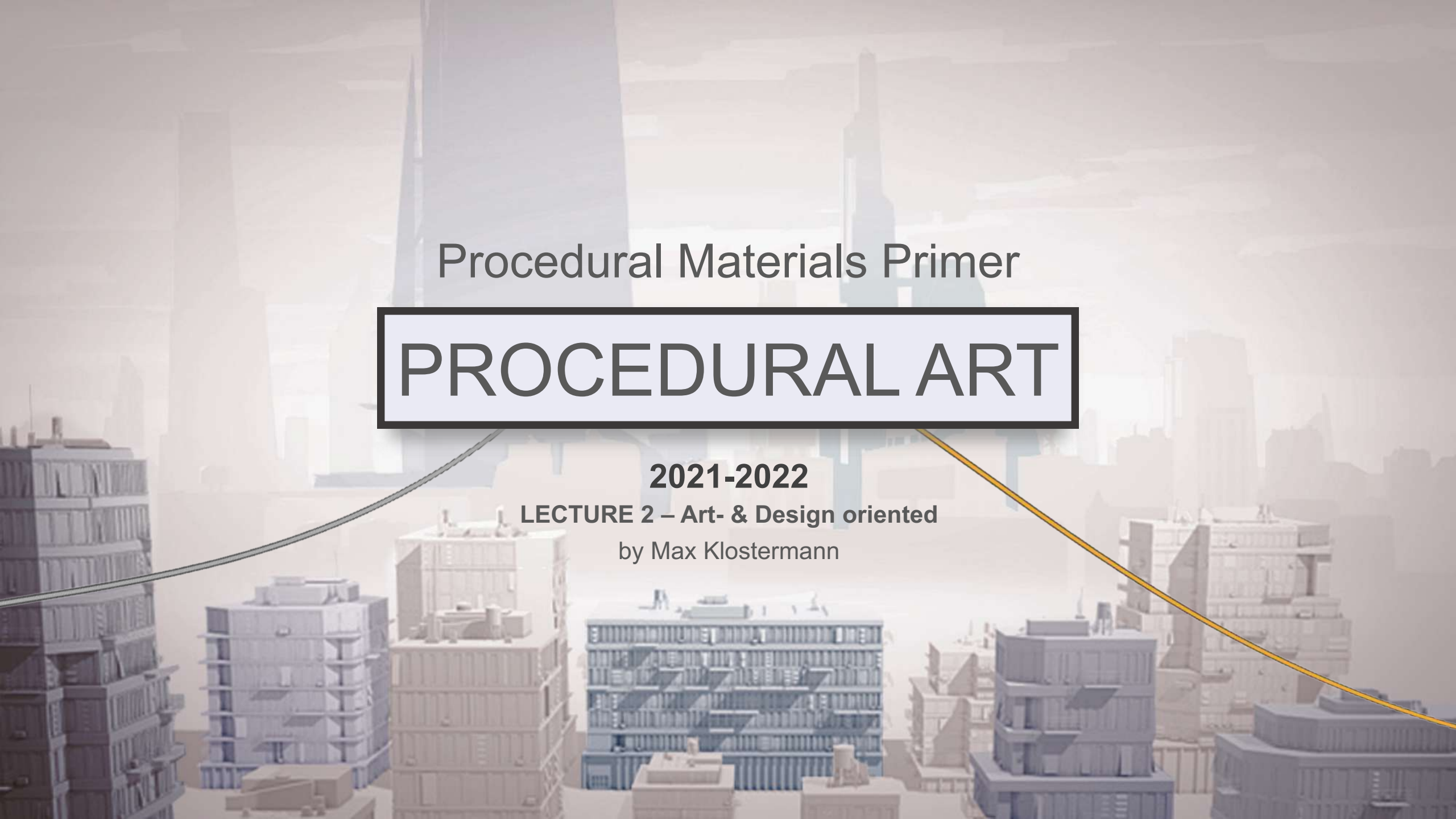


Procedural Materials Primer

PROCEDURAL ART

2021-2022

LECTURE 2 – Art- & Design oriented

by Max Klostermann

TABLE OF CONTENTS

WHAT APPROACH?

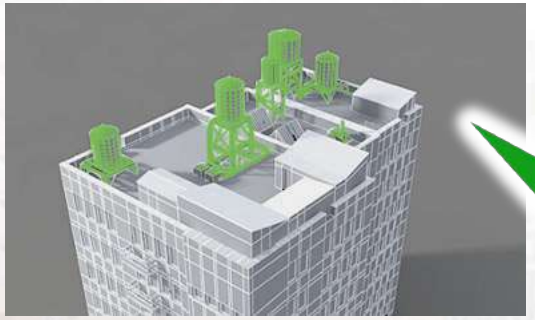
Let's create a poll:

"I would be using Substance 3D **Painter** on…"

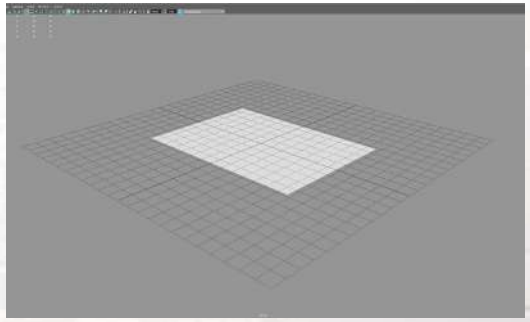
A. this 3D Housing Estate

B. this 3D Environment Prop

C. this 3D Building Complex



D. this Flat Plane



LET‘S REFRESH OUR MEMORY

PBR / PBS = Physically **B**ased **R**endering / **S**hading

- a method of **shading** (depicting a surface on screen) that provides a **more** (scientifically) **accurate representation** of how **lights** interact with **surfaces**
- replaced the former (unreliable) **legacy shading** method used 2015 (ish)

What are the main benefits of PBR?

- **reliable** art asset creation
- **scientifically** accurate (based on measured values)
- **takes away** all the previous **guesswork**
- **consistent** results in **all lighting conditions** (unlike legacy shading)
- **reusability** across projects (if the art style allows for it)

ON ‘TEXTURING CREATIVELY’

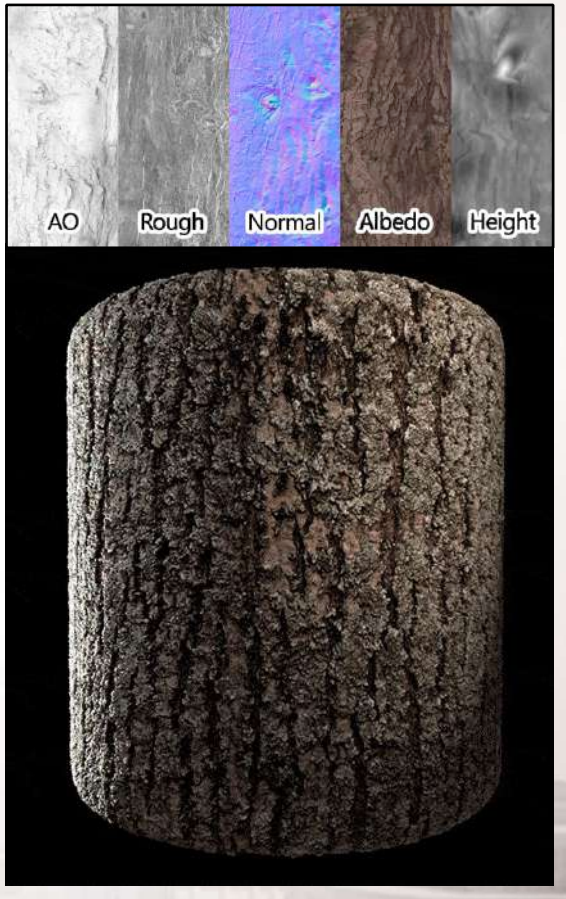
Why do I need to know about this PBR thing and its map types?

- it is indispensable to know the different PBR **map types** well **or**
  - you’ll **never know** what you’re **really** doing
  - you **don’t get** the final visual **results** you’re after
  - you will always **be frustrated** about working ‘blindly’

The skill level for “texturing creativity” required is upped now!

