

MSI140 Core Music Practice



# Natural Revolution

MICHAEL Z FREEMAN (HOLMES), 2023

# Summary

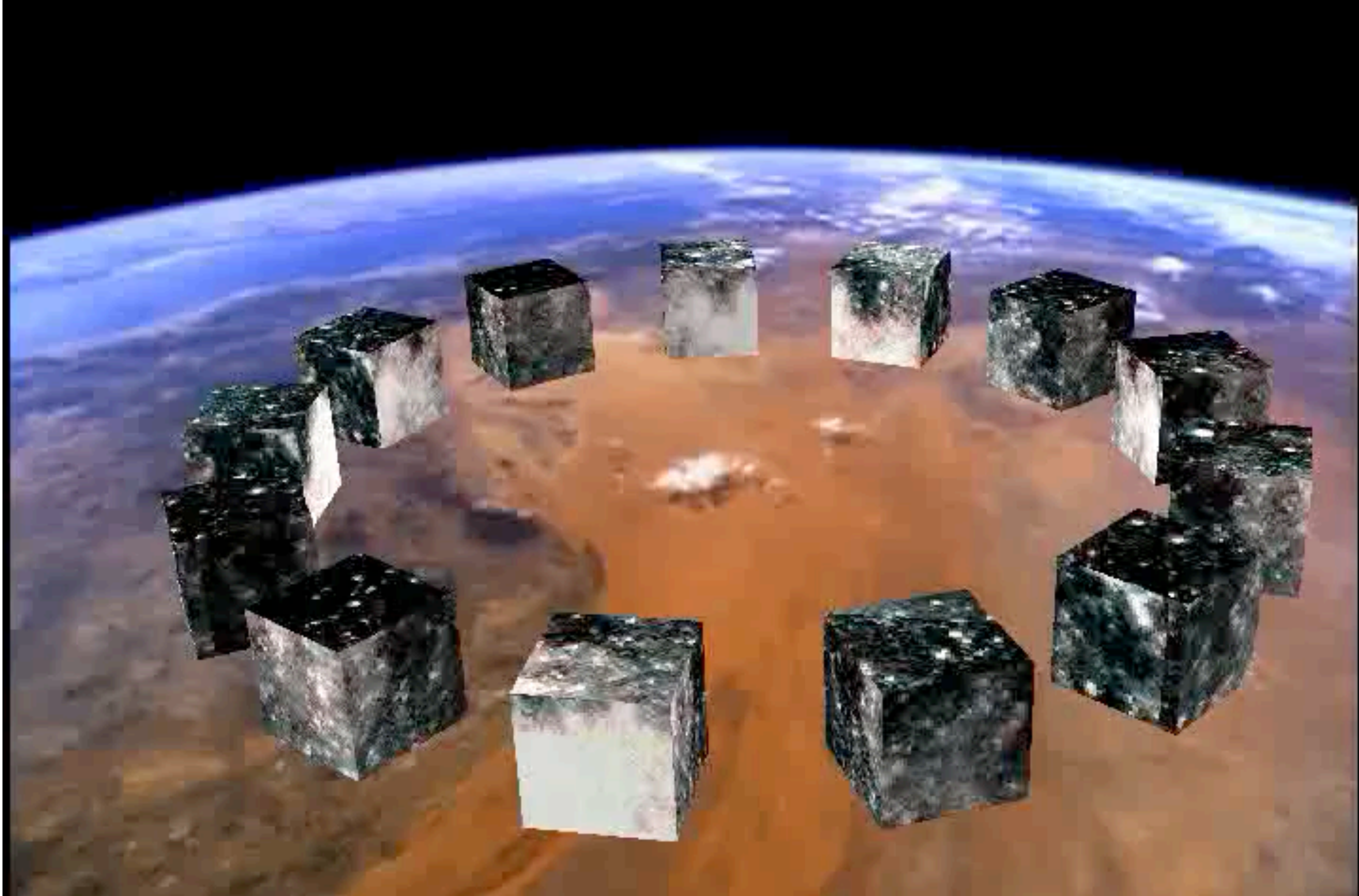
1. VJ'ing
2. Rendering of the 3D Fractal.
3. Object Capture.
4. Simplification.
5. Import into Blender Game Engine.
6. Interactive controls.
7. Audio to object motion.
8. Music production.
9. Artists who use fractals.

# VJ'ing

As a DJ I've always had an interest in VJ'ing. In 1992 I noticed some artistically layered visuals on a screen in the techno club *The Orbit* in Leeds. I noticed a fellow up on a balcony in front of equipment. I found him using using a an analogue video mixing desk. He was mixing together various source material from VHS video tapes as he responded to music being played by the DJ.

In 2003 I experimented with 3DS Max, importing audio into the application and using the audio to trigger movement of a 3D model (see the next slide).

Over the years VJ'ing has been a developing practice although the term "Video Jockey" has fallen out of use. These days visuals take the place of video installations and "visuals" that accompany performances of rock bands, DJ's and theatre performances. However the promise of a modern and sophisticated interactive and closely knit relationship of the visuals to the music has been lost. My practice intends to explore and reestablish this relationship.



# Introduction



- A fractal is a geometric rendering of a mathematical equation that describes natural objects (Mandelbrot 1982).
- The inventor of Fractals, Benoit Mandelbrot, was tutored privately by an uncle who despised rote learning. Benoit stated that this tutoring allowed him to “*open my eyes to everything around me*” informing his eventual mathematical interpretation of natural objects (Mandelbrot 2002).
- Because Fractals verge across into art they reveal a truly revolutionary vision of nature. A combination of the technical and the artistic.

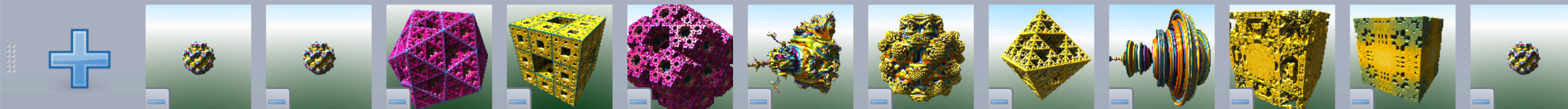


Image adjustments

Image resolution

Image width: 1920

Image height: 1080

Image proportion: 16:9 x2 ÷2

Anti-aliasing ...

Connect fractal detail level with image resolution

Presets

720x480	1280x720	1920x1080
2560x1440	4096x2160	7680x4320
320x240	800x600	1600x1200

Stereoscopic rendering ...

