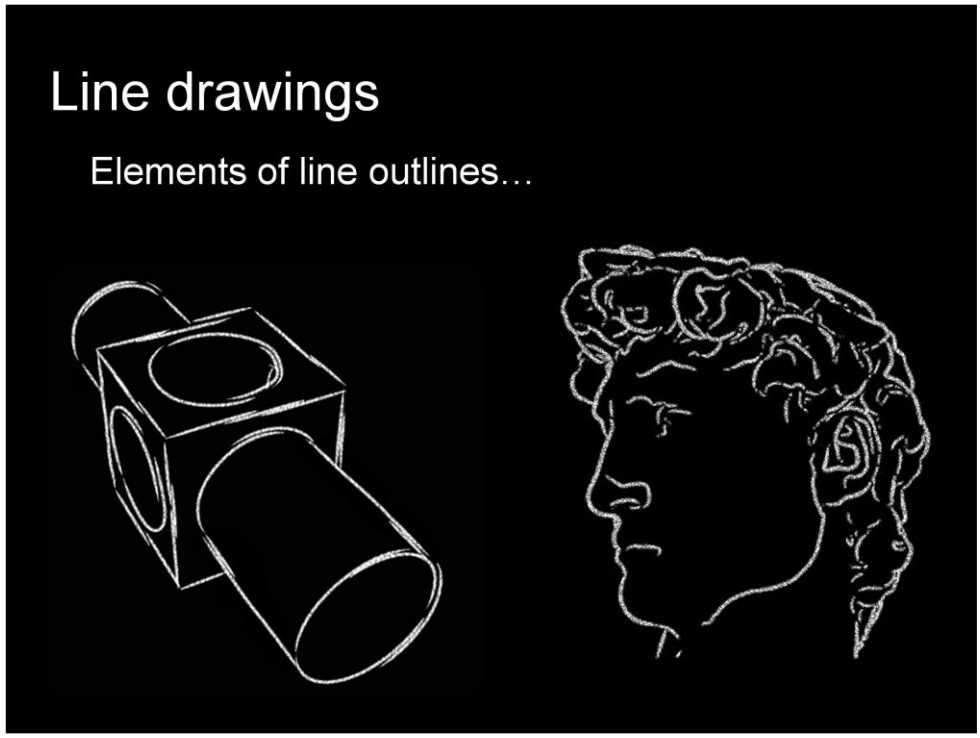
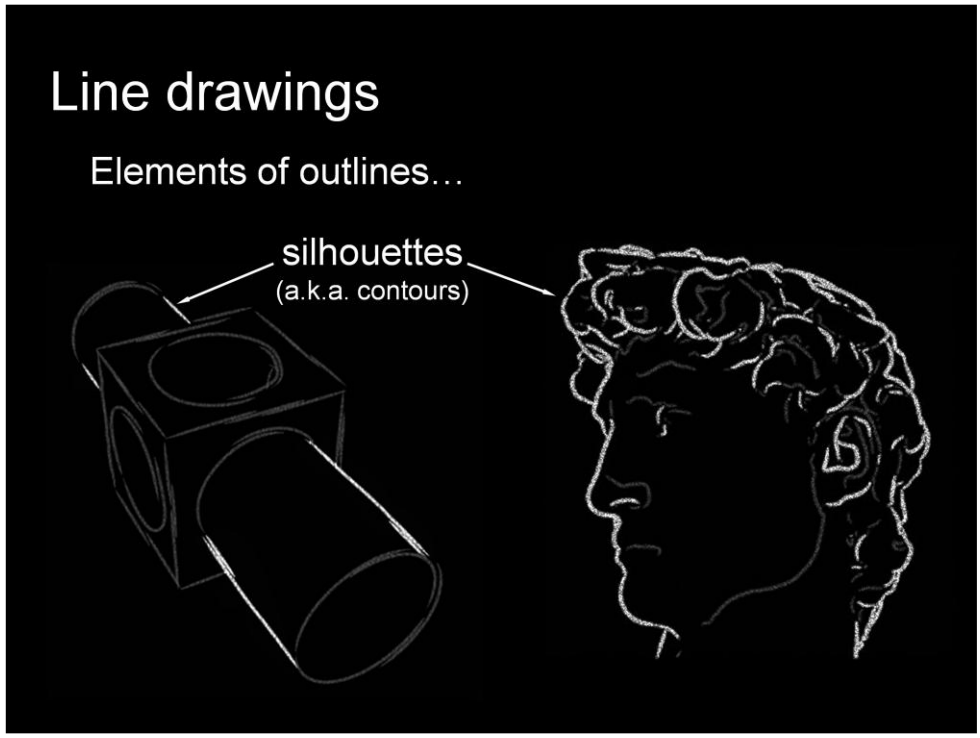


