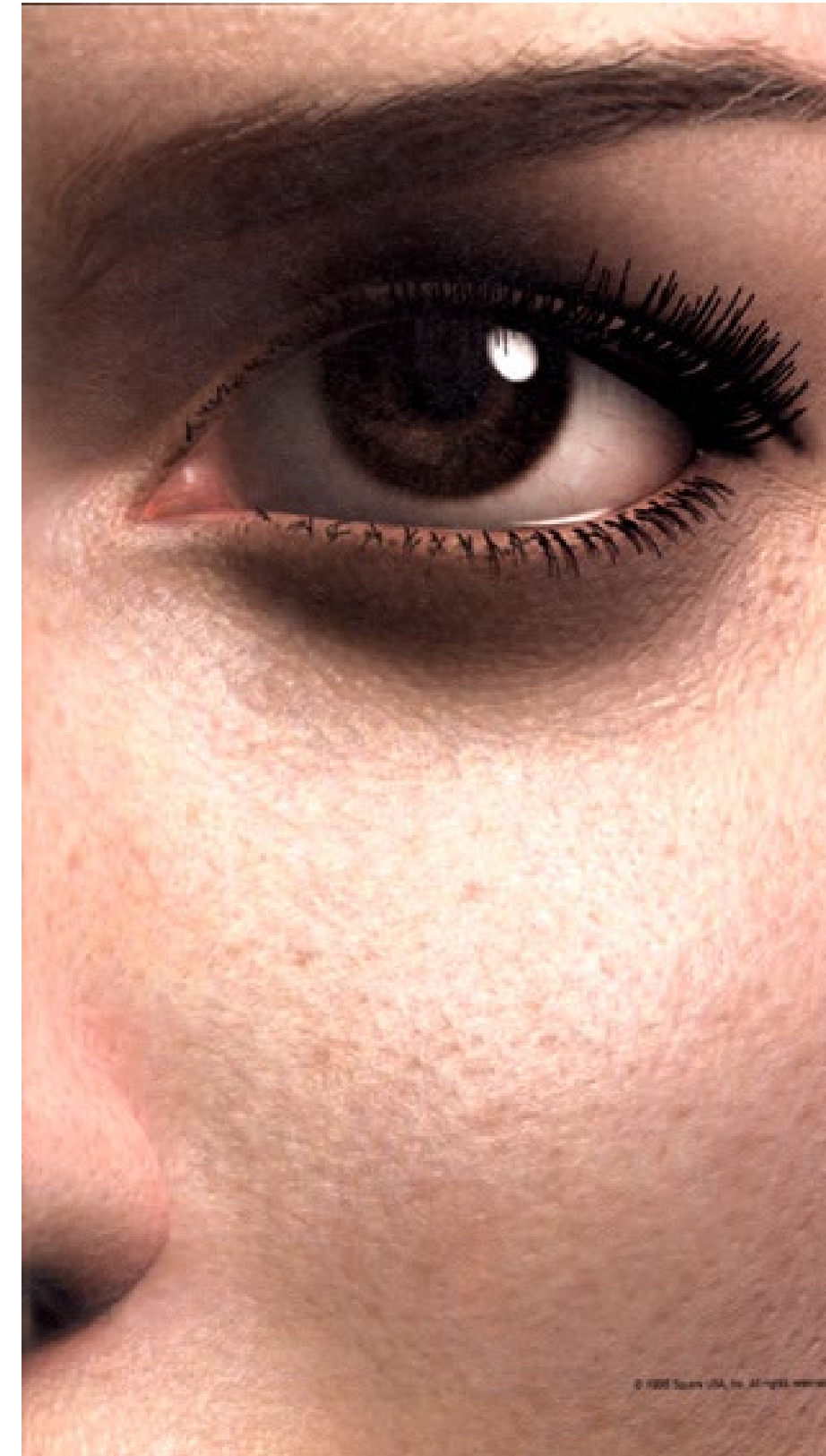


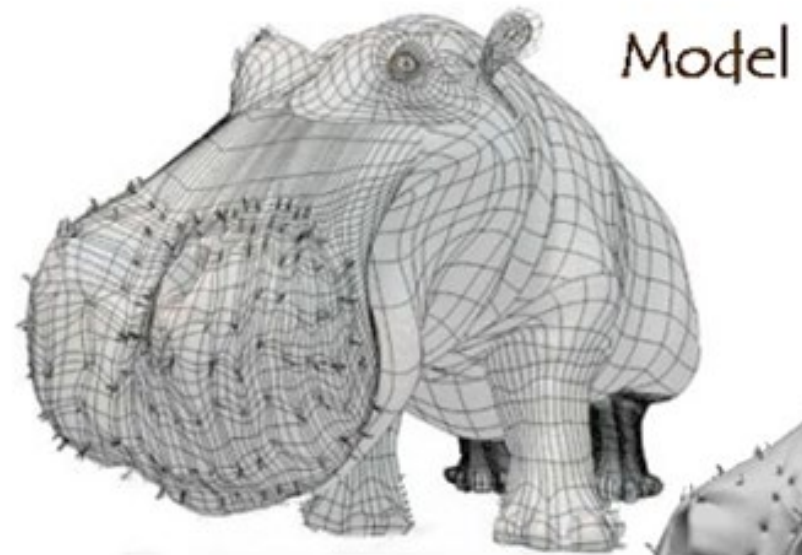
2. Computer Graphics Primer



Source: Various: LGDV, Nvidia, BMW

Prof. Dr. Matthias Teßmann

Computer Graphics



Model + Shading



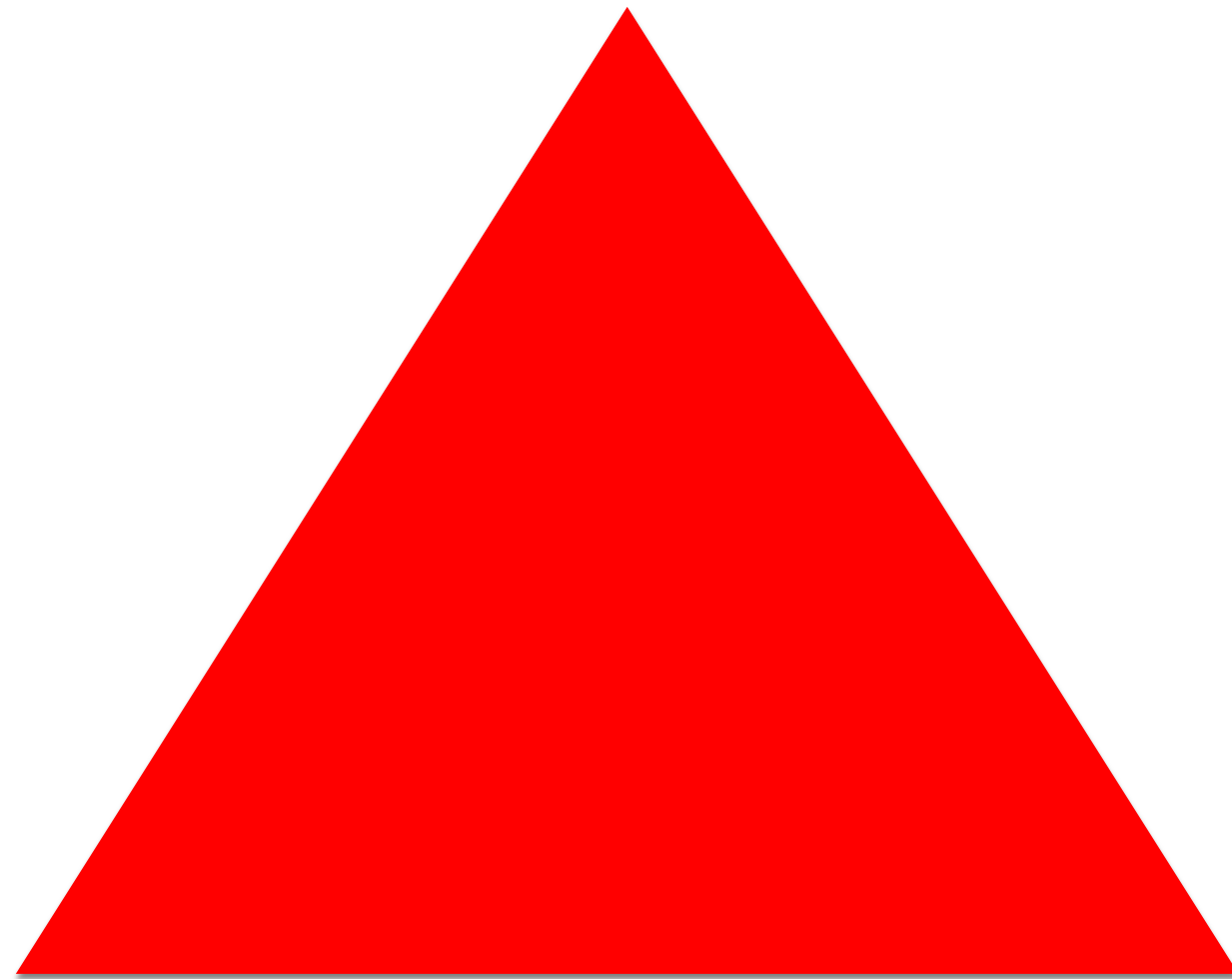
Model + Shading
+ Textures



At what point
do things start
looking real?

Computer Graphics

We start here



Contents

- The rendering pipeline
- Transformations
- Projections
- Color
- Lighting and Shading
- Texture Mapping

2.1 The Rendering pipeline

The Rendering Pipeline

The Rendering Pipeline

Key Graphics Areas

- Modeling
 - Mathematical specification of shape and appearance properties of objects
 - Primitives: Points, lines, curves, surfaces, ...
 - Attributes: color, texture maps, lighting properties, ...
 - Geometric transformations
- Animation
 - Create the illusion of motion: sequence of still images
 - Time as parameter for modeling and rendering
 - Keyframes, physically-based animations, collision detection, ...