Image quality presets

Very low (no shadows no ambient occlusion)	Low (no ambient occlusion)
Normal	High (HQ ambient occlusion accurate raymarching)

Picture

Brightness: 1.00

Contrast: 1.00

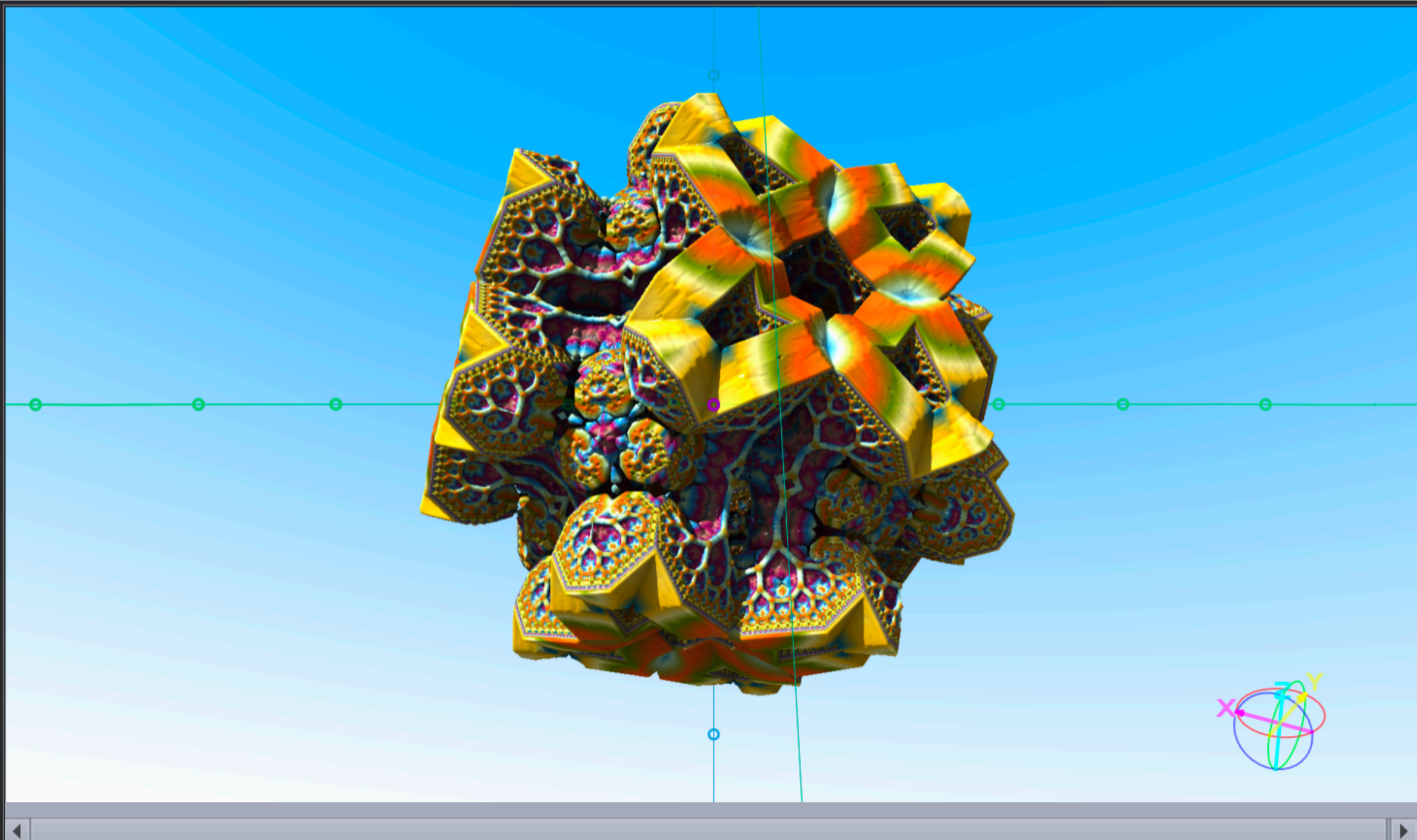
Gamma: 1.00

Saturation: 1.00

High Dynamic Range (HDR)

Apply changes

Camera

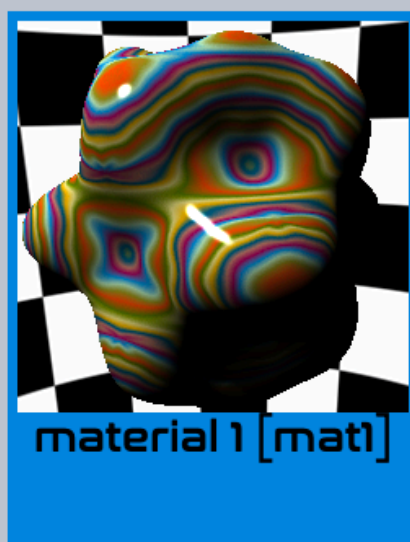


Zoom: Fit to window |  Show cursor | Mouse click function: Move the camera | Grid: Crosshair

Materials

+ New material | X Delete material | Edit material

Load materials... | Save material as...



Navigation

RENDER | STOP

UNDO | REDO

Open new navigator

OpenCL mode: full

Auto-refresh

Coordinates:

Camera

x: 3.69185457134708

y: 10.5484377378696

z: -6.31750995879274

Target

x: 0

y: 0

z: 0

Reset view

Move camera

Measurement

Get point by mouse pointer

Last picked point

x: 0

y: 0

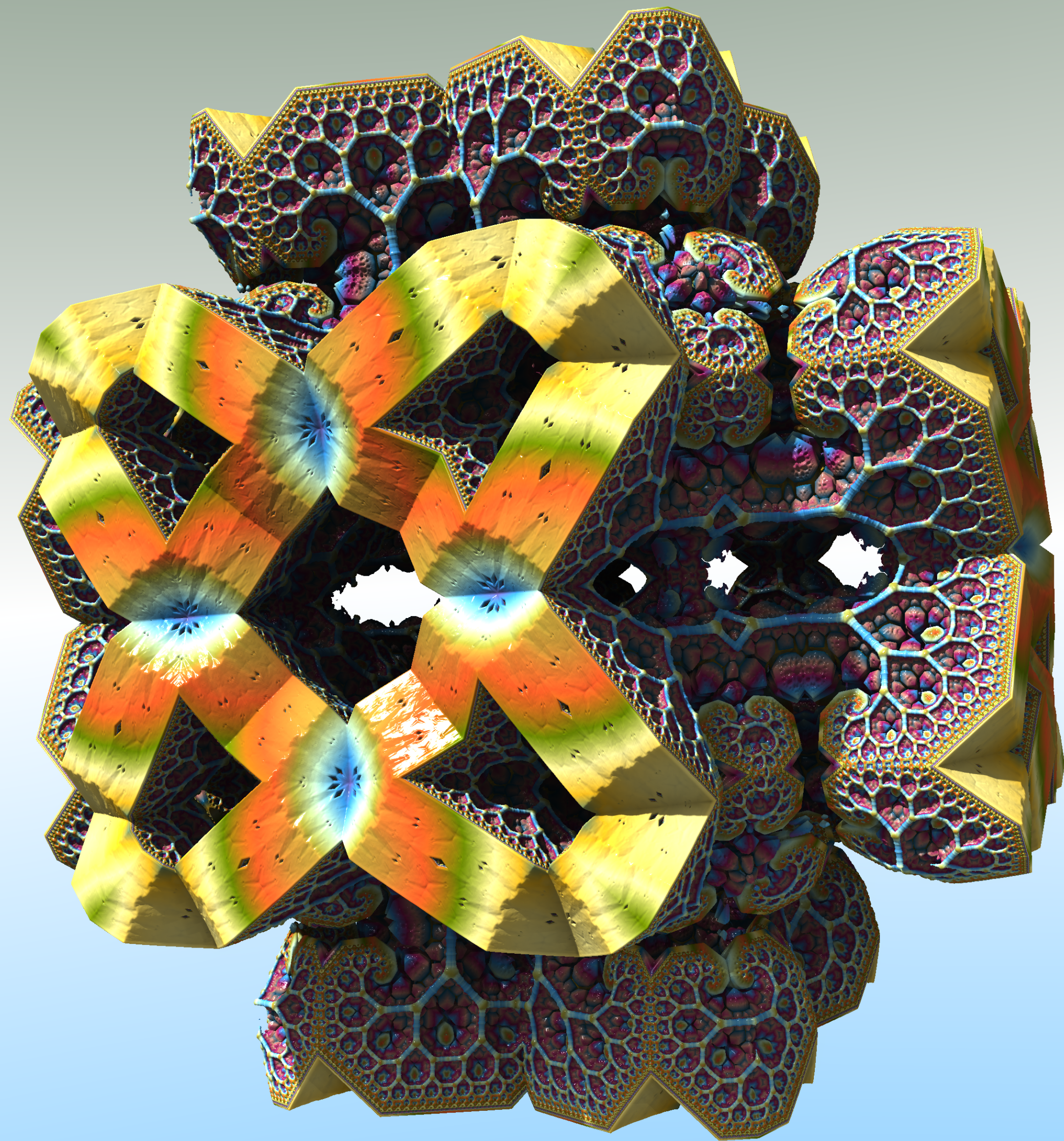
z: 0

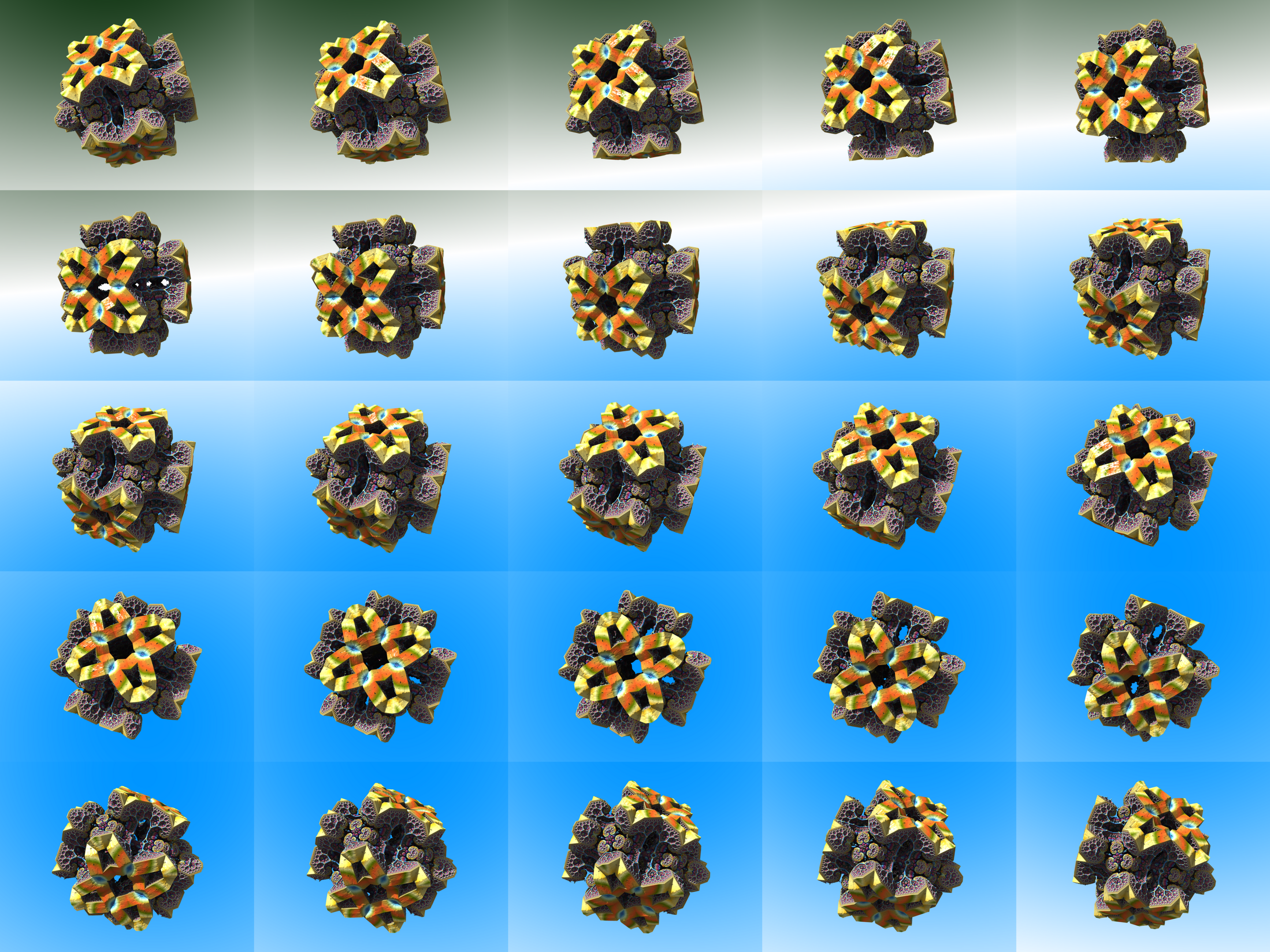
Distance from last point: 0

Distance from camera: 0

Midpoint of last two picked points

x: 0





Input Images

/Users/michaelzfreeman/mandelbulber/animation

Output Model

/Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz

Model  
Complexity

--feature-sensitivity normal

-d medium

--sample-ordering sequential

- HelloPhotogrammetry M
  - README.md
  - HelloPhotogrammetry
    - main.swift
  - Products
    - HelloPhotogrammetry
  - Configuration
    - SampleCode.xcconfig
  - LICENSE

- Package Dependencies
- swift-argument-parser 0....
    - README.md
    - Package.swift
  - cmake
  - Documentation
  - Examples
  - Scripts
  - Sources
  - Tests
  - Tools
  - CHANGELOG.md
  - CMakeLists.txt
  - CODE\_OF\_CONDUCT....
  - CONTRIBUTING.md
  - LICENSE.txt

# Creating a Photogrammetry Command-Line App

Generate 3D objects from images using RealityKit Object Capture.