Back then: **Procedural (bitmap) textures** = working “blindly” gets you quite far

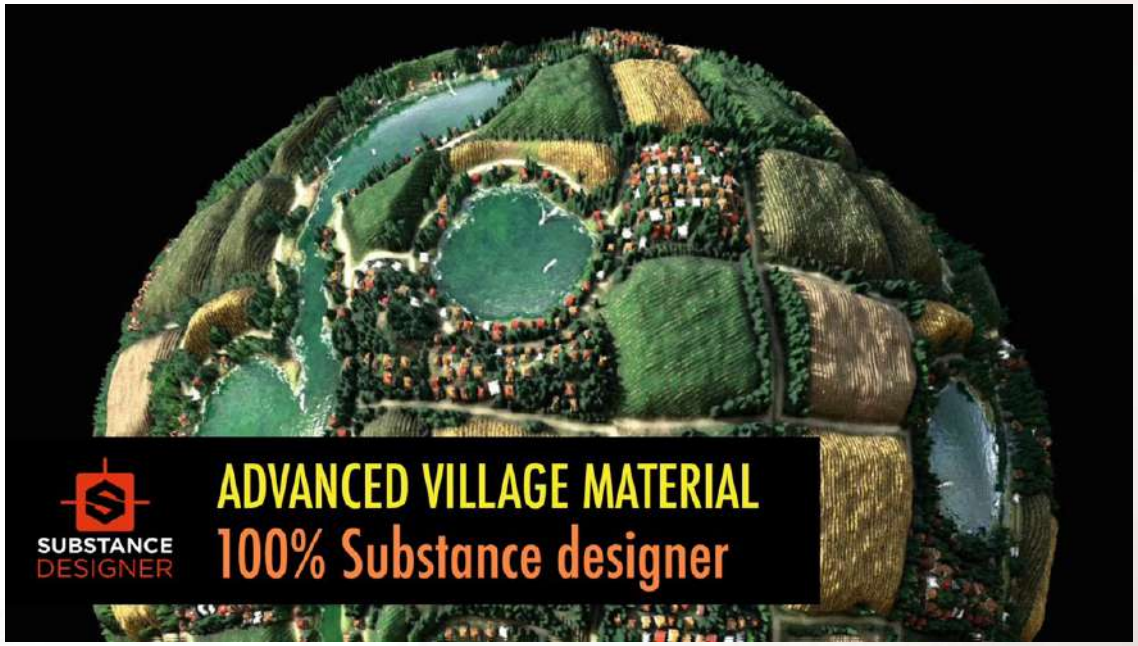
Now: **Procedural materials** = not **knowing** each map type will get you “**nowhere**”

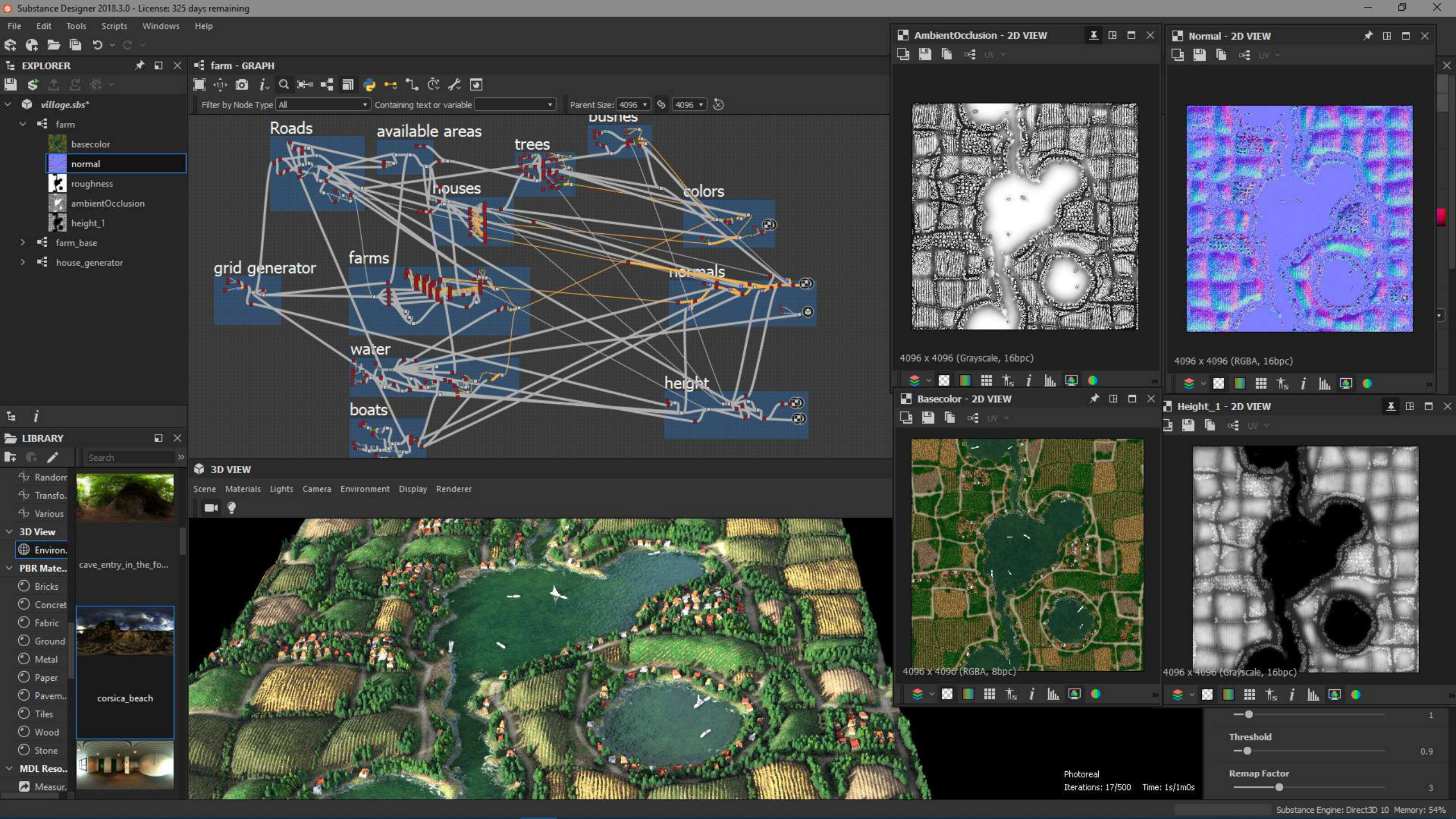


WHY SUBSTANCES?

Benefits of node-based texturing

1. **creative ways** of approaching a material
2. **nearly** an **unlimited** amount of **possibilities**
3. **room** for **experimentation** & **creative "abuse"** of nodes that probably "weren't meant" to do XY
4. **efficiency** in saving memory budget **for hardware** (especially **RAM & GPU RAM**)
5. **non-destructive** setup with possibilities for **reiterating** and **reusing** nodes/entire materials




Substance Designer 2018.3.0 - License: 325 days remaining
File Edit Tools Scripts Windows Help
EXPLORER
village.sbs*
farm
basecolor
normal
roughness
ambientOcclusion
height_1
farm_base
house_generator
farm - GRAPH
Filter by Node Type All
Containing text or variable
Parent Size: 4096 4096
Roads
available areas
trees
houses
colors
grid generator
farms
normals
water
height
boats
AmbientOcclusion - 2D VIEW
4096 x 4096 (Grayscale, 16bpc)
Normal - 2D VIEW
4096 x 4096 (RGBA, 16bpc)
Basecolor - 2D VIEW
4096 x 4096 (RGBA, 8bpc)
Height_1 - 2D VIEW
4096 x 4096 (Grayscale, 16bpc)
LIBRARY
Search
Random
Transfo.
Various
3D View
Environ.
PBR Mate..
Bricks
Concret
Fabric
Ground
Metal
Paper
Pavem..
Tiles
Wood
Stone
MDL Reso..
Measur.
cave_entry_in_the_fo...
corsica_beach
3D VIEW
Scene Materials Lights Camera Environment Display Renderer
Photoreal
Iterations: 17/500 Time: 1s/1m0s
Threshold
0.9
Remap Factor
3
Substance Engine: Direct3D 10 Memory: 54%

Physically based maps

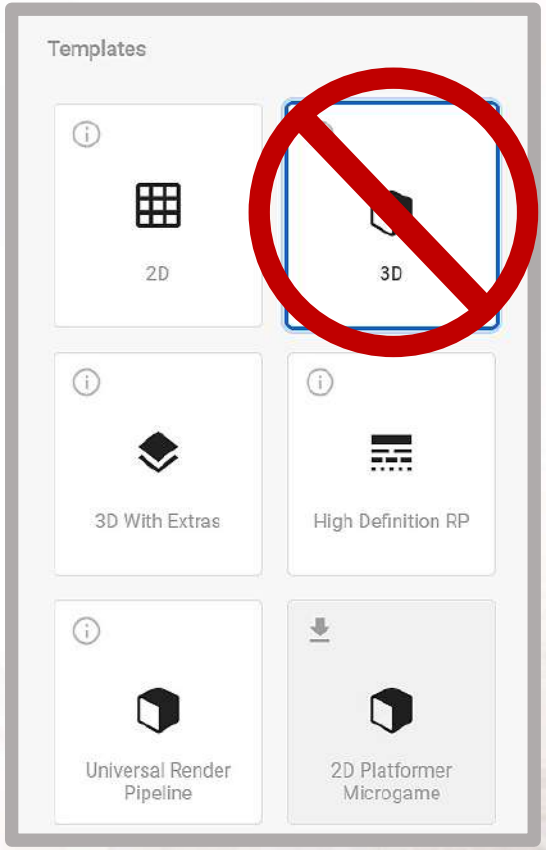
RENDER PIPELINES

What map types are required for Unity's render pipelines?