The Rendering Pipeline

Key Graphics Areas

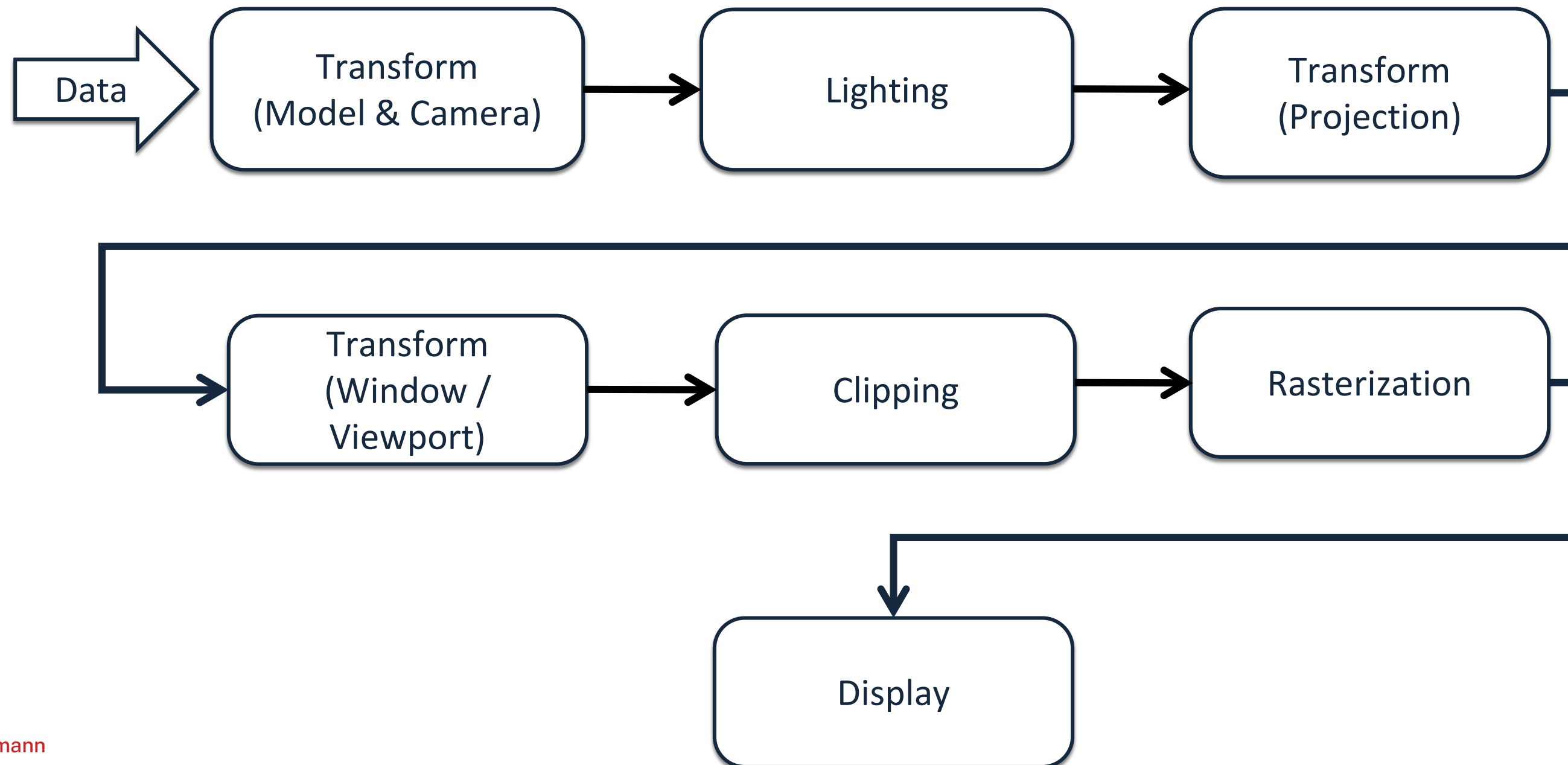
- Rendering
 - Creation of shaded images from 3D computer models given
 - A virtual camera
 - Objects (modeling)
 - Light sources
 - 2D images from 3D scenes
- Important issues
 - Visibility and Projection
 - Simulation of light
 - Interactivity vs. photorealism

The Rendering Pipeline

- **3D input**
 - Virtual camera
 - Position, orientation, focal length, ...
 - Objects
 - Points, lines, polygons and attributes
 - Light sources
 - Position, direction, color, ...
 - Textures
 - Images
- **2D output**
 - Per-pixel color values in the framebuffer