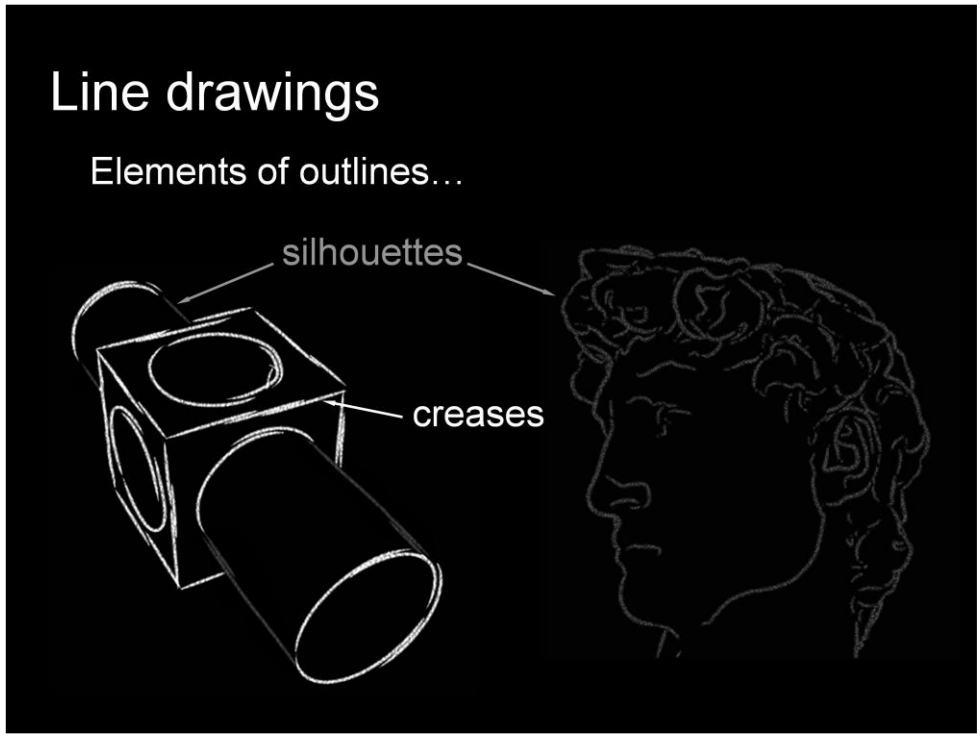
A single illustration can incorporate many different technical elements that combine to form a cohesive image. So there are many different tools that have emerged from the NPR community to be able to make such illustrations with computers. For example, we have cartoon shading, stylized strokes, effects for interaction of media with paper, the ability to draw specific marks onto surfaces, hatching, and automatic outlining tools.