1. **Unity Scriptable Render Pipeline (3D)** ***(officially canned now!)***
   - **Standard** Shader (Metal-"Rough")
2. **Universal Render Pipeline (URP)**
   - **Lit** Shader (URP-Specific Metal-"Rough" + Mask Map)
3. **High Definition Render Pipeline (HDRP)**
   - **Lit** Shader (HDRP-Specific Metal-"Rough" + Mask Map + Extras)

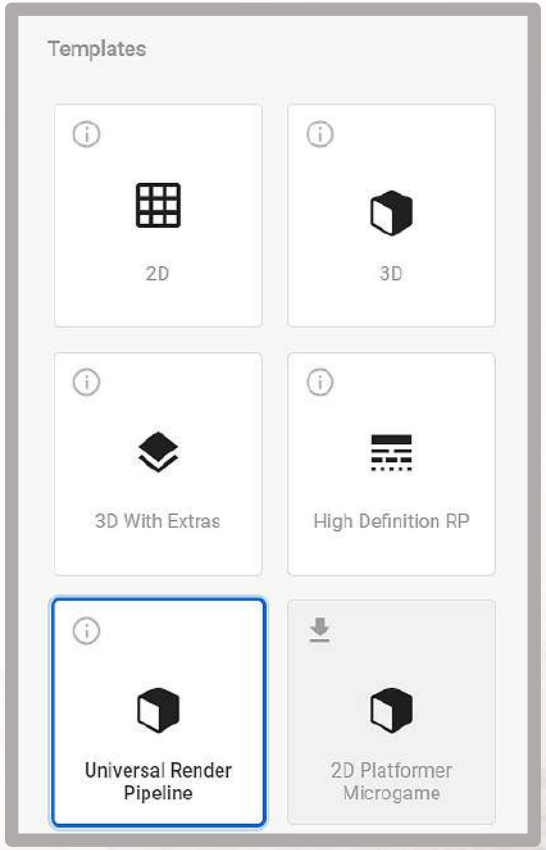
RENDER PIPELINES

1. **Unity Scriptable Render Pipeline**
   - **Standard** Shader (Metallic-”Roughness”)
     - **Albedo** map (Base color)
     - **Metallic** map
     - Smoothness map (**inverted Roughness** map!)
     - (Ambient) Occlusion (**AO**) map
     - **Normal** map
     - **Height** map



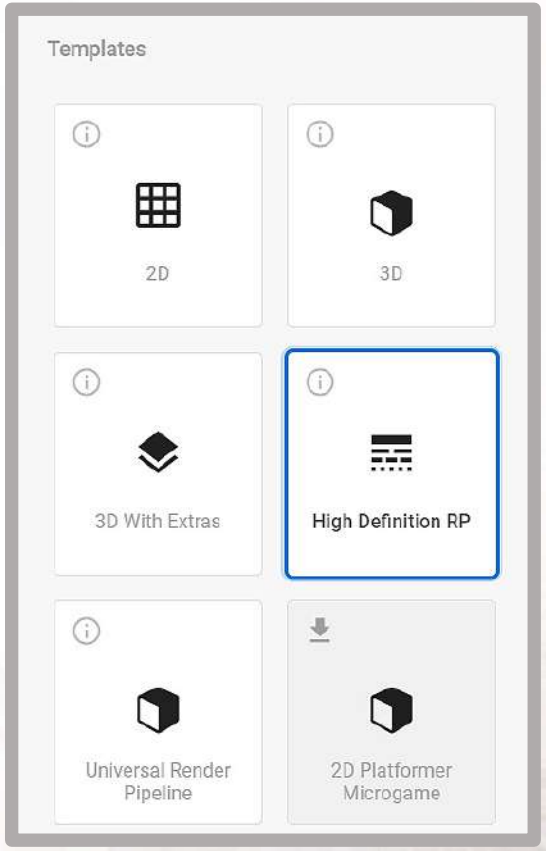
RENDER PIPELINES

2. **Universal Render Pipeline** (previously known as **Lightweight RP**)
    - **Lit** Shader (URP)
        - **Albedo** map (Base color)
        - **Mask map (Channel packing / RGBA)**
            - **Red:** ← Metallic map
            - **Green:** ← (Ambient) Occlusion (AO) map
            - **Alpha:** ← Smoothness map (**inverted Roughness**)
        - **Normal** map
        - **Height** map



RENDER PIPELINES

3. **High Definition Render Pipeline**
    - **Lit** Shader (HDRP)
        - **Albedo** map (Base color)
        - **Mask map (Channel packing / RGBA)**
            - **Red:** ← Metallic map
            - **Green:** ← (Ambient) Occlusion (AO) map
            - **Alpha:** ← Smoothness map (**inverted Roughness**)
        - **Normal** map
        - **Height** map



Physically based maps

ESSENTIAL PBR BASICS

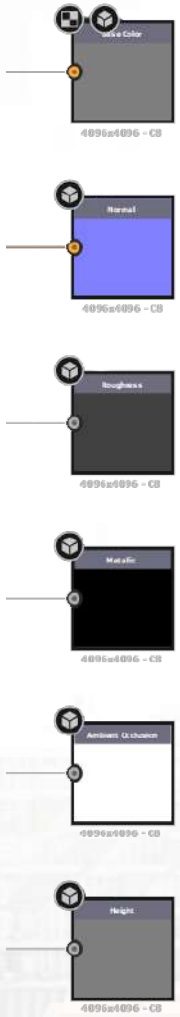
Every map type (output) counts.

ESSENTIAL PBR BASICS

Map types (outputs) that we **need** to **feed** with information in Substance 3D Designer (and later, the game engine):

Base Color (Albedo)
Roughness
Metallic
Normal
Height
+ Ambient Occlusion (AO)

= the finished "texture"



=

Physically based maps

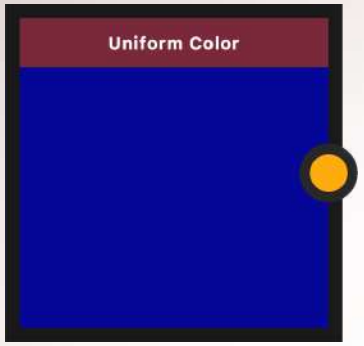
ESSENTIAL PBR BASICS

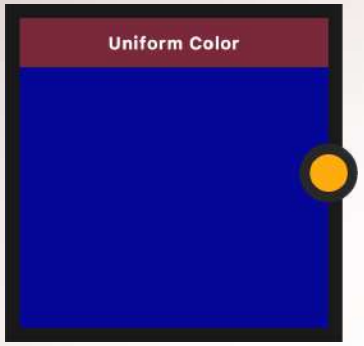
Base color (or Albedo/Diffuse) = RGB color

A colored texture of a surface's color information

ESSENTIAL PBR BASICS

Base color (or Albedo/Diffuse) = RGB color





ESSENTIAL PBR BASICS

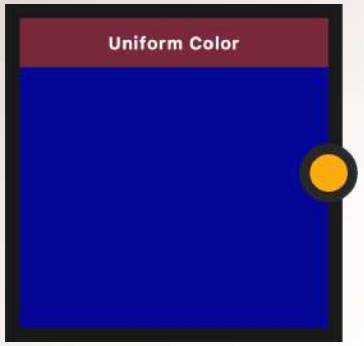
Base color (or Albedo/Diffuse) = RGB color

The base color is the **least impactful** and **easiest** map type (usually the last map type to take care of).

Physically based maps

ESSENTIAL PBR BASICS

Base color (or Albedo/Diffuse) = RGB color



Can also be a **regular bitmap** texture with more detail (self-made or found) but those will most likely not be very "PBR accurate" (too much dark shading)

Physically based maps

ESSENTIAL PBR BASICS

Roughness = Grayscale

A black and white texture - the brighter the pixel the more blurred reflections will be

In the old days (legacy shading) formerly known as?