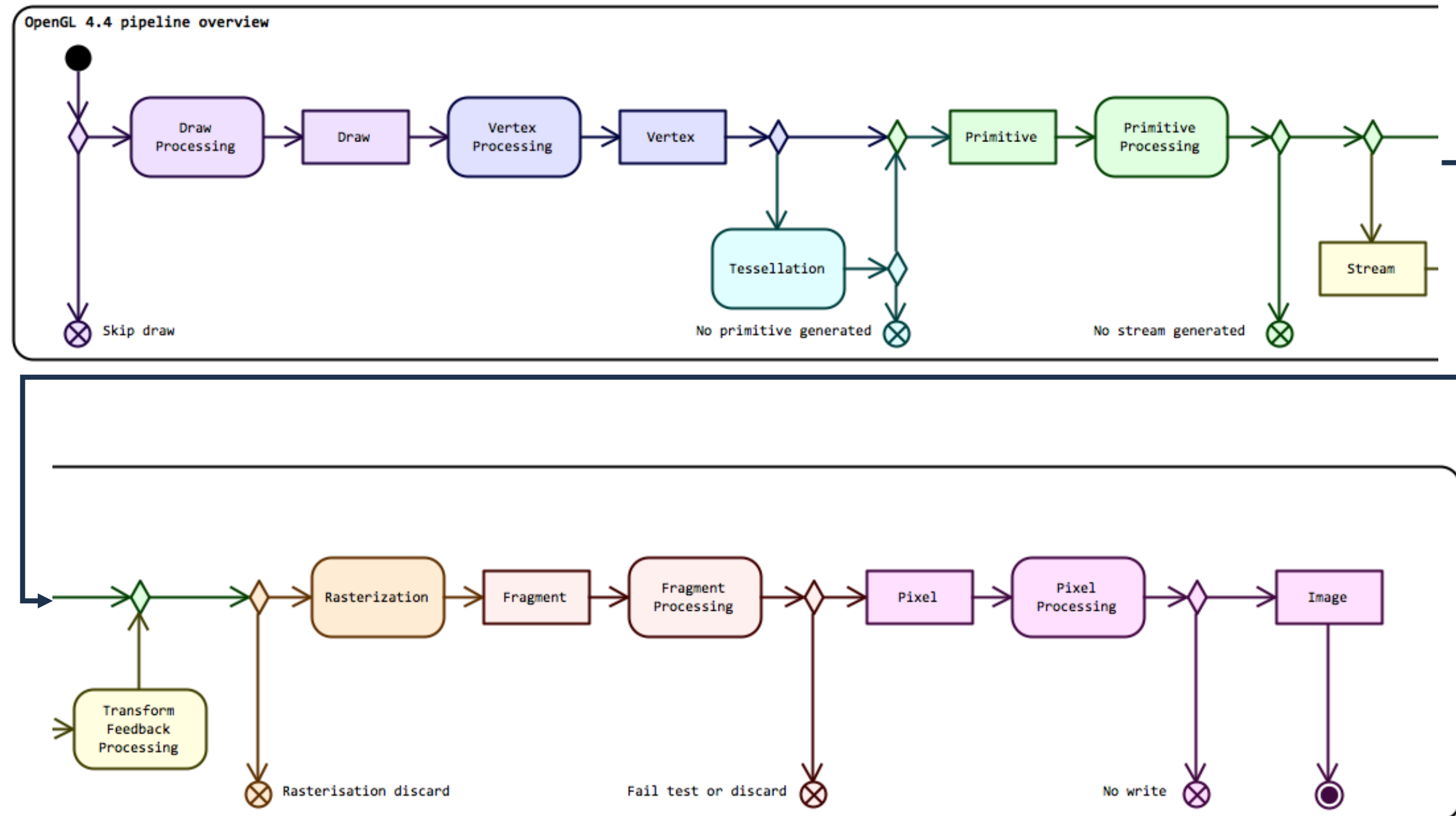
The Rendering Pipeline

Classic pipeline architecture



The Rendering Pipeline

