Introduction to the OpenGL Shading Language (GLSL)

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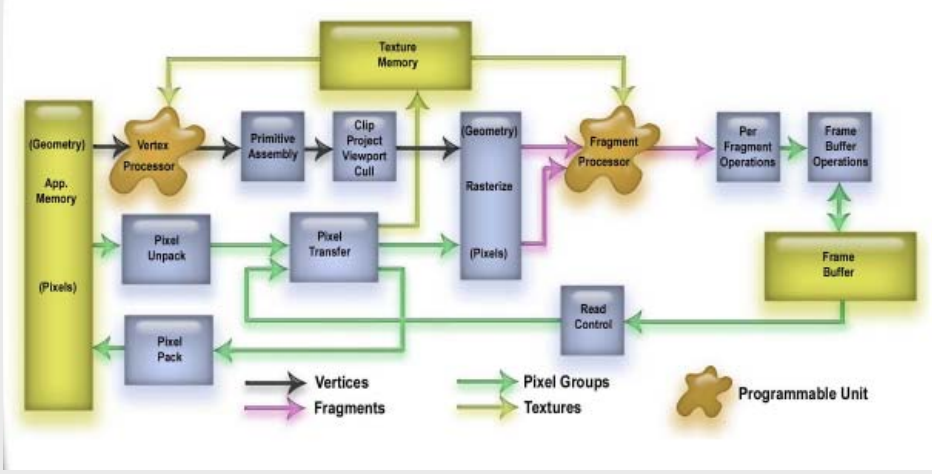
Fundamental Differences Between RenderMan Shaders and OpenGL Shaders

Topic	RenderMan	GLSL
Goals	1. Image quality, 2. Speed	1. Speed, 2. Image quality
Shader Types	Surface, Displacement (+3 others)	Vertex, Fragment, Geometry
Surface Preprocessing	Microfacets	None
Recompute Normals	CalculateNormal	None
Get Rid of Pixels	Oi = 0.;	discard;
Surface/Fragment shader sets	R, G, B, αr, αg, αb	R, G, B, A, Z
Shader Variables	Uniform, Varying	Attribute, Uniform, Varying
Coordinate Systems	Shader, World, Object	Model (=OC), Eye (≈WC)
Noise	Built-in	Eventually built-in, Texture for now
Compile Shaders	Must do yourself	Driver does it for you
Compiler messages	Cryptic	Cryptic

OpenGL Graphics Pipeline



Courtesy of Randi Rost

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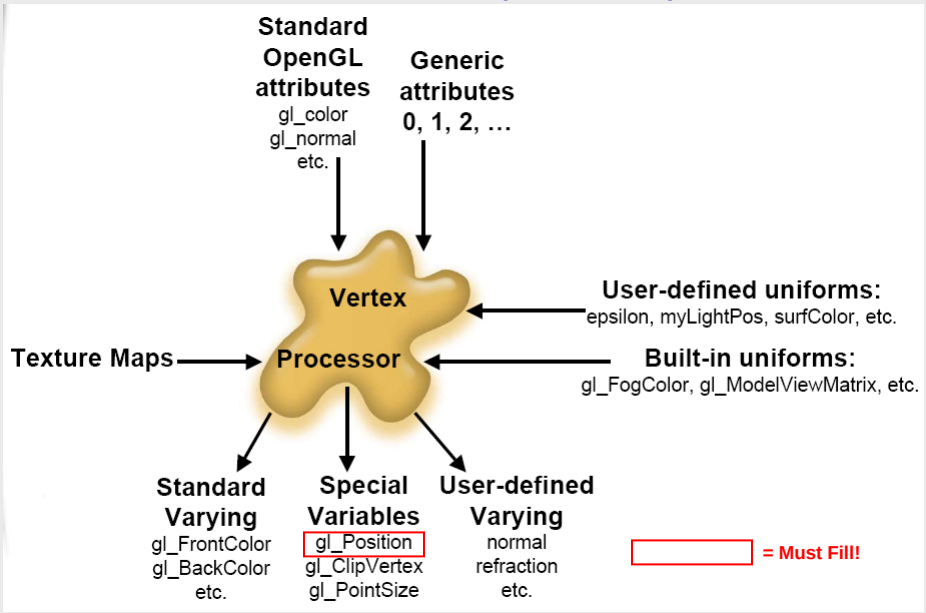
GLSL Vertex Shader Inputs and Outputs



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A GLSL Vertex Shader Replaces These Operations:

- Vertex transformations
- Normal transformations
- Normal normalization
- Handling of per-vertex lighting
- Handling of texture coordinates

A GLSL Vertex Shader Does Not Replace These Operations:

- Frustum clipping
- Homogeneous division
- Viewport mapping
- Backface culling
- Polygon mode
- Polygon offset

Built-in Vertex Shader Variables You Will Use *a Lot*:

vec4 gl_Vertex

vec3 gl_Normal

vec4 gl_Color

vec4 gl_MultiTexCoordi (i=0, 1, 2, …)

