

# PV227 GPU Rendering

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# Geometry Shader

- new programmable stage (optional),
- between vertex shader and fragment shader,
- before the rasterizer.

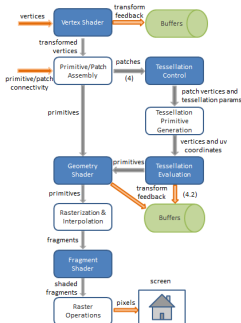


Figure: Taken from [lighthouse3d.com](http://lighthouse3d.com)

## Geometry shader (cont.)

- needs input and output format,
- receives the assembled primitives (no strip, fan or loop),
- full knowledge of the primitive.



# Input Types

primitive	#vertices
points	1
lines	2
lines_adjacency	4
triangles	3
triangles_adjacency	6

- primitive type must match the draw command,
- `layout (triangles) in;`

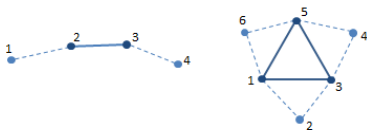


Figure: Taken from [lighthouse3d.com](http://lighthouse3d.com)

# Input Data

- build-in:
  - array `gl_in` of input vertices,
  - default vertex attributes.

```
1 in gl_PerVertex
2 {
3     vec4    gl_Position;
4     float  gl_PointSize;
5     float  gl_ClipDistance [];
6 } gl_in []; // # of vertices: gl_in.length()
7
8 in int gl_PrimitiveIDIn;
```

- user-defined:
  - same way as usual,
  - array, data for each vertex.

```
1 in Data
2 {
3     vec3 normal;
4 } vertexData [];
```

# Output Types

primitive  
points  
line\_strip  
triangle\_strip

- output type need not match the input type,
- `GL_MAX_GEOMETRY_OUTPUT_VERTICES` (1024),
- can output `[0, max]` primitives,
- input primitive is discarded,
- `layout ( line_strip , max_vertices = 4) out;`



# Output Data

- outputs vertices,
- attributes passed the same way as in the vertex shader,
- vertex definition ended with `EmitVertex()`;
- need enough vertices to form primitives,
- primitive definition ended with `EndPrimitive()`;



# Examples

- culling,
- explosion,
- tessellation,
- normal visualization.





# Culling

- render only triangles visible from a point,
- do not emit triangles for the others.

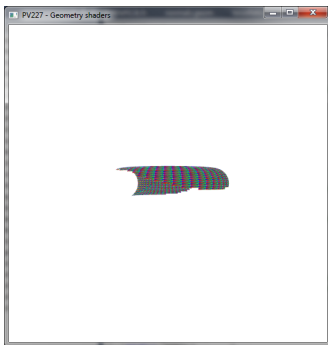


Figure: Point view culling

# Explosion

- move vertices along the common triangle normal,
- color the vertices with R, G, B.

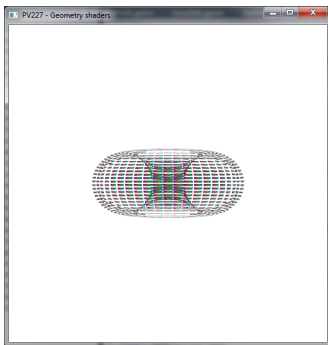


Figure: Explosion in  $t = 0.5f$

# Tessellation

- only minor amplification,
- create new point in the barycenter.

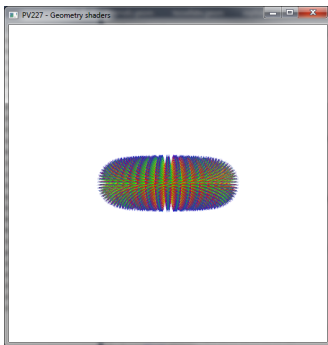


Figure: Extruded tessellation in  $t = 0.5f$

# Tessellation (triangle)

- one new point and three triangles.

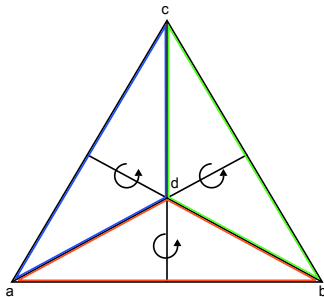


Figure: Tessellated triangle.

# Triangle Strips

- mind the emit order of primitives,
- must follow the winding order of triangle strips.

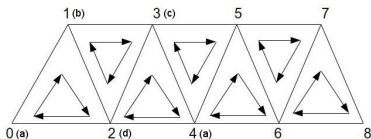


Figure: Taken from [atspace.co.uk](http://atspace.co.uk)

# Normal visualization

- draw lines for normals,
- visualize both kinds of normals.

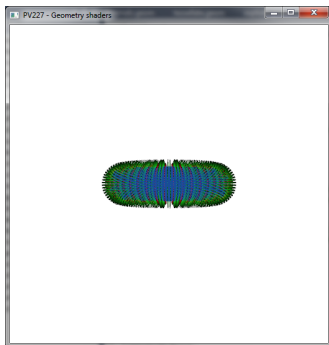


Figure: Visualized vertex and face normals.