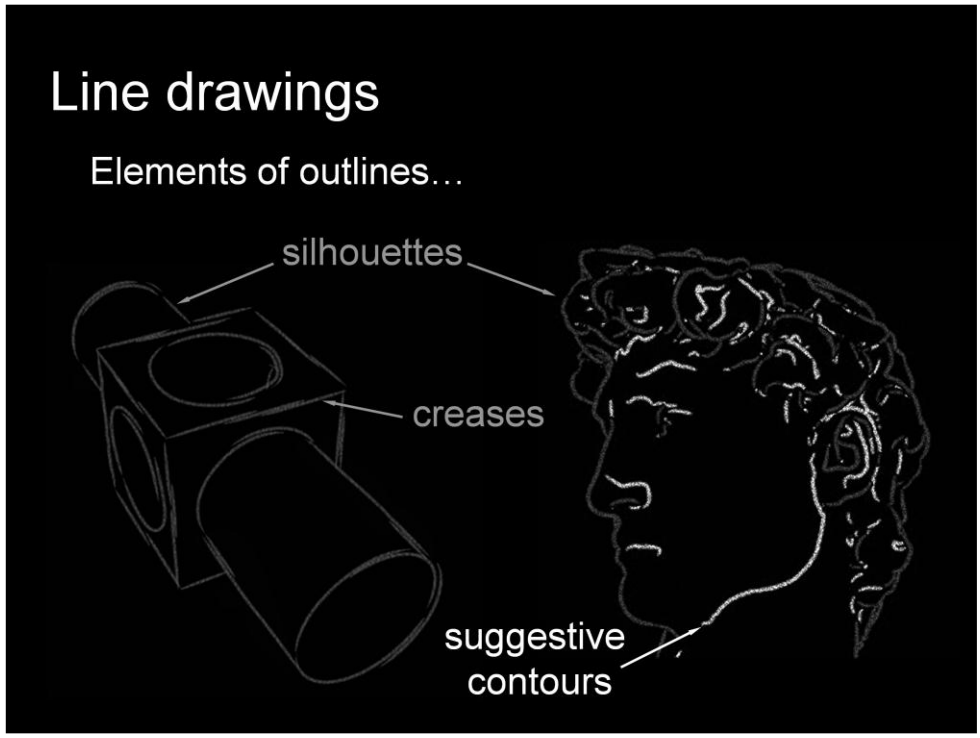
In this course we focus on line drawings, in part because they tend to be the simplest form of rendering from 3D models and are often used as a component of more sophisticated rendering schemes. And within line drawings, most of our emphasis will be on outlines such as those shown here. There are three kinds of lines that contribute to the outlines.



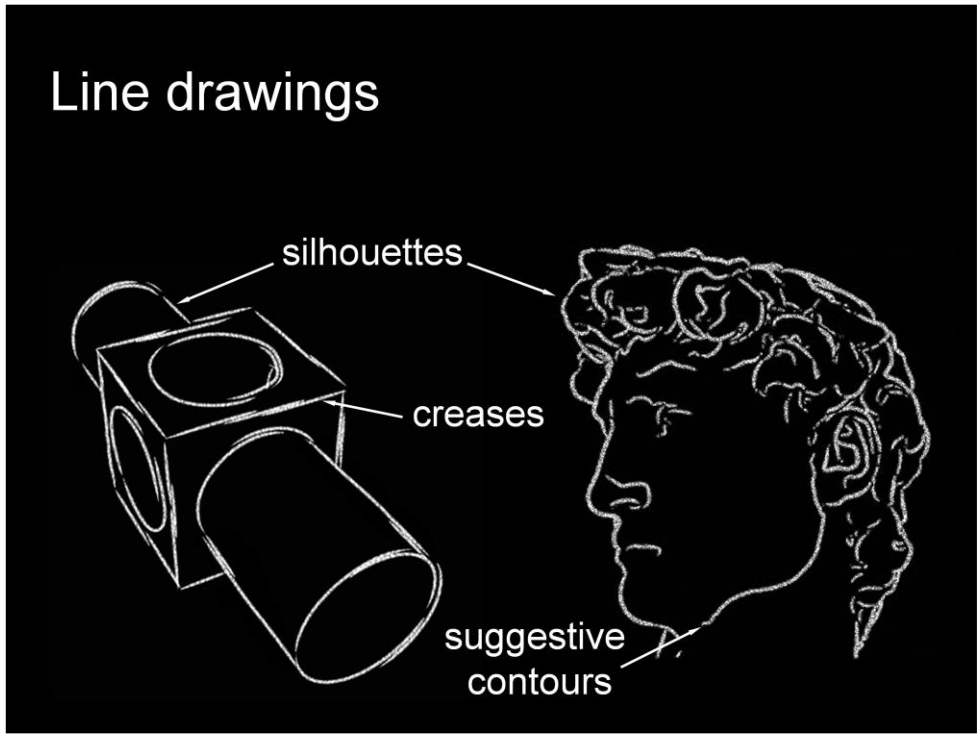
First are the silhouettes (equivalently called “contours” by some researchers) They separate front-facing from back-facing regions of the surface, as a function of view point…