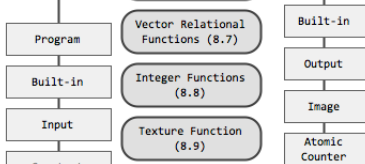
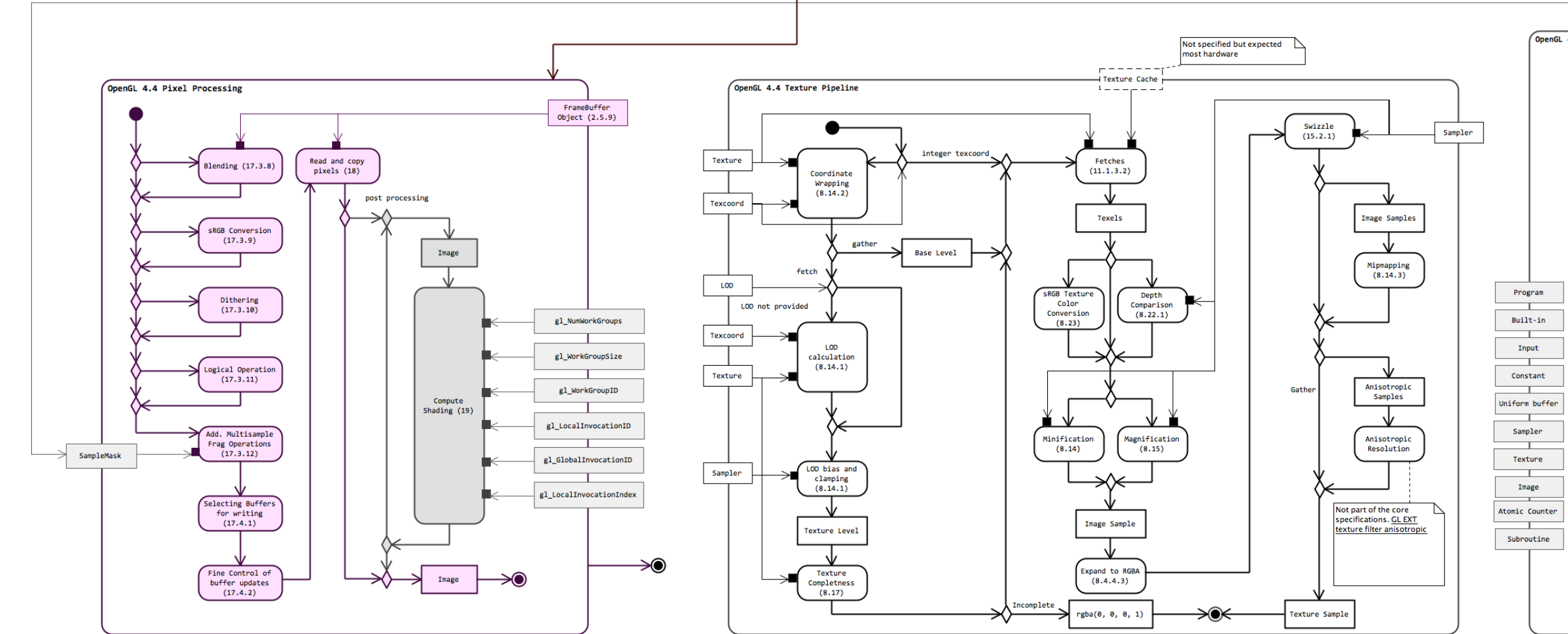
Current pipeline architecture (OpenGL 4.4)