## Overview

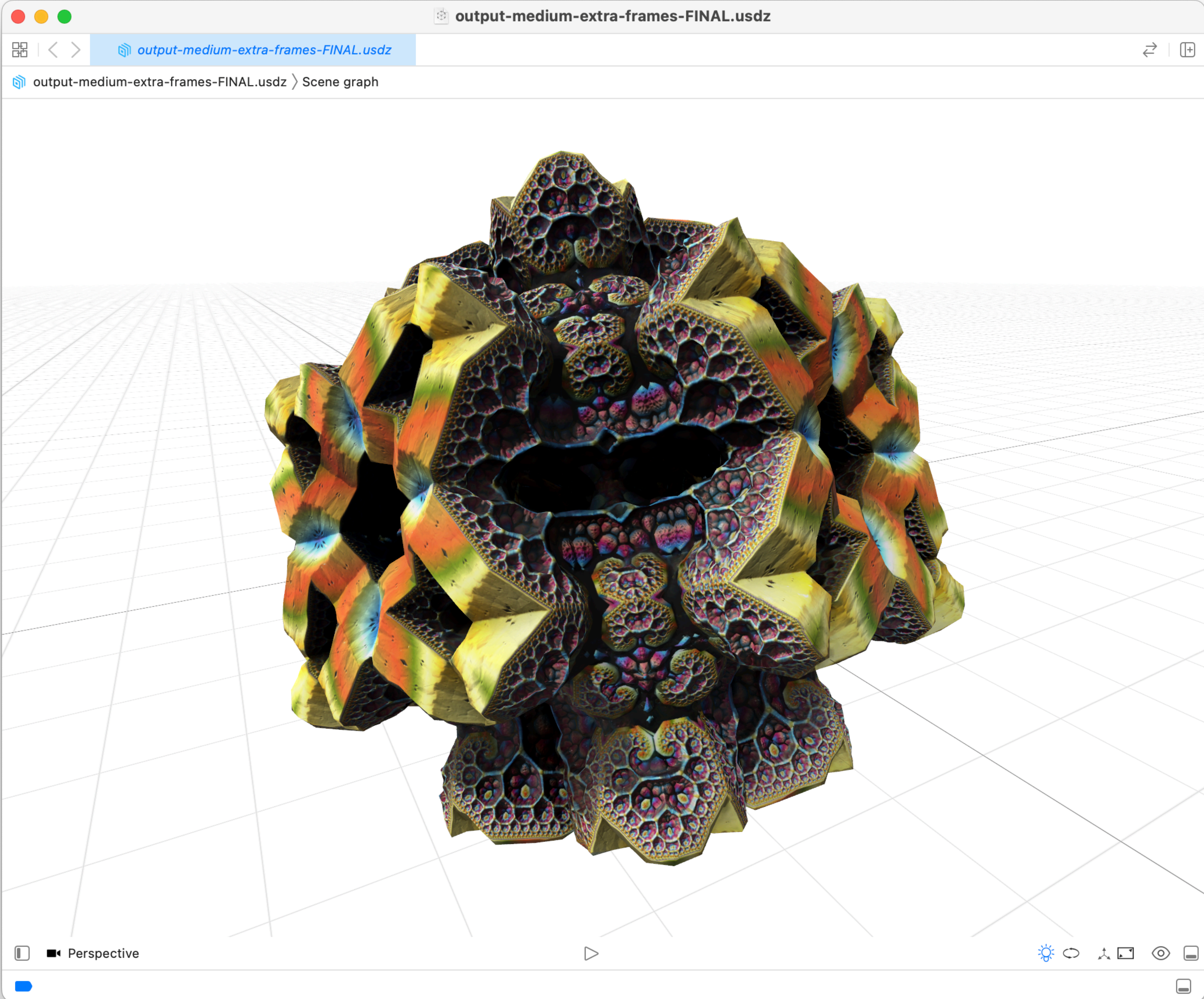
### Note

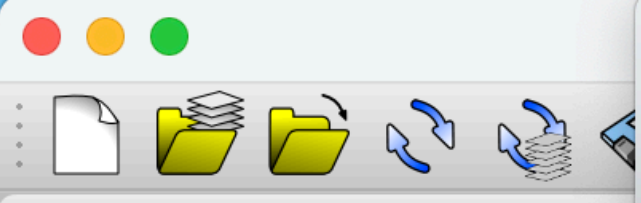
This sample code project is associated with WWDC21 session [10076: Create 3D Models with Object Capture](#).

```

2023-04-26 17:58:20.482176+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.945726
2023-04-26 17:58:20.482246+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.950249
2023-04-26 17:58:20.482279+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.954772
2023-04-26 17:58:20.482306+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.959294
2023-04-26 17:58:20.482385+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.963817
2023-04-26 17:58:21.713796+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.968340
2023-04-26 17:58:21.713875+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.972863
2023-04-26 17:58:21.713918+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.977386
2023-04-26 17:58:30.994527+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.981909
2023-04-26 17:58:30.994603+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.986431
2023-04-26 17:58:30.994636+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.990954
2023-04-26 17:58:30.994696+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 0.995477
2023-04-26 17:58:30.994735+0100 HelloPhotogrammetry[12457:334404] [HelloPhotogrammetry] Progress(request = modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) = 1.000000
2023-04-26 17:58:32.102717+0100 HelloPhotogrammetry[12457:334293] [HelloPhotogrammetry] Request complete: modelFile(url:
file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz, detail: RealityFoundation.PhotogrammetrySession.Request.Detail.medium, geometry: nil) with result...
2023-04-26 17:58:32.102750+0100 HelloPhotogrammetry[12457:334293] [HelloPhotogrammetry] modelFile available at
url=file:///Users/michaelzfreeman/Temp/output-medium-extra-frames.usdz
2023-04-26 17:58:32.103250+0100 HelloPhotogrammetry[12457:334293] [HelloPhotogrammetry] Processing is complete!
2023-04-26 17:58:32.104036+0100 HelloPhotogrammetry[12457:340097] [client] No error handler for XPC error: Connection invalid
Program ended with exit code:0

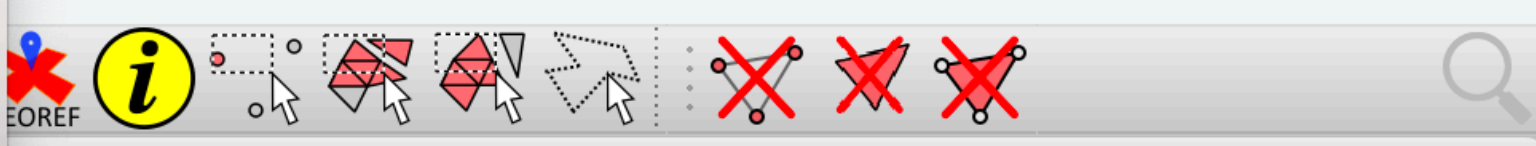
```