Specularity or **Specular map**

Physically based maps

ESSENTIAL PBR BASICS

Roughness = Grayscale

0.0 = black

Physically based maps

ESSENTIAL PBR BASICS

Roughness = Grayscale

0.0 = black

1.0 = white

Physically based maps

ESSENTIAL PBR BASICS

Roughness = Grayscale

0.25 = dark-gray

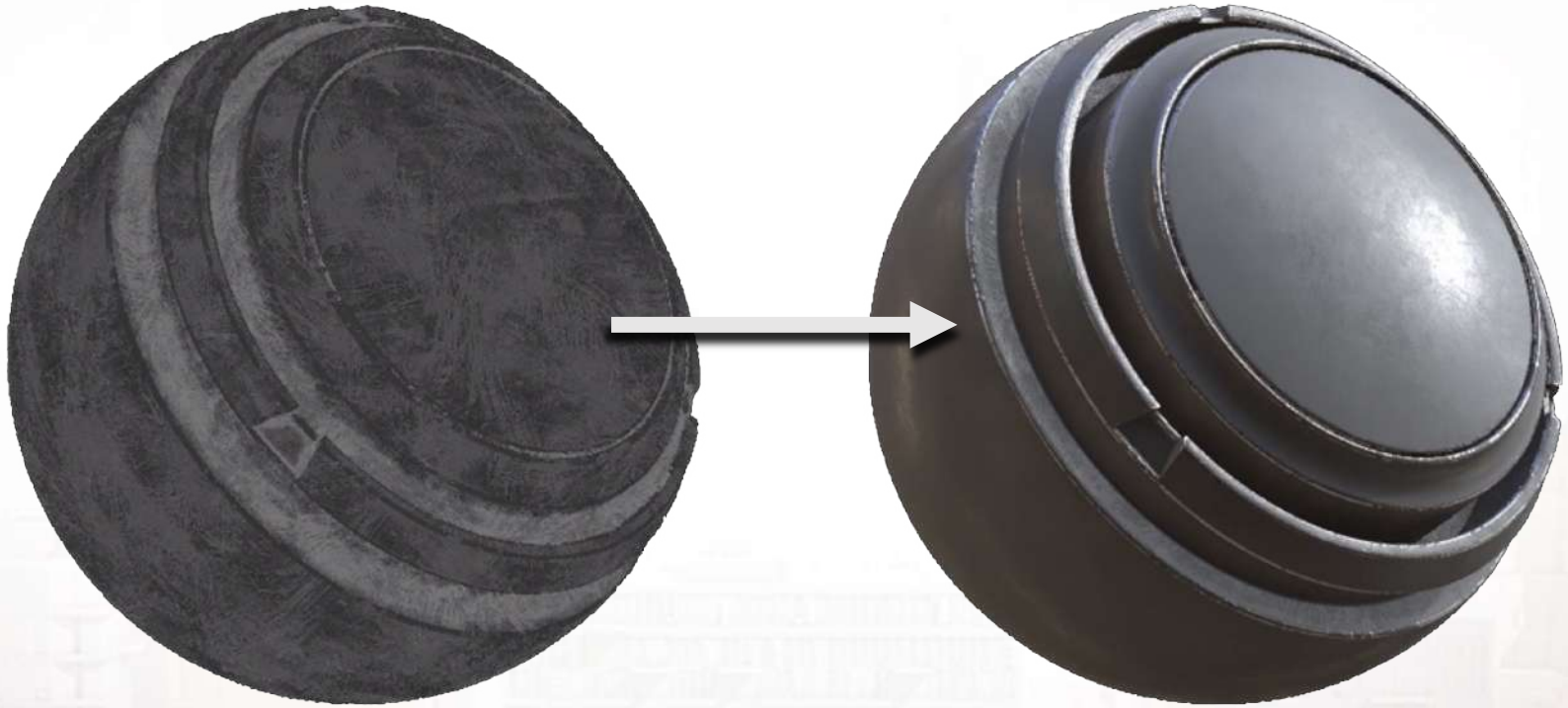
0.5 = gray

0.75 = light-gray

Physically based maps

ESSENTIAL PBR BASICS

Roughness = Grayscale



Roughness maps have the power to tell the **story** and **history** of a material.
Add **wear & tear**, **scratches**, **fingerprints** etc. through (blended) **NOISES** & **GRUNGE MAPS!**

Physically based maps

ESSENTIAL PBR BASICS

Metallic = Grayscale

A grayscale (black and white) texture, where black pixels define insulator surfaces (non-metal), and white defines metal (conductors)

Physically based maps

ESSENTIAL PBR BASICS

Metallic = Grayscale

0.0 = black

1.0 = white

Physically based maps

ESSENTIAL PBR BASICS

Metallic = Grayscale

0.0 = black

1.0 = white

Physically based maps

ESSENTIAL PBR BASICS

Metallic = Grayscale

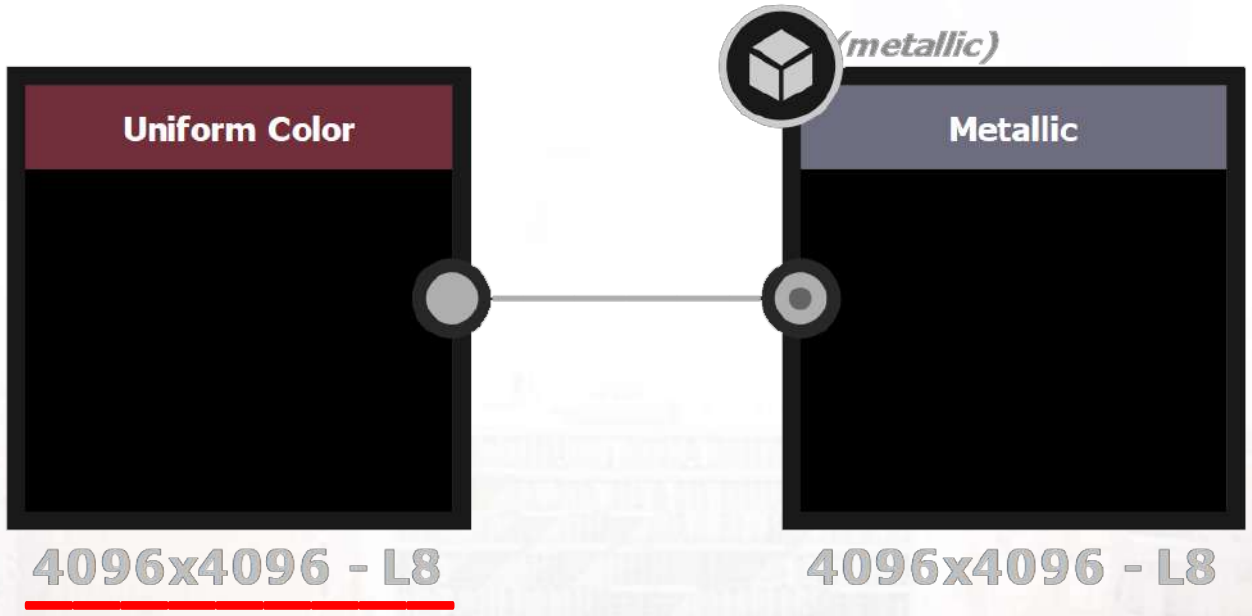
Receives its color from the base color (albedo) map
to get materials such as copper, gold etc.