Source: <http://openglinsights.com/pipeline.html>

Prof. Dr. Matthias Teßmann





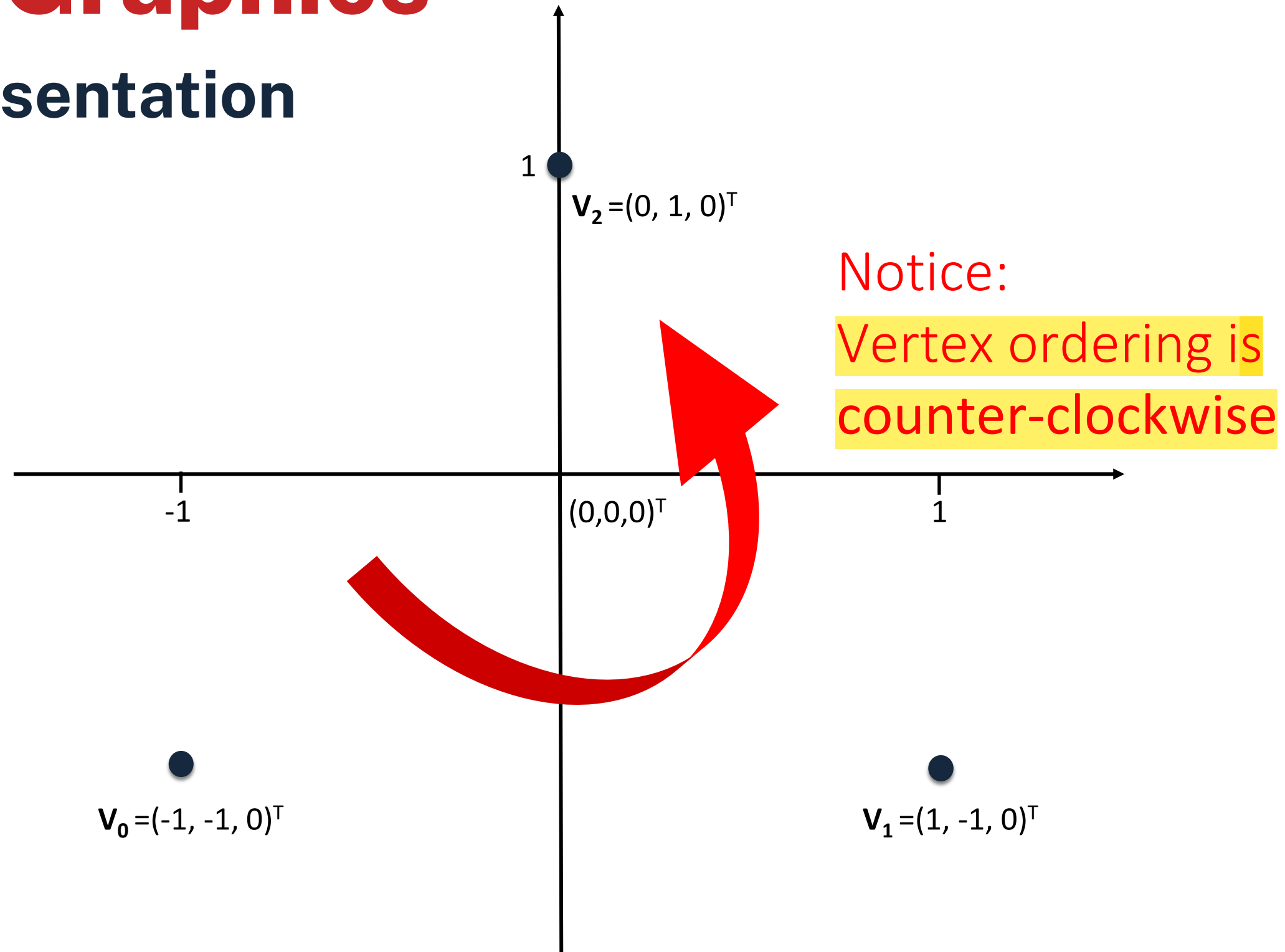
The Rendering Pipeline

Geometry representation

- Points (**vertices**) w.r.t. a known coordinate system
 - Vertices are used for modeling polygons (objects)
- Arbitrary polygons and surfaces are represented as triangles
 - Triangles, Triangle Strips, Triangle Fans - used to build meshes
 - Meshes form objects
- Attributes are associated with vertices
 - Color, material, surface normal vectors, ...
 - Used to calculate final appearance (pixel color)
- **Every single vertex is processed in the same way**
 - The series of processing steps is known as the rendering pipeline
 - This is what graphics hardware is for

