

IHS Math Seminar Fall 2023

Graphics Programming Conclusion

December 20

Benjamin G. Thompson

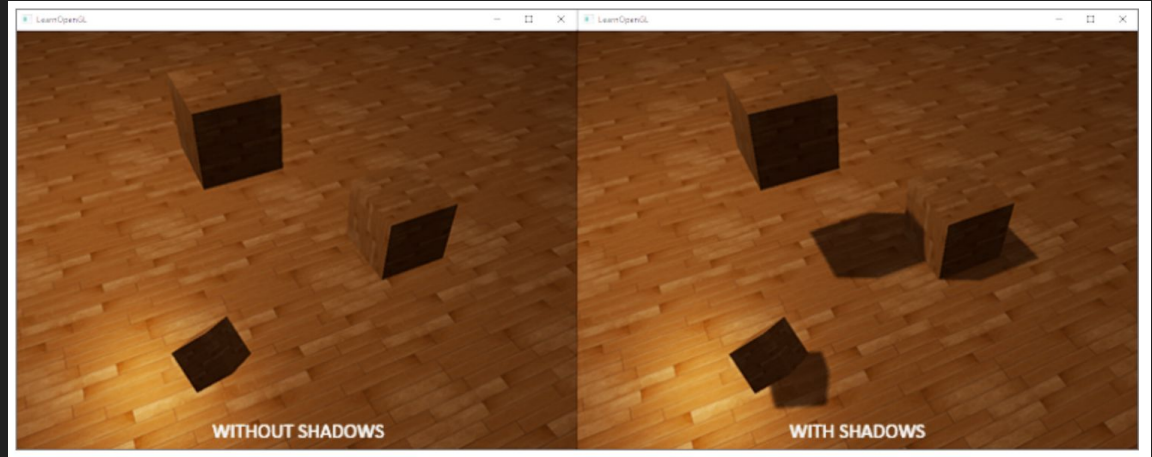
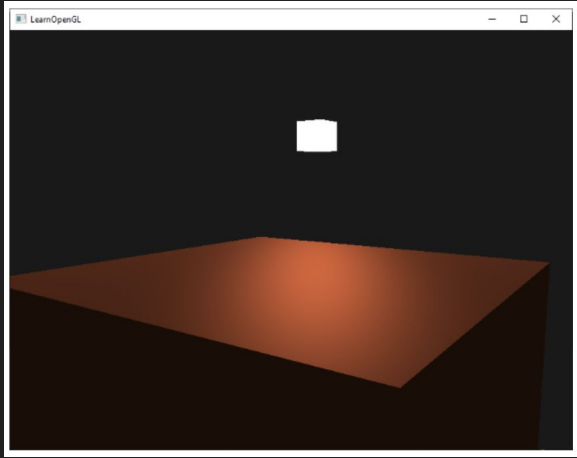
he/they

Where to now?

So many different options! Some possible directions:

- Lighting / shadows / textures
- Perspective geometry
- Signed distance functions
- Physically Based Rendering
- Lower-level GPU APIs
- Graphics rendering without a GPU
- Animations / simulations
- Videogames

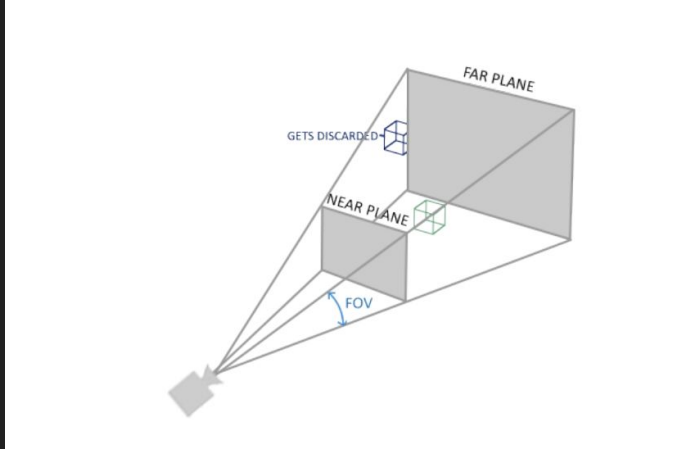
Lighting / shadows / Textures



From [Learn OpenGL - Graphics Programming \(2020\)](#)

Joey de Vries

Projective geometry



From [Learn OpenGL - Graphics Programming \(2020\)](#)

Joey de Vries

```
camera_to_x_mat := [9] f32 {
    1, 0, 0,
    0, 0, -1,
    0, 1, 0,
}

ch :: f32(3) // Cube offset
k  :: f32(0.5) // Cube scale

translation_mat := [16] f32 {
    k, 0, 0, 0,
    0, k, 0, 0,
    0, 0, k, ch,
    0, 0, 0, 1,
}
// The math behind calculating a perspective matrix
// below can be found in any decent graphics program
perspective_mat := [16] f32 {
    2, 0, 0, 0,
    0, 2, 0, 0,
    0, 0, 3, -8,
    0, 0, 1, 0,
};
```