Physically based maps

ESSENTIAL PBR BASICS

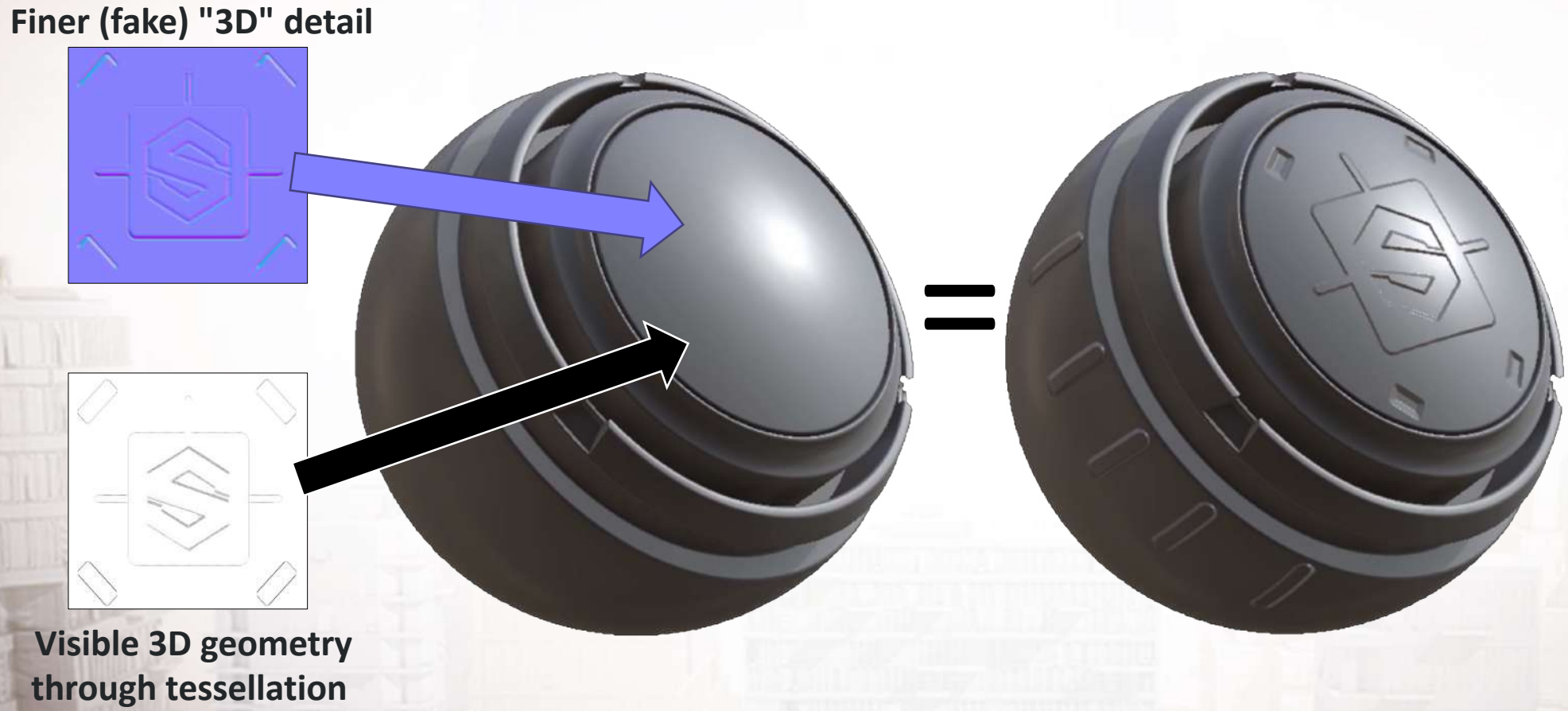
Metallic = Grayscale

Is it an entirely non-metallic material altogether? **Leave it black.**



ESSENTIAL PBR BASICS

Normal = RGB color | Height = Grayscale

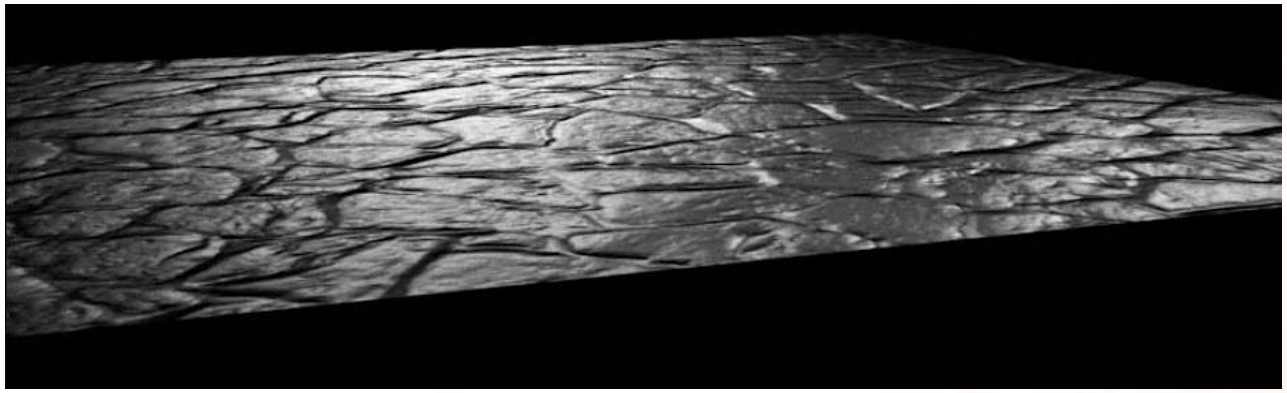


Physically based maps

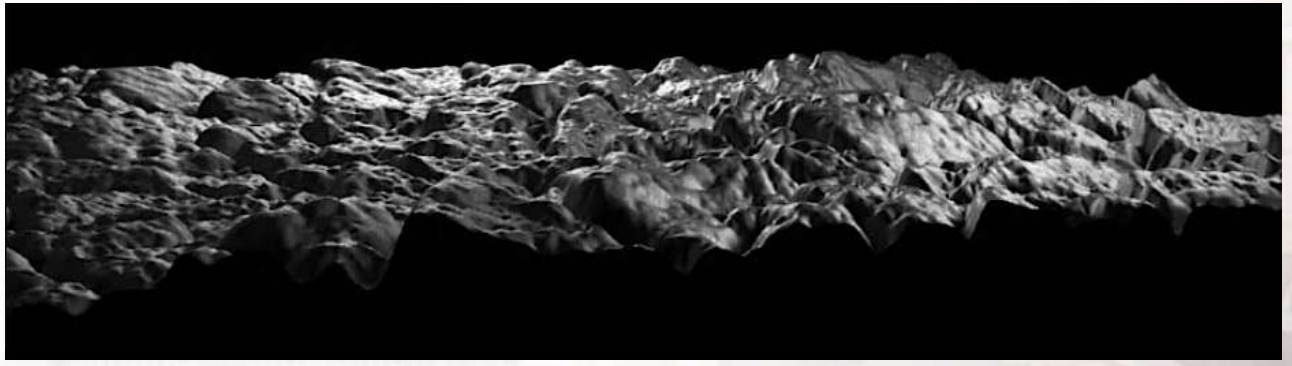
ESSENTIAL PBR BASICS

Normal = RGB color | Height = Grayscale

"Bump mapping"
through a Normal map



Displacement mapping
through a Height map
with enabled
Tessellation (shader)

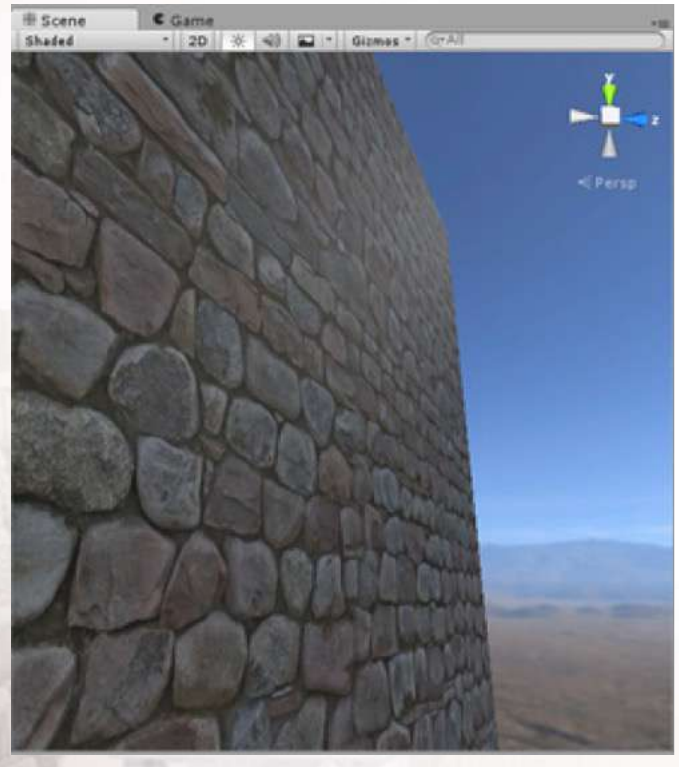


Physically based maps

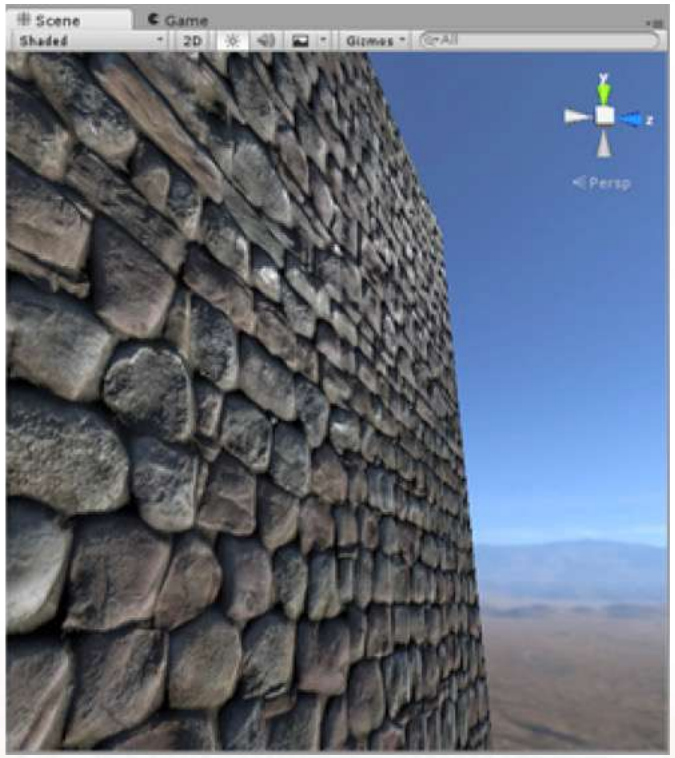
ESSENTIAL PBR BASICS

Normal = RGB color | Height = Grayscale

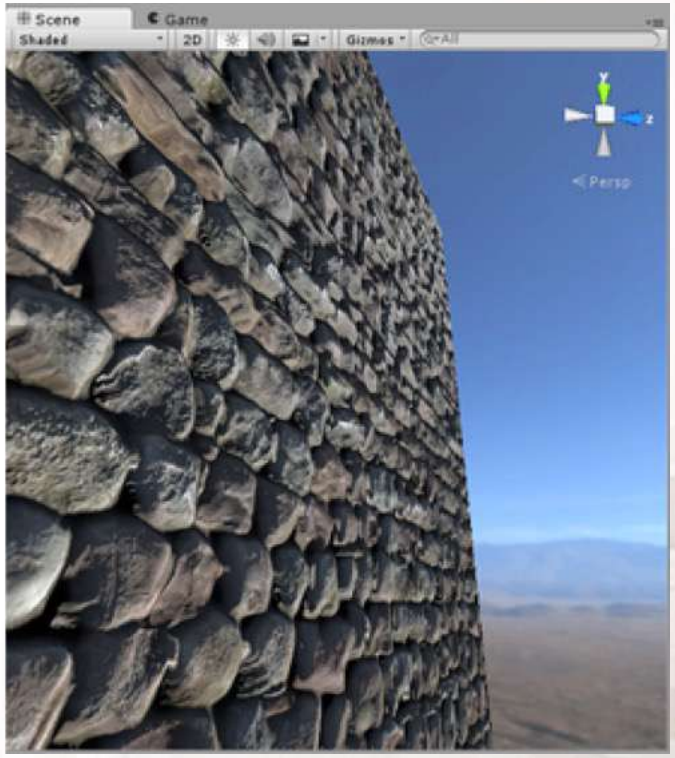
Base Color (Albedo) & **Roughness only**