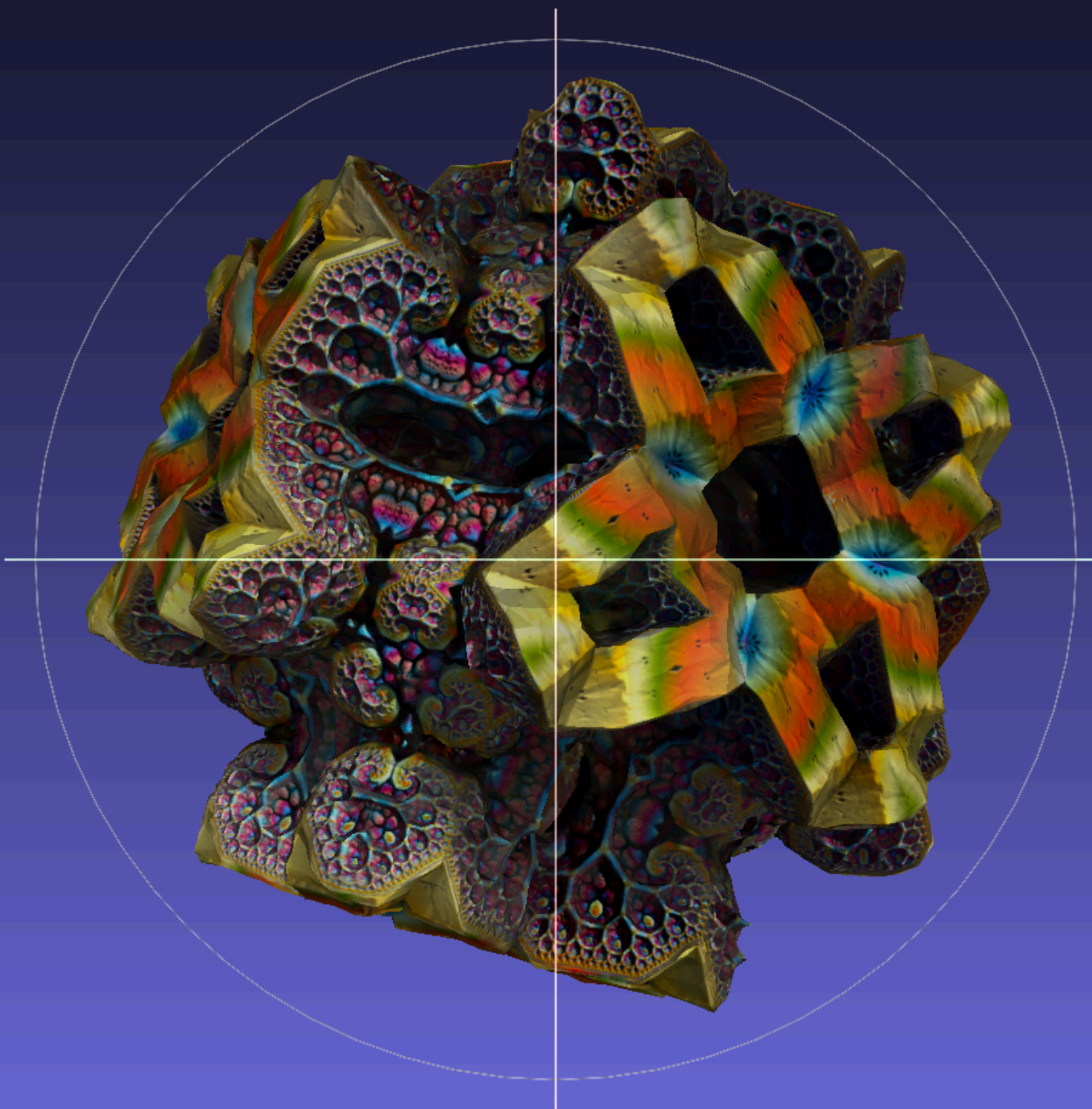
- Apply filter ⌘ P
- Show current filter script
- Selection >
- Cleaning and Repairing >
- Create New Mesh Layer >
- Remeshing, Simplification and Reconstruction >
- Polygonal and Quad Mesh >
- Color Creation and Processing >
- Smoothing, Fairing and Deformation >
- Quality Measure and Computations >
- Normals, Curvatures and Orientation >
- Mesh Layer >
- Raster Layer >
- Range Map >
- Point Set >
- Sampling >
- Texture >
- Camera >
- Other >

- Alpha Complex/Shape
- Build a Polyline from Selected Edges
- Close Holes
- Convex Hull
- Create Solid Wireframe
- Curvature flipping optimization
- Cut mesh along crease edges
- Generate Scalar Harmonic Field
- Global Align Meshes
- ICP Between Meshes
- Iso Parametrization Build Atlased Mesh
- Iso Parametrization Remeshing
- Iso Parametrization transfer between meshes
- Iso Parametrization: Main
- Marching Cubes (APSS)
- Marching Cubes (RIMLS)
- Mesh Boolean: Difference
- Mesh Boolean: Intersection
- Mesh Boolean: Symmetric Difference (XOR)
- Mesh Boolean: Union
- Planar flipping optimization
- Points Cloud Movement
- Refine User-Defined
- Remeshing: Isotropic Explicit Remeshing
- Select Crease Edges
- Simplification: Clustering Decimation
- Simplification: Edge Collapse for Marching Cube meshes
- Simplification: Quadric Edge Collapse Decimation
- Simplification: Quadric Edge Collapse Decimation (with texture)**
- Subdivision Surfaces: Butterfly Subdivision
- Subdivision Surfaces: Catmull-Clark
- Subdivision Surfaces: LS3 Loop
- Subdivision Surfaces: Loop
- Subdivision Surfaces: Midpoint
- Surface Reconstruction: Ball Pivoting
- Surface Reconstruction: Screened Poisson
- Surface Reconstruction: VCG
- Tri to Quad by 4-8 Subdivision



ction Adem Hilmi/meshlab simplify.mlp

FOV: 60  
FPS: 212.8  
BO\_RENDERING



Simplification: Quadric Edge Collapse Decimation (with texture)

*Simplify a textured mesh using a Quadric based Edge Collapse Strategy preserving UV parametrization. Inspired in the QSLIM surface simplification algorithm by Michael Garland, which turned into the industry standar method for mesh simplification.*

See:  
 M. Garland and P. Heckbert.  
**Simplifying Surfaces with Color and Texture using Quadric Error Metrics** ([pdf](#))  
 In Proceedings of IEEE Visualization 98.

Target number of faces

Percentage reduction (0..1)

Quality threshold

Texture Weight

Preserve Boundary of the mesh

Boundary Preserving Weight

Optimal position of simplified vertices

Preserve Normal

Planar Simplification

Simplify only selected faces

Default Help

Close Apply

FOV: 60  
FPS: 212.8  
BO\_RENDERING

Mesh: g0  
Vertices: 32,095  
Faces: 55,436  
Selection: v: 0 f: 0  
WT



User Perspective  
(0) Collection | Mandelbulber Optimised\_1.glb.stl.obj

Objects 1 / 4  
Vertices 11,306  
Edges 24,968  
Faces 13,858  
Triangles 13,858



Scene Collection

- Collection
  - Empty
  - Light
  - Mandelbulber**
    - Animatic
    - Mandelt

Man... > Man...

Mandelbulber Optim...

Vertex Groups

Shape Keys

UV Maps

Vertex Colors

Face Maps

Attributes

Material Properties

Metallic	0.000
Specular	1.000
Specular Int	0.000
Roughness	0.500
Anisotropic	0.000
Anisotropic Rotation	0.000