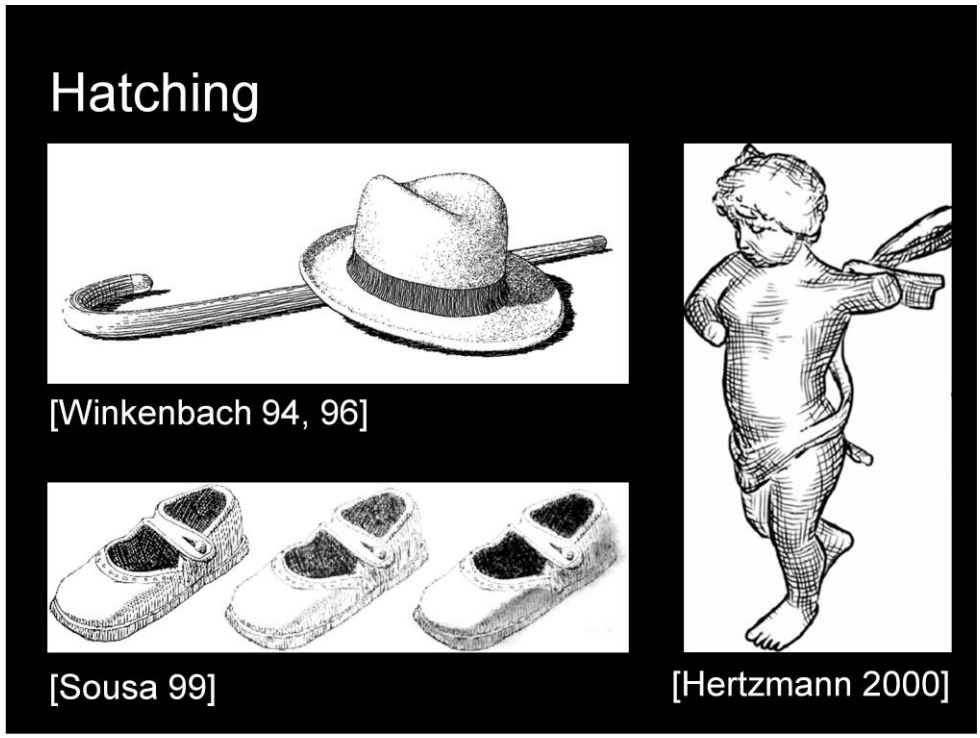
Creases are path which are defined statically on the mesh surface generally representing sharp features, such as the those present on this mechanic part on the left. Other features behave similarly, such as marks drawn directly onto the surface denoting for example the boundary between two different surface textures.



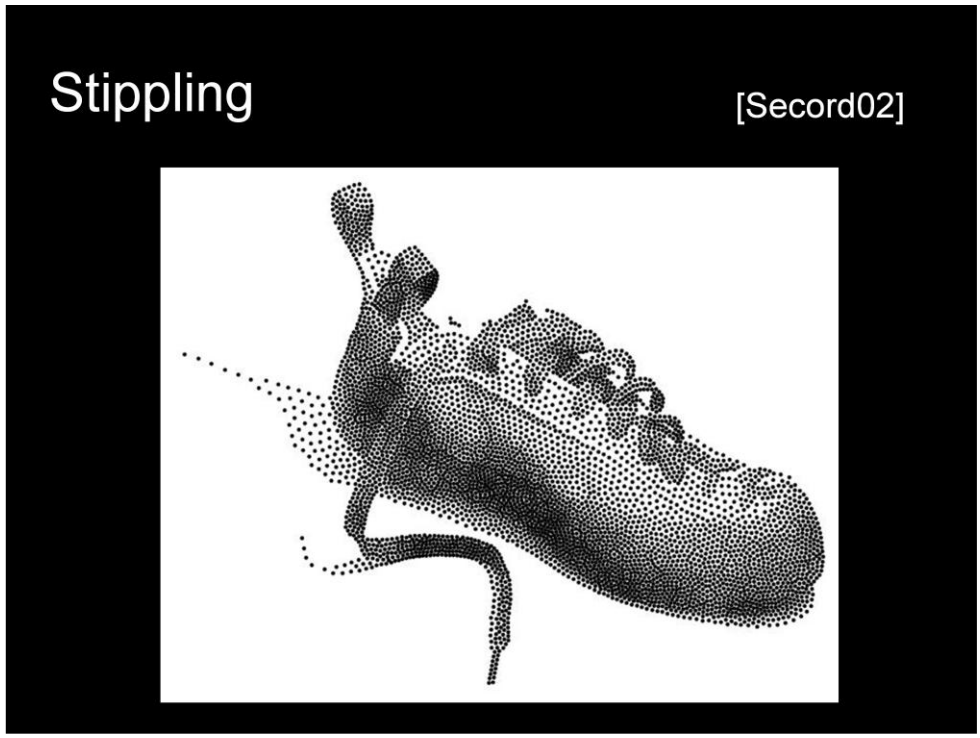
Third, in in 2003 we introduced “suggestive contours” which are dynamic features similar to silhouettes that are view dependent and help denote the shape. It turns out that suggestive contours may be thought of as places on the shape that would be silhouettes from nearby views. Since then there have been a number of related line definitions proposed, such as suggestive highlights or apparent ridges, and we will discuss these shortly.