+ Normal map



+ Height map (**Tessellation** enabled)



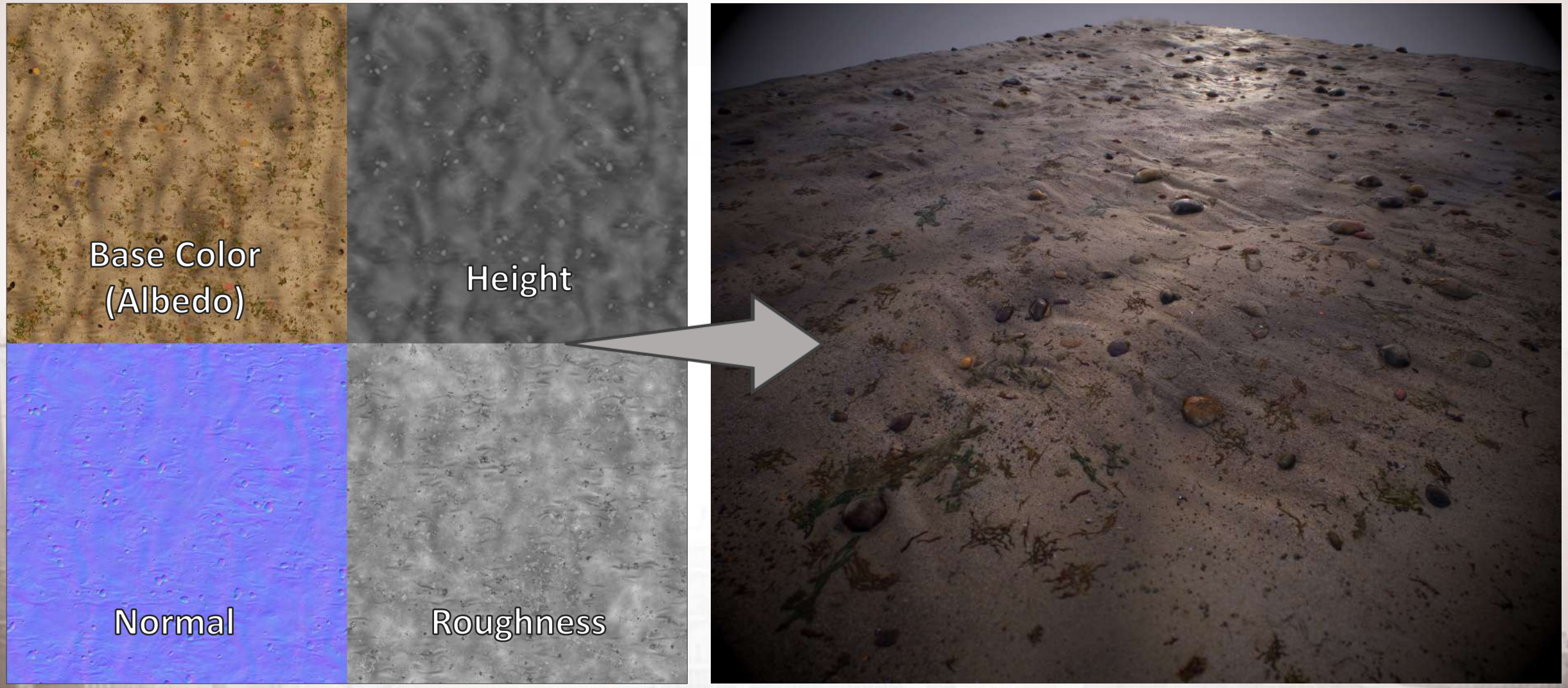
ESSENTIAL PBR BASICS

Let’s create another poll:

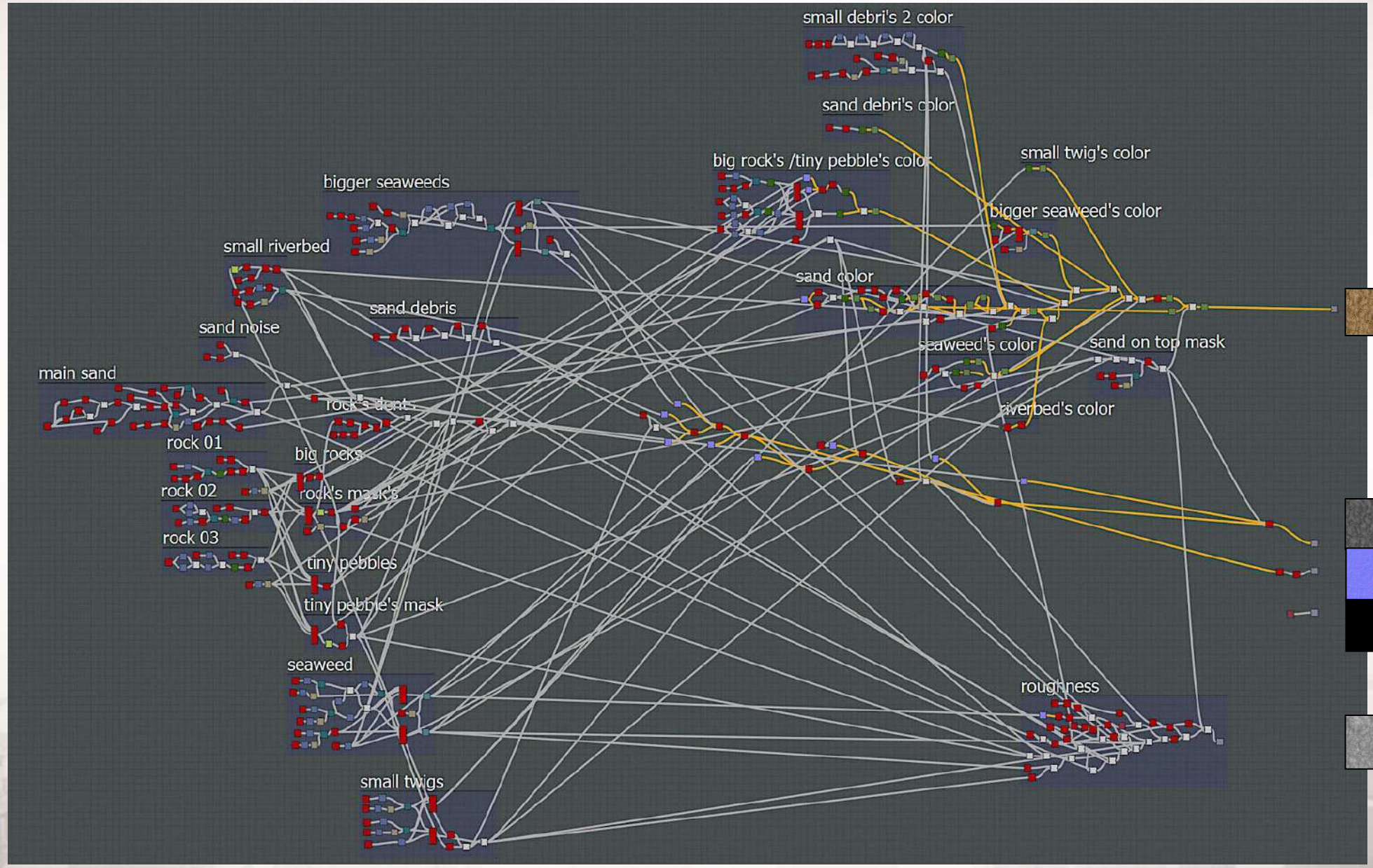
“In Substance 3D Designer, I will in 99% of the cases start with creating…”

1. **the colour map (albedo)**
2. **the height map (grayscale)** 
3. **the roughness map (grayscale)**

Workflow



Workflow

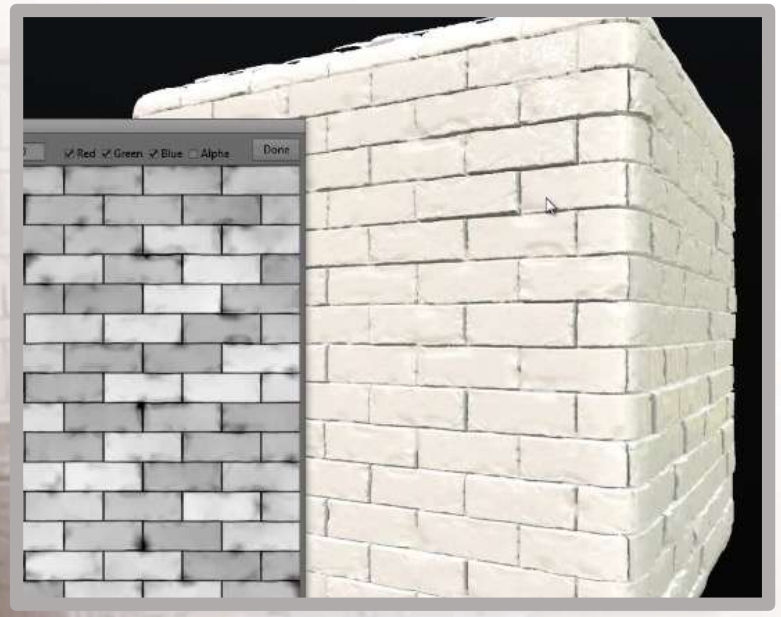

small debri's 2 color
sand debri's color
big rock's /tiny pebble's color
small twig's color
bigger seaweeds
bigger seaweed's color
small riverbed
sand color
sand debris
sand noise
seaweed's color
sand on top mask
main sand
rock's dent
riverbed's color
rock 01
big rocks
rock 02
rock's mask's
rock 03
tiny pebbles
tiny pebble's mask
seaweed
roughness
small twigs
Base Color
Height
Normal
Metallic
Roughness