Node Editor

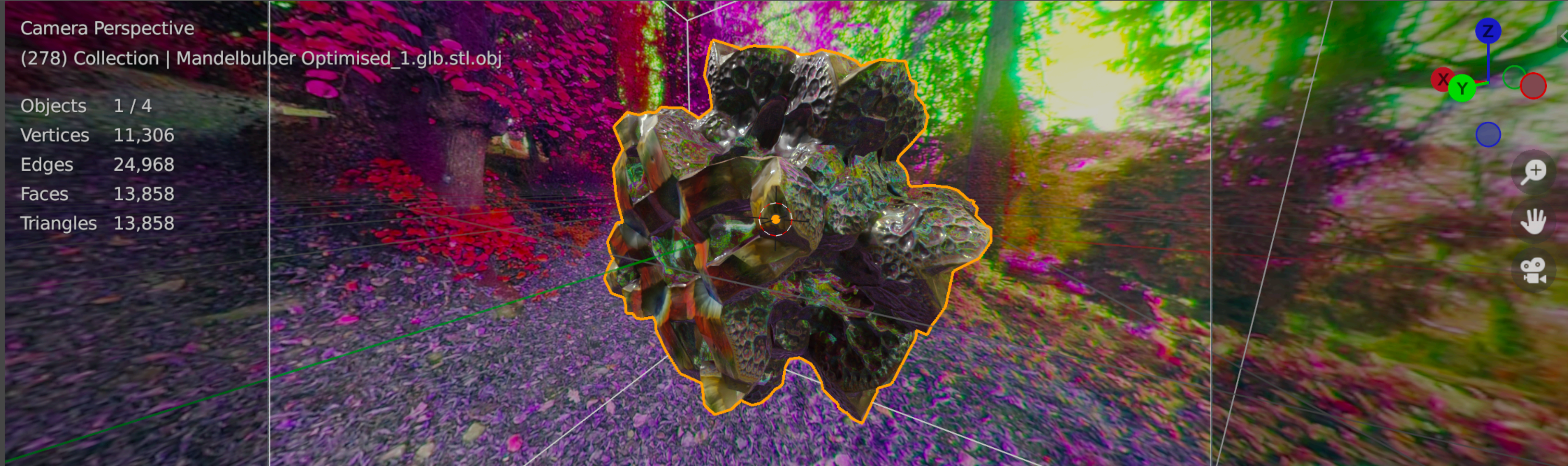
Name: Mix Shader

Label:



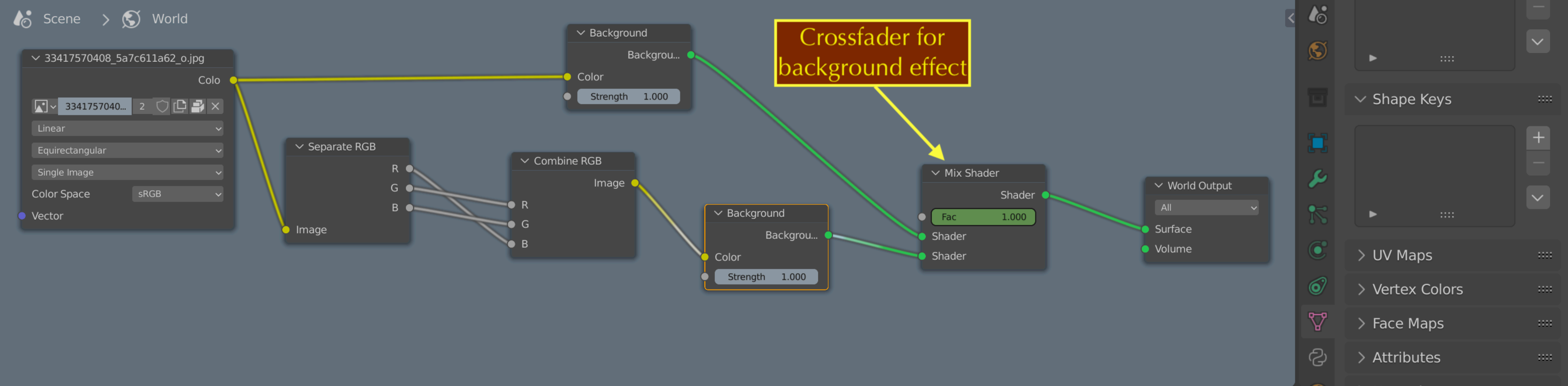
Camera Perspective  
(278) Collection | Mandelbulber Optimised\_1.glb.stl.obj

Objects 1 / 4  
Vertices 11,306  
Edges 24,968  
Faces 13,858  
Triangles 13,858



Scene Collection

- Collection
- Empty
- Light
- Mandelbulber**
- Animatic
- Mandelt



Man... > Man...

Mandelbulber Optim...

Vertex Groups

Shape Keys

UV Maps

Vertex Colors

Face Maps

Attributes

Camera Perspective  
(0) Collection | Mandelbulber C

Objects 1 / 4  
Vertices 11,306  
Edges 24,968  
Faces 13,858  
Triangles 13,858

- Easing Type ⌘ E ▶
- Interpolation Mode T ▶
- Handle Type V ▶
- Delete Keyframes
- Duplicate ⌘ D
- Paste Flipped ⌘ V
- Paste Keyframes ⌘ V
- Copy Keyframes ⌘ C
- Jump to Keyframes ⌘ G
- Bake Sound to F-Curves
- Add F-Curve Modifier ⌘ M
- Insert Keyframes
- Mirror ^ M ▶
- Snap ▶
- Transform ▶



Mandelbulber Optimised\_1.glb

- Mandelbulber Optimised\_1.glb.stl.c
- Object Transform:
- X Scale
- Y Scale
- Z Scale



Scene Collection

- Collection
- Empty
- Light
- Mandelbulber
- Animatic
- Mandelt

Mandelbulber Optim...

Vertex Groups

Shape Keys

UV Maps

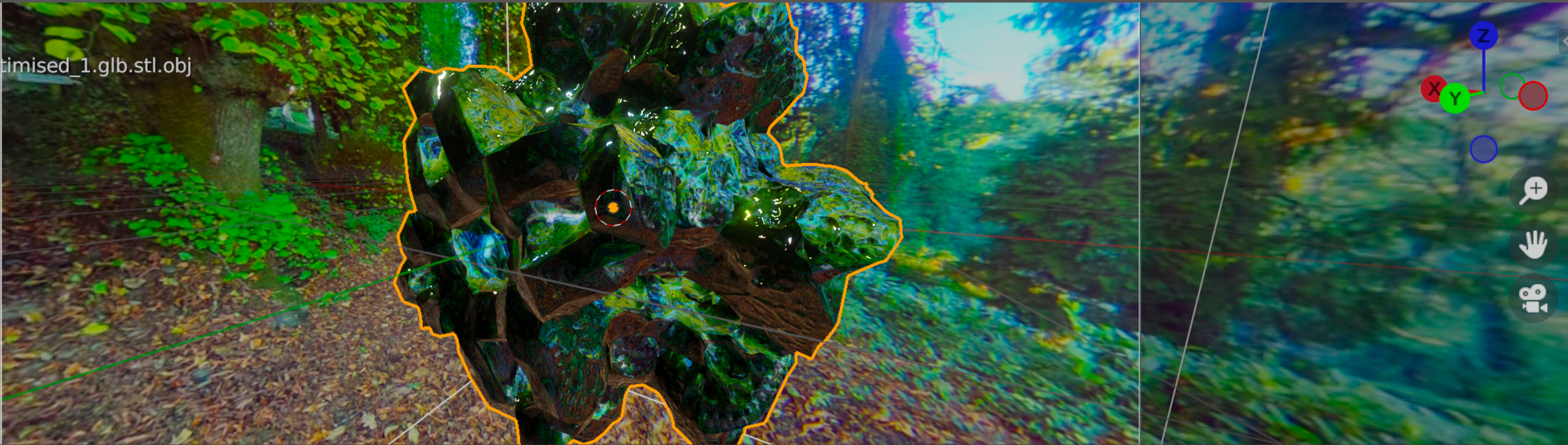
Vertex Colors

Face Maps

Attributes

Camera Perspective  
(0) Collection | Mandelbulber Optimised\_1.glb.stl.obj

Objects 1 / 4  
Vertices 11,306  
Edges 24,968  
Faces 13,858  
Triangles 13,858



Options [Dropdown]

[Icons for visibility, camera, and other settings]