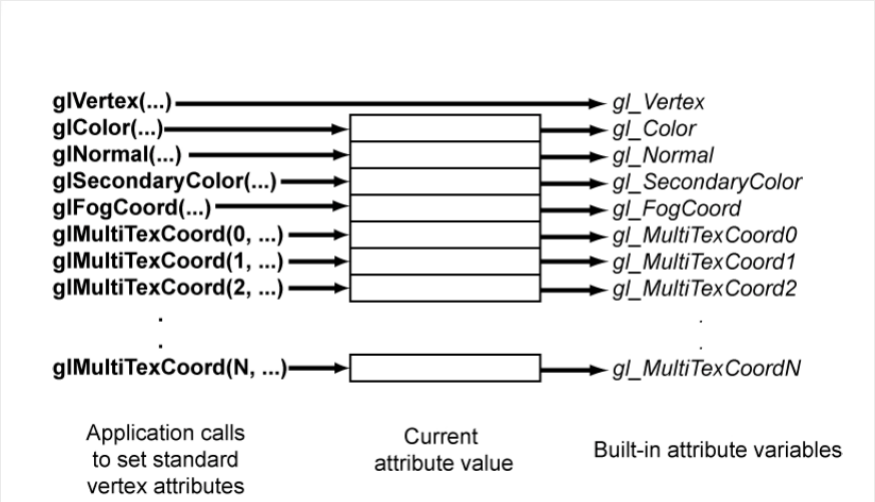
mat4 gl_ModelViewMatrix

mat4 gl_ProjectionMatrix

mat4 gl_ModelViewProjectionMatrix

mat4 gl_NormalMatrix

GLSL Vertex Shader Internal Names



Courtesy of Randi Rost

GLSL Shaders Are Like C With Extensions for Graphics:

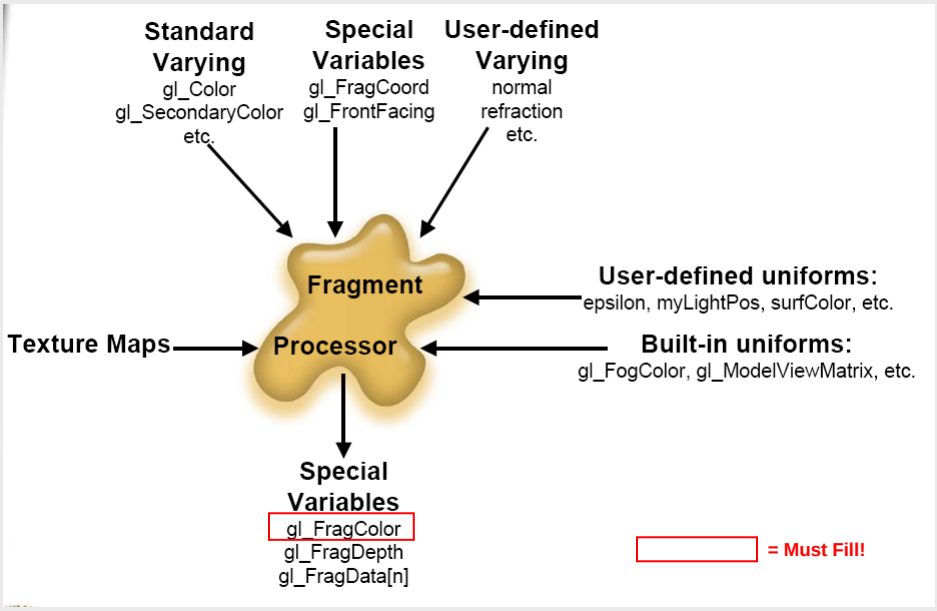
- Types include int, ivec2, ivec3, ivec4
- Types include float, vec2, vec3, vec4
- Types include mat2, mat3, mat4
- Types include bool, bvec2, bvec3, bvec4
- Types include sampler to access textures
- Vector components are accessed with [index], .rgba, .xyzw, and .stpq

- Vector components can be "swizzled" (c1.rgba = c2.abgr)
- *discard* operator used in frag shaders to discard fragments
- Type qualifiers: const, attribute, uniform, varying
- Procedure type qualifiers: in, out, inout

GLSL Shaders Are Missing Some C-isms:

- No type casts (use constructors instead)
- No automatic promotion
- No switch statement
- No pointers
- No strings
- No bitwise operators (this is changing)
- No enums
- Can only use 1-D arrays (no bounds checking)
- Array indices must be compiler-time constants
- No *file-based* pre-processor directives

GLSL Fragment Shader Inputs and Outputs



Courtesy of Randi Rost

A GLSL Fragment Shader Replaces These Operations:

- Color computation
- Texturing
- Color arithmetic
- Handling of per-pixel lighting
- Fog
- Blending
- Discarding fragments

A GLSL Fragment Shader Does Not Replace These Operations:

- Stencil test
- Z-buffer test
- Stippling

Built-in Fragment Shader Variables You Will Use *a Lot*:

vec4 gl_FragColor

float gl_FragDepth