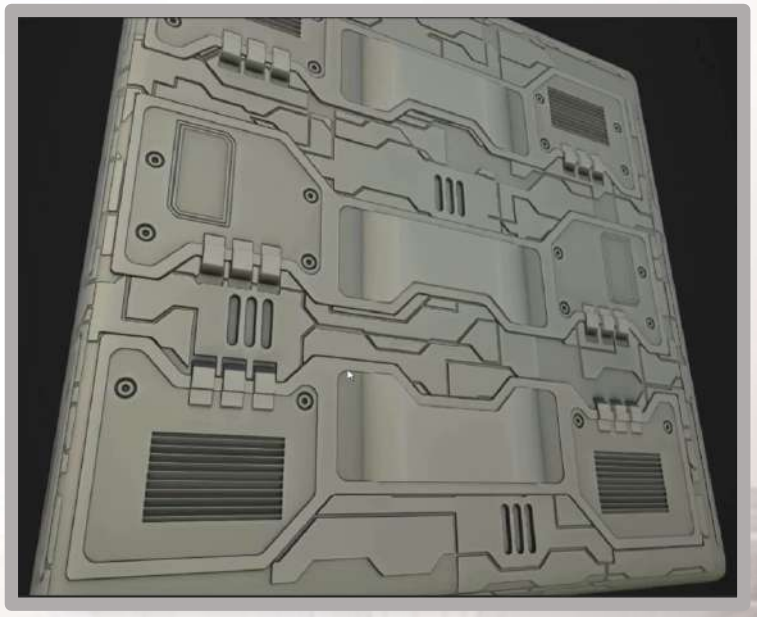
I UNDERSTAND NONE OF THIS

1. Substance 3D Designer is a **digital** node-based **compositing tool** in which you
   - ✓ **combine** artist-friendly **nodes** using noises, shapes, color correction and generators
   - ✓ **create** various **shapes** and **patterns** that fake the appearance of believable surfaces (materials)
   - ✓ **connect** nodes in a similar fashion to stacking **layers**, use **clipping masks** and **blend them together** just like you would in Adobe **Photoshop**
2. Study the previous slides, remember the map types and **look at examples** (node by node)
   - there's a Substance 3D Designer node you should check out called **bricks_001**
     - **load** it into your **graph editor** (spacebar), type **bricks_001**, right-click → **Open reference**
     - it's a **full-blown Substance** with all outputs – a great starting reference!
3. This video is the **great to understand the basics** (check it out after the lecture):
   - Substance 3D Designer First Steps: 01 - Overview & Basics

HOW WOULD I EVEN START?

- always **start** with designing the (grayscale) **height map output**! Just do it.
- height is **easy** to understand: **black** is **minimum (0.0)** height and **white** is **maximum** height **(1.0)**
- **height** information **sets** the **base** for **nearly all** other nodes / **maps**
- usually the **go-to-map** for **geometrical detail** and source for **clipping masks** (B&W = uber useful!)





SUBSTANTIAL ADVICE

Now's the time to take some nodes!

Shape Node

Generates a variety of procedural shapes, with options to modify base shapes. The shapes are always perfectly interpolated and high-precision.

The useful part: it is the building block of most procedural Heightmap generation! By combining basic shapes with transform nodes, you can create a procedural Heightmap shape that is very precise.

Directional Warp Node

The directional warp is an extremely useful node to create all sort of effects: depending on your input and your intensity mask you can create an infinite amount of patterns.

Just like with the Warp node it distorts the input image but the benefit of using the Directional Warp over the regular Warp is that you can adjust the Warp Direction.

Warp Node

The Warp node will warp the input map, according to the intensity that is set in the parameters tab.

This node can be used in combination with a lot of other nodes. Most common is beginning with a shape node or a noise generator and then adding a warp node to soften the edges of the shapes. Especially when creating rocks this node is very useful.

Gaussian Noise Node

This node generates one of the most basic, but also most useful noises, with soft, simple random blobs at a customisable scale. Another useful noise is the Perlin noise.

This is mostly used for distorting Shape nodes using the Warp node. Or to create patterns like stones when combined with a Slope Blur Grayscale node.

SUBSTANTIAL ADVICE

Slope Blur Grayscale Node
This is one of the most interesting and powerful blurs in Designer. It can be used to achieve some very interesting and unexpected effects, such as chipping and weathering edges or smearing and leaking dirt or rust.

This is because the node performs and advanced HQ directional blur using a Slope Map (Height Map-ish).

Blend Node
The blend node is one of the most important nodes of SD. It is commonly used to composite one texture over another. Then by switching between blending modes (for example like in Photoshop) the results vary.

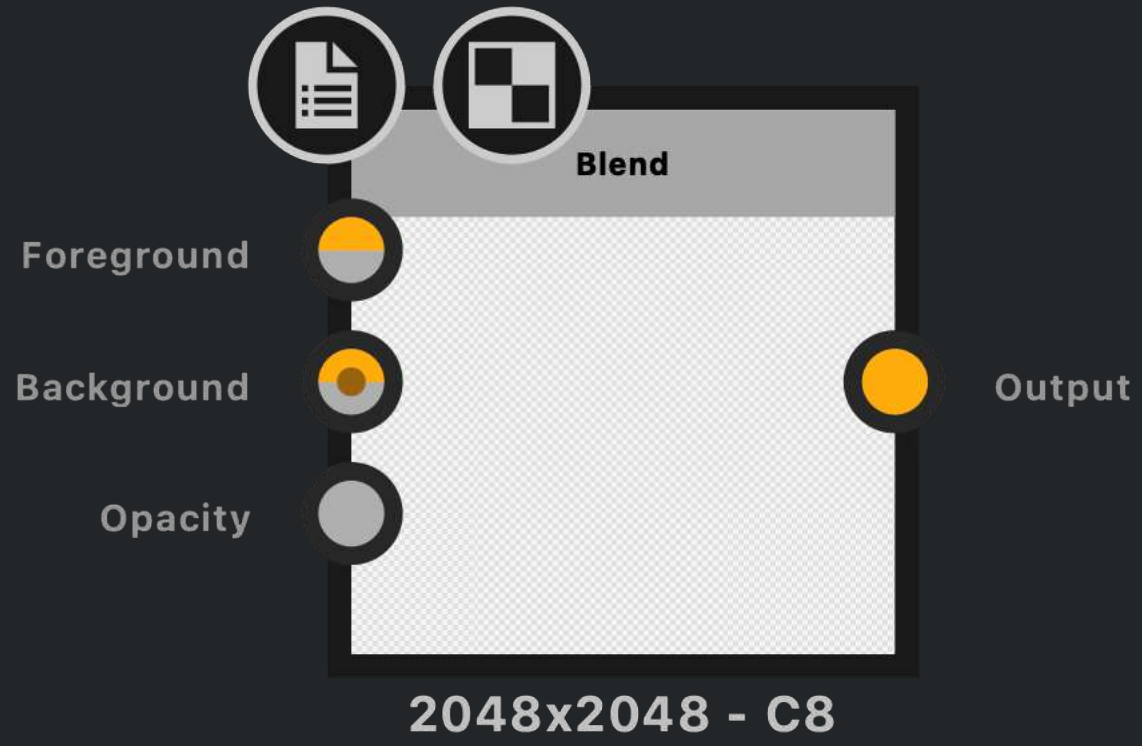
The powerful part about this node is that both Color and Grayscale inputs can be connected to the node. But both inputs have to be the same type.

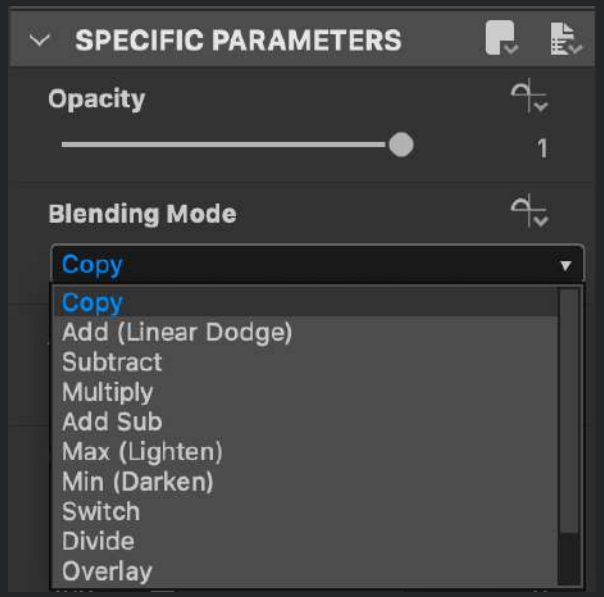
Levels
Everyone knows Levels from Photoshop.
Perfect for quick, but precise leveling of greyscale information.
Also useful for creating masks quickly.