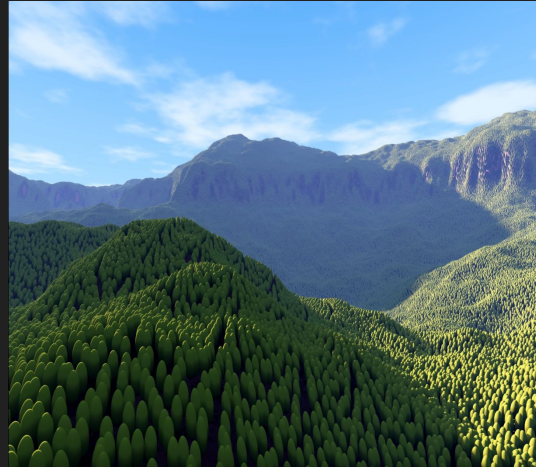
From "[Rotating Cube](#)"

Signed Distance Functions



[Heart - distance 2D](#) (2021)

Inigo Quilez



color = material · lighting

material = $\text{green} \cdot (1 - \lambda_1) + \lambda_1 \cdot \text{darkgreen}$

lighting = $(\mathbf{n} \cdot \mathbf{s})_+ \cdot \text{sh}(\mathbf{p}) + \left(\frac{1 + \mathbf{n}_y}{2} \cdot \frac{\text{blue}}{10} + (\mathbf{n} \cdot \mathbf{b})_+ \cdot \frac{\text{orange}}{10} \right) \cdot \lambda_2$

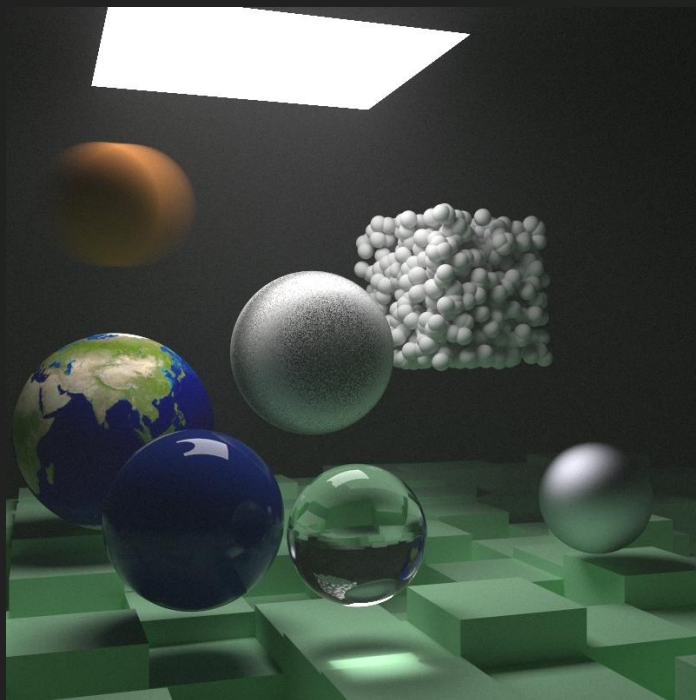
$\lambda_1 = S(0.7, 0.9, \mathbf{n}_y)$

$\lambda_2 = \frac{\mathbf{r}_y + \mathbf{w}_y}{2 \mathbf{r}_y} \cdot 0.8 + 0.2$

[Painting a Landscape with Maths](#)
(2022)

Inigo Quilez

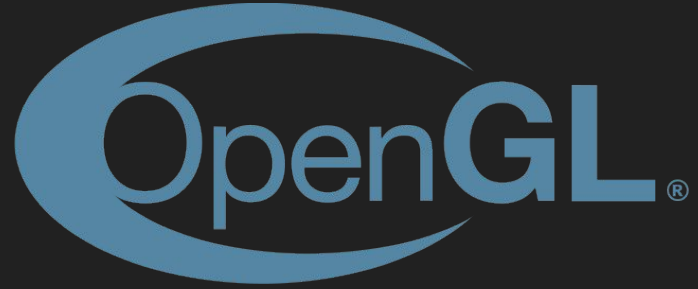
Physically Based Rendering



[Ray Tracing: The Next Week](#) (2023)