Sensors	Controllers	Actuators
<input checked="" type="checkbox"/> Sel <input checked="" type="checkbox"/> Act <input checked="" type="checkbox"/> Link <input checked="" type="checkbox"/> State	<input checked="" type="checkbox"/> Sel <input checked="" type="checkbox"/> Act <input checked="" type="checkbox"/> Link	<input checked="" type="checkbox"/> Sel <input checked="" type="checkbox"/> Act <input checked="" type="checkbox"/> Link <input checked="" type="checkbox"/> State
Mandelbulber Optimised_1.glb.stl.obj Add Sensor	Mandelbulber Optimised_1.glb.stl.obj Add Controller	Mandelbulber Optimised_1.glb.stl.obj Add Actuator
Always Always	And And (O... Sta 1	Motion Rotation
Always Always.002	And And (S... Sta 1	Sound Sound
Keyboard Left Arrow	And And (M... Sta 1	Motion Spin Left
Keyboard Right Arrow	And And Sta 1	Motion Spin Right
Always Always.001	And And.001 Sta 1	Action Sound Motion

F-Curve imported into game engine for object movement along to music



Play Force Add L

Mandelbulber Opti... x Continue

Start Fra 0.00 End 5424.00  Child

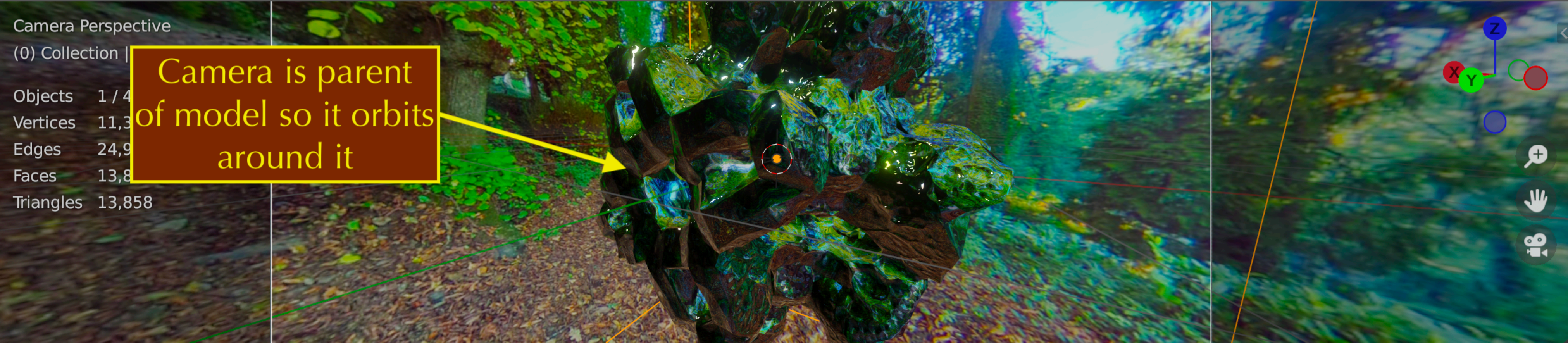
Blendin 0 Priority 0

Layer 0 Layer 0.000 Blend

Frame Prope...

Camera Perspective  
(0) Collection  
Objects 1 / 4  
Vertices 11,3  
Edges 24,9  
Faces 13,8  
Triangles 13,858

Camera is parent of model so it orbits around it



Sensors	Controllers	Actuators
<b>Empty</b> Add Sensor	<b>Empty</b> Add Controller	<b>Empty</b> Add Actuator
▶ Always Always [Pin] [Up] [Down] [Check] [X] [Link]	▶ And And (C... Sta 1 [Pin] [Up] [Down] [Check] [X] [Link]	▶ Motion Camera Orbit [Pin] [Up] [Down] [Check] [X]
▶ Keyboard 1 [Pin] [Up] [Down] [Check] [X] [Link]	▶ And And Sta 1 [Pin] [Up] [Down] [Check] [X] [Link]	▶ Action Background FX [Pin] [Up] [Down] [Check] [X]
▶ Keyboard 2 [Pin] [Up] [Down] [Check] [X] [Link]	▶ And And.001 Sta 1 [Pin] [Up] [Down] [Check] [X] [Link]	Play Force Add L
▶ Keyboard Up Arrow [Pin] [Up] [Down] [Check] [X] [Link]	▶ And And.002 Sta 1 [Pin] [Up] [Down] [Check] [X] [Link]	▶ Shader NodetreeAc... [X] [Pin] [Up] [Down] [Check] [X]
▶ Keyboard Down Arrow [Pin] [Up] [Down] [Check] [X] [Link]	▶ And And.003 Sta 1 [Pin] [Up] [Down] [Check] [X] [Link]	Start 116.00 End Fr 433.00 [Child]
		Blendin 0 Priority 0
		Layer 0 Layer 0.000 Blend
		Frame Prop...
		▶ Action Shader FX [Pin] [Up] [Down] [Check] [X]
		▶ Motion Move in [Pin] [Up] [Down] [Check] [X]
		▶ Motion Move out [Pin] [Up] [Down] [Check] [X]

F-Curves from Blender timeline that are triggered for background and shader FX

106 3 120 4/4 Cmaj

1234

Region: 23 selected Edit Functions View Snap: Smart Drag: X-Fade

Track: Titans of Bass

1 17 33 49 65 81 97 113

Titans of B... Setting

EQ

DMD Bus 12 Phat FX

2

Titans of Bass

M S R Track

Read Volume

-16.6 dB -16.3 dB

Clas Clas

Empty space left by FX dragged to Bus leaves "58 (unused)" automation behind

Send 1 -> Aux 1

Display off

Cycle Through

Automation

- Smart Controls
- Volume
- Main
- 1 Enveloper
- 2 Compressor
- 4 Bitcrusher
- 5 AutoFilter
- 6 Ensemble
- 7 St-Delay
- 8 PtVerb
- 9 Channel EQ

Used

- Volume
- Instrument Bypass (Enveloper)
- 58 (unused)
- Insert 6 Bypass (St-Delay)
- Insert 7 Bypass (PtVerb)

Automation can be converted to Bus ("Send 1 -> Aux") by holding down Option when clicking in it

Bitcrusher

AutoFilter

Ensemble

St-Delay

PtVerb

Channel EQ

B 12

Stereo Out

Group

Read

-16.3

0.0

22

Tube Rhythm

M S R

Read

Volume

23

Scripter

M S R

Read

Untitled

Untitled

Untitled

Titans of Bass

Aux 1

106 3 120 4/4 Cmaj

1234

Region: 23 selected Edit Functions View Snap: Smart Drag: X-Fade

Track: Titans of Bass

Titans of B... Setting

EQ

DMD Bus 12 Phat FX

Enveloper Compressor

Bitcrusher AutoFilter Ensemble St-Delay PtVerb Channel EQ

B 12 Sends

Stereo Out Stereo Out

Group Group

Read Read

-16.3 0.0

0 3 6 9 12 15 18 21 24 30 35 40 45 50 60

0 3 6 9 12 15 18 21 24 30 35 40 45 50 60

M S M S

Titans of Bass Aux 1

2

Titans of Bass

M S R Track

Read Volume

Send 1 → Aux 1

58 (unused)

22

Tube Rhythm Sequence

M S R Track

Read Pan

Volume

23

Scripter

M S R Track

Read Volume

Untitled

1 17 33 49 65 81 97 113

Clas Clas

Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti U U U U Unti Unti Unti Unti Unti Unti

+14

-1.0 dB

+0.0 dB

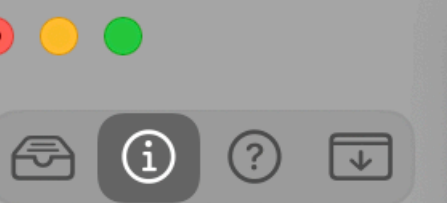
Untitled Untitled Untitled

Do you want to convert or copy the automation data?