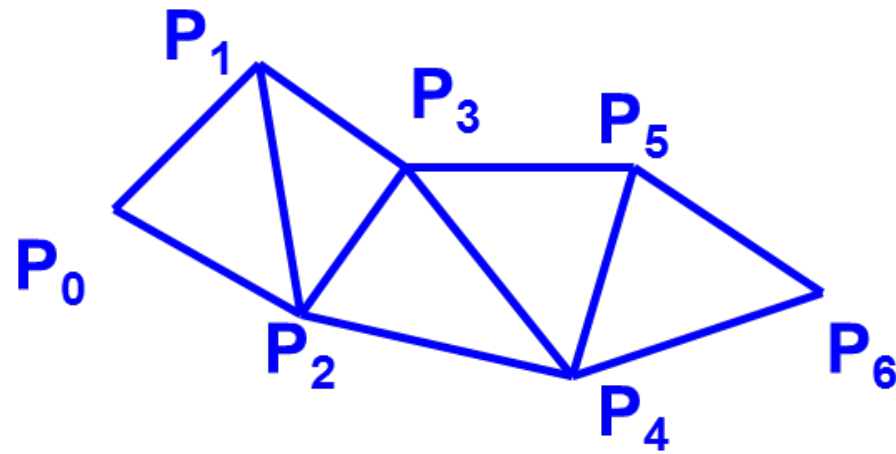
Computer Graphics

Geometry representation

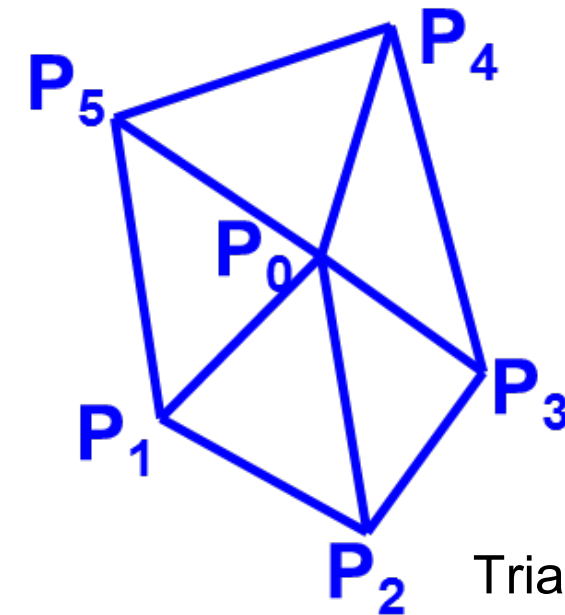


The Rendering Pipeline

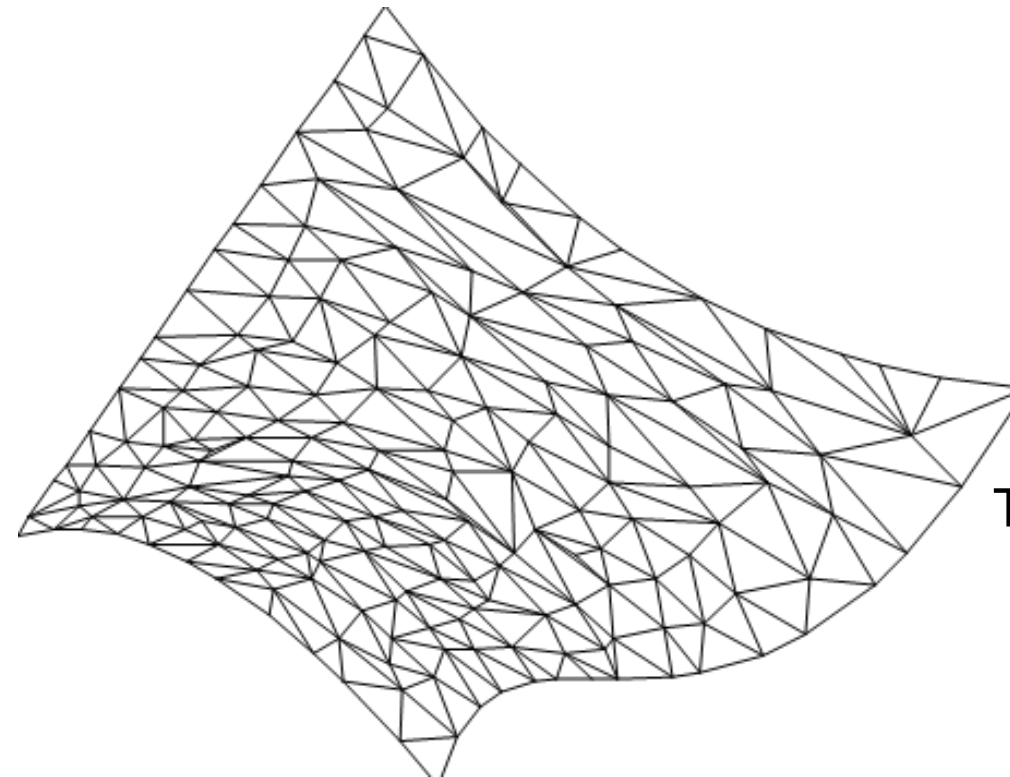
Geometry representation



Triangle strip



Triangle fan



Triangle mesh

The Rendering Pipeline

Rasterization

Object space	Image space
<pre>for all objects set pixel color</pre>	<pre>for all pixels for all objects calculate color contribution of object to pixel</pre>

- The framebuffer is the intermediate memory space storing the accumulated pixel values

The Rendering Pipeline

Rasterization