Peter Shirley, Trevor David Black, Steve Hollasch

Lower level GPU APIs



Graphics without a GPU

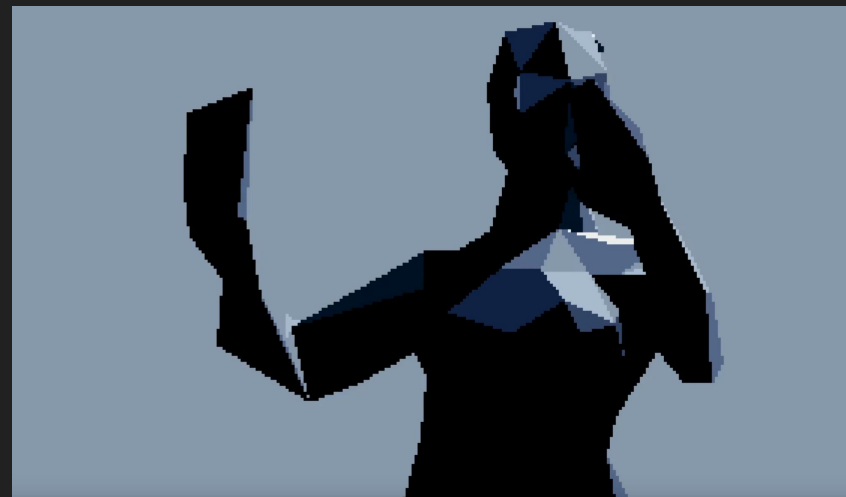
Released in 1987!

3D Graphics on an Amiga 500:
An astonishing achievement,
technical masterpiece



[Amiga500 system](#)

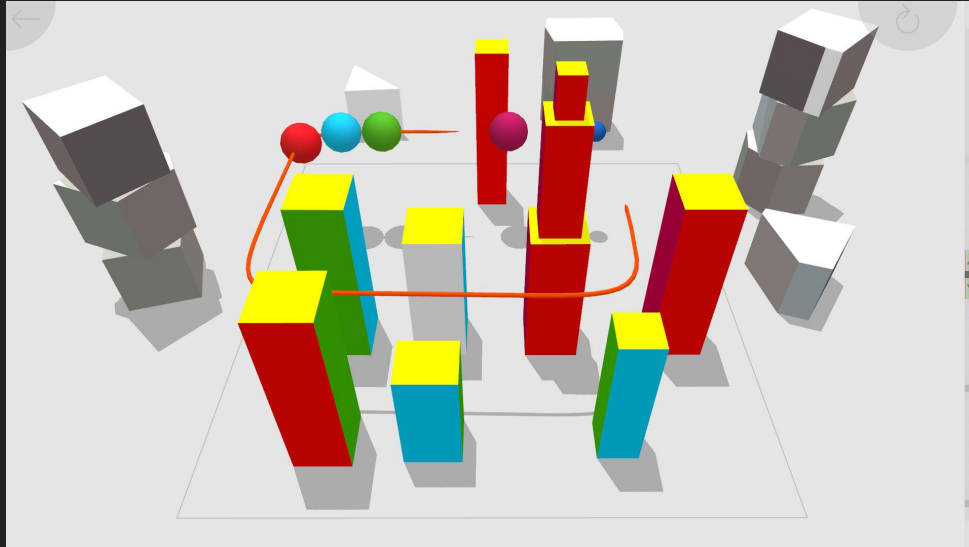
[Bill Bertram 2006, CC-BY-2.5 — Attribution.](#)



[Eon \(2019\)](#)

The Black Lotus

Animations / Simulations



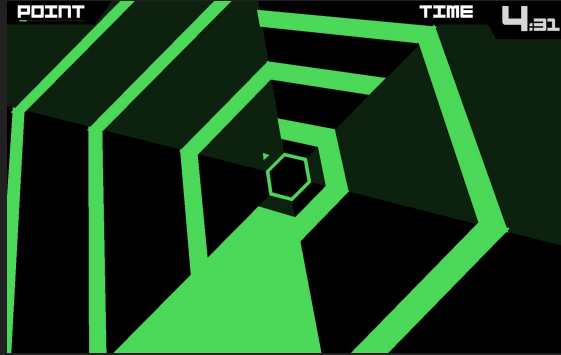
[4D Toys](#) (2017)

Marc ten Bosch

Videogames

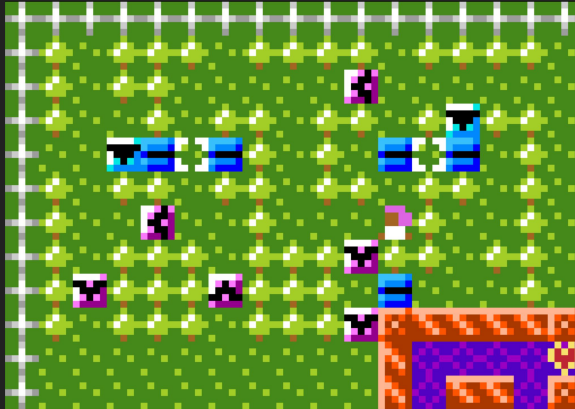
[Super Hexagon](#)
(2012)

Terry Cavanagh



[Aunt Flora's Mansion](#)
(2015)

Anna Anthropy



[Stephen's Sausage Roll](#) (2016)

Stephen Lavelle



[Kine](#) (2019)

Gwen Frey