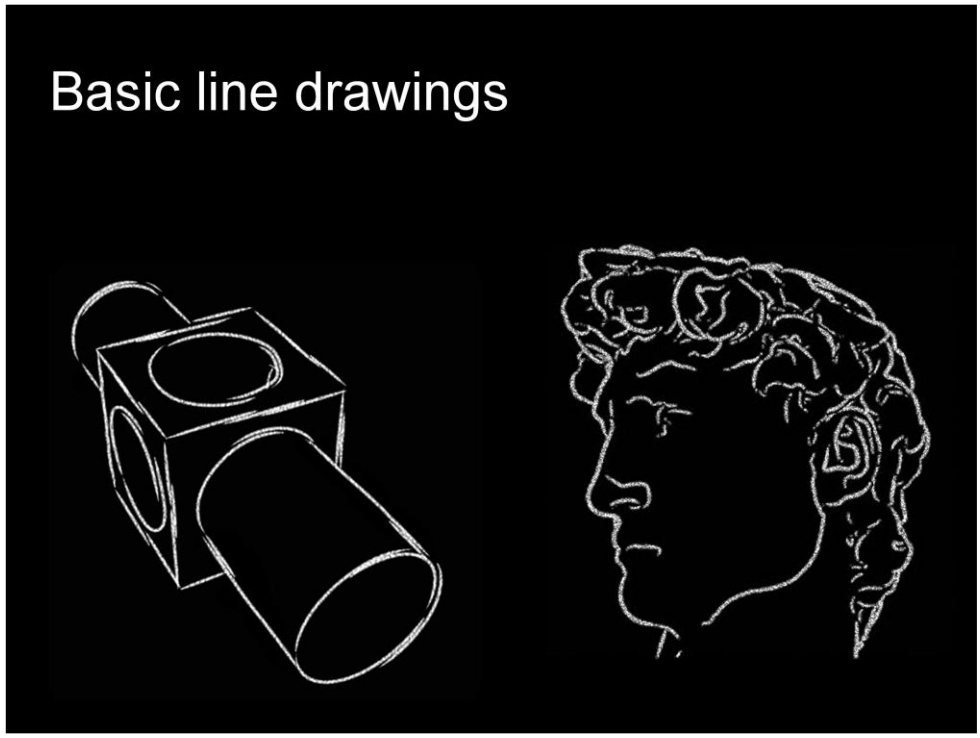
These three elements, though not exhaustive, can produce a wide range of line drawings, and often contribute to more complex illustrations.



For the purposes of this course we will be ignoring more sophisticated line drawing methods used by artists (and that have been explored by the NPR community). For example, hatching lines can suggest material and tone and are often used in conjuntion with basic line drawings.



I should also mention stippling, which can use a collection of small dots to convey tone. This is an important drawing technique and may be used in conjunction with lines. In contrast with hatching, these marks do not follow the curvatures of the shape and generally do not have the expressiveness to suggest surface texture.



This course will dwell largely on these basic line drawing elements, because they give us plenty to talk about.