Copy And Convert

Convert

Cancel



- Can't Undo ⌘ Z
- Can't Redo ⇧ ⌘ Z
- Undo History... ⌘ ⇧ Z
- Delete Undo History
- Cut ⌘ X
- Copy ⌘ C
- Paste ⌘ V
- Paste Replace ⇧ ⌘ V
- Paste at Original Position
- Delete
- Delete and Move
- Copy Region Selection to Live Loops ⌘ ⇧
- Select >
- Select Tracks >
- Show Flex Pitch/Time ⌘ F
- Repeat >
- Length >
- Split >
- Bounce and Join >
- Move >
- Trim >
- Convert >
- Time Stretch >
- Copy MIDI Events... >
- Delete MIDI Events >
- Separate MIDI Events >
- Cut/Insert Time >
- Tempo >
- Open in Audacity.app ⇧ W
- Open Smart Tempo Editor

- Cut Section Between Locators ^ ⌘ X
- Copy Section Between Locators**
- Insert Section at Playhead ^ ⌘ V
- Insert Silence at Locators ^ ⌘ Z
- Repeat Section Between Locators ^ ⌘ R
- Copy Scene to Playhead
- Insert Scene at Playhead ⌘ ↵

Project 9 transferring FX to busses.logicx - Fractal Project 9 transferring FX to busses - Tracks

00:00:00.000 48 120.000  
0001 1 1 001 KHZ Keep Tempo

Snap: Smart Drag: X-Fade

1 17 33 49 65 81 97 113

Clas Clas

Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti Unti U U U U Unti Unti Unti Unti Unti Unti

+2.2 dB

+1.4

-1.0 dB

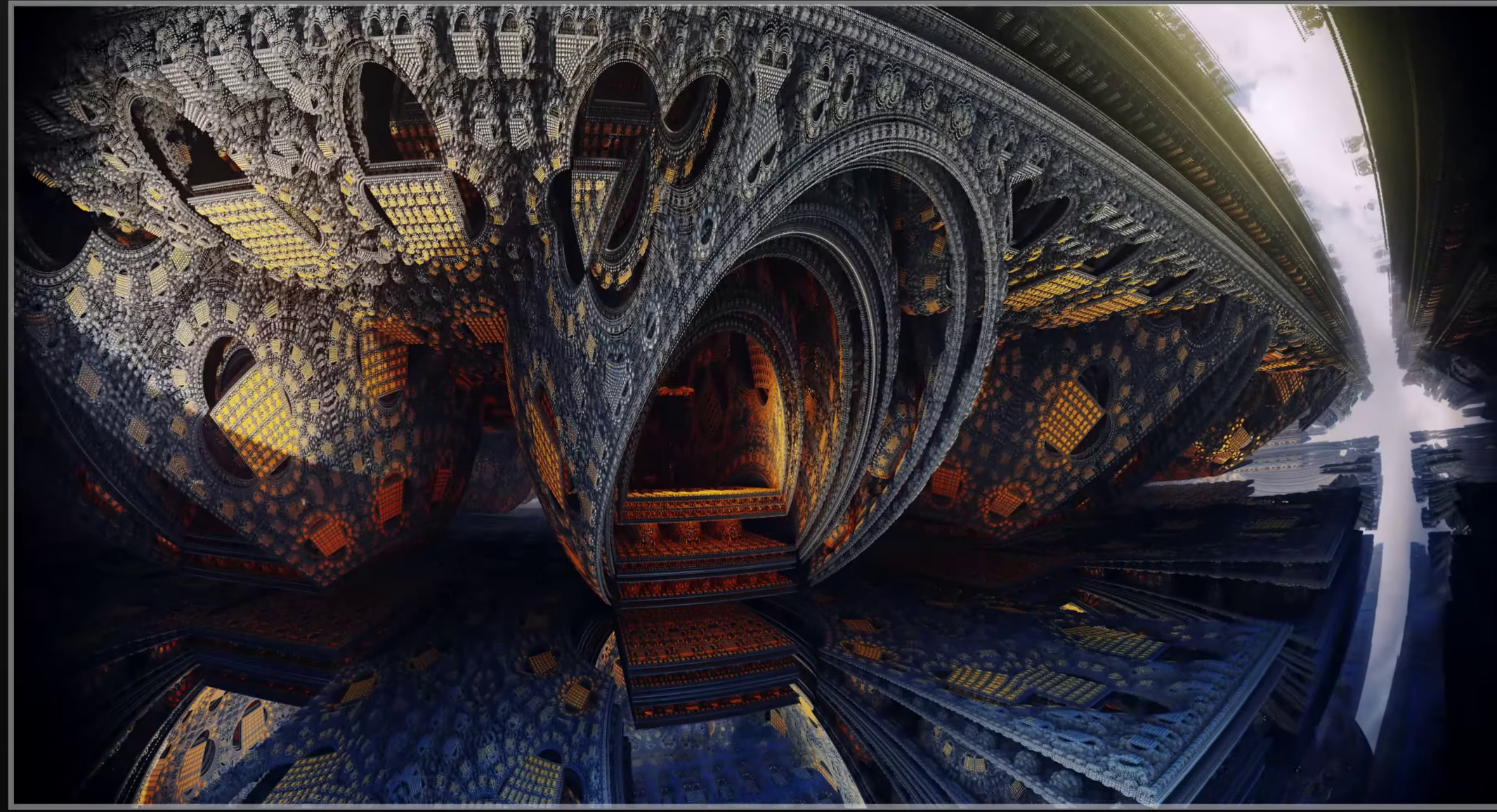
+0.0 dB

Untitled Untitled

M S M S

Titans of Bass Stereo Out

# Artists



Recombination, the Fulldome Journey (Julius Horsthuis)

- ★ Julius Horsthuis is a Dutch artist who uses fractals (Horsthuis 2023)
- ★ The use of and inspiration by Fractal mathematics is prevalent in movie CGI design. For example in the movie *Avatar: Way of the Water*; “... we were looking at a lot of fractal patterns and fractal designs” (Below the Line 2022).
- ★ Another example is the film *Annihilation* (Garland 2018).



*Annihilation* (2018) Ending Alien Scene

# Summary

- I feel that I've developed a successful interactive piece that along with the audio affecting the 3D fractal as well as the live manipulation of the model and shader effects using the keyboard, produces a closely knit interaction between music and visuals.
- The skills developed here can be used in careers in the entertainment industry, such as Visual Effects artists and supervisors.
- Blender Game Engine (UPBGE) can also import live and prerecorded video into a scene as "video textures". In the future I'd like to setup a video mixing experience that uses this technology. This would mean that video could not only be looped and mixed together but moved around in 3D space and projected onto 3D models.

# References

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