Histogram Scan
Sort of like Levels, but more restricted. Works with 2 sliders called Position and Contrast.
Performing even faster and cleans up edges well.

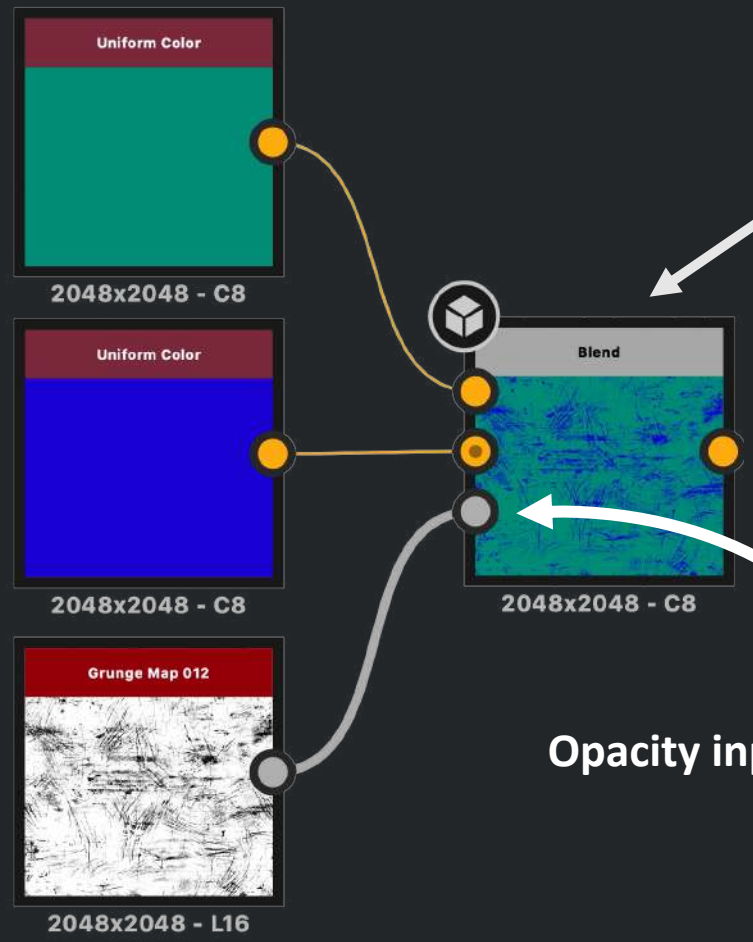
Gradient Map
The perfect node for the final Base Color output.
Lets you color pick anything, even hundreds of random colors at once.
Also used for conversions.

BLENDING IN NICELY





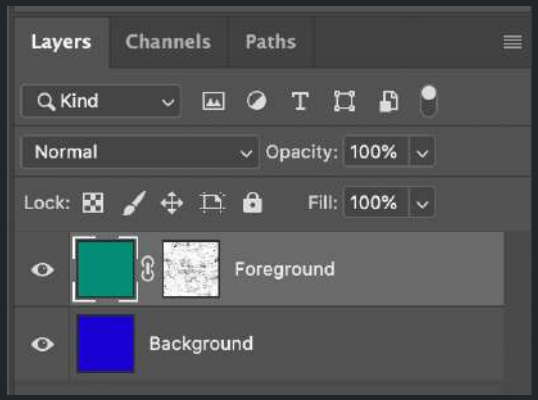
BLENDING IN NICELY



Designer is just like Photoshop.

Ds

Ps

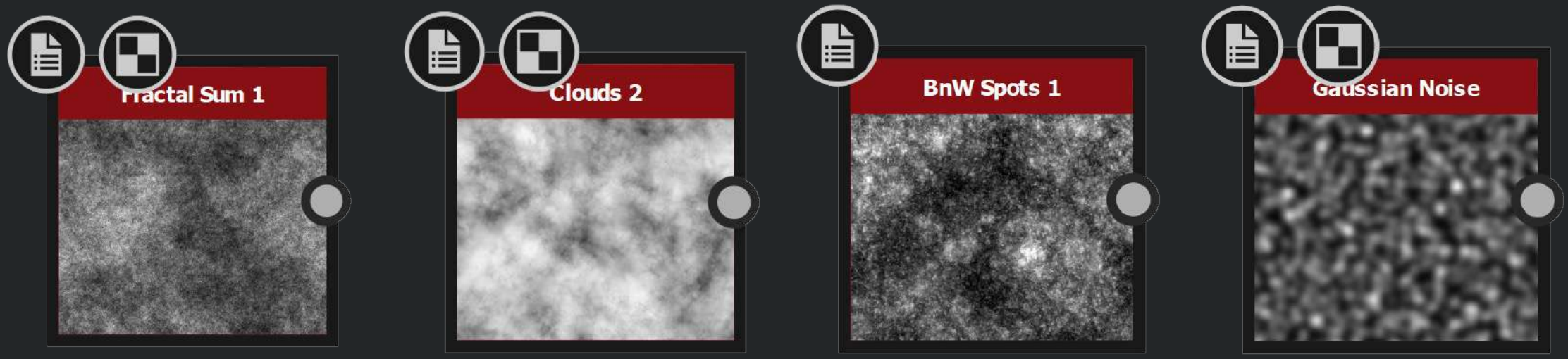


Opacity input acts as layer **mask**

Regular **layer stack** + layer **mask**

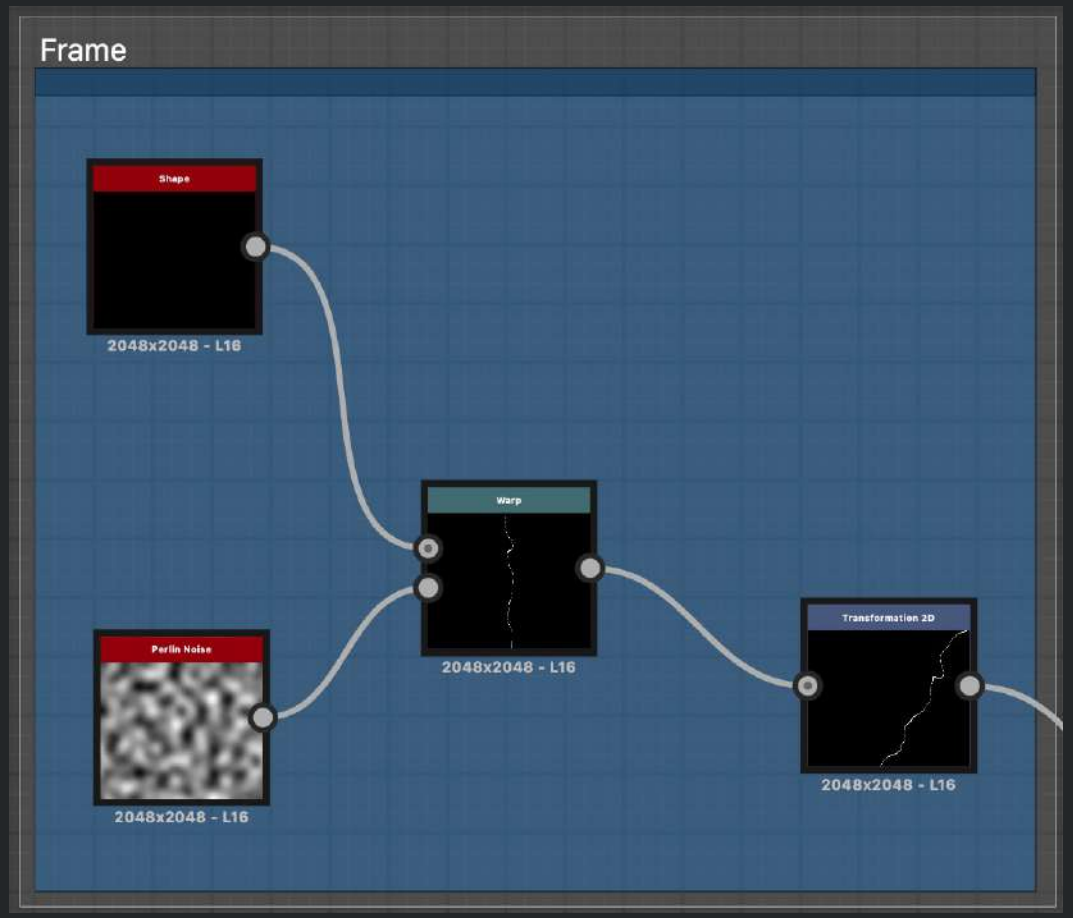
MAKE SOME NOISE

Do an experiment by adding these types of noises into a height map output. Experiment with the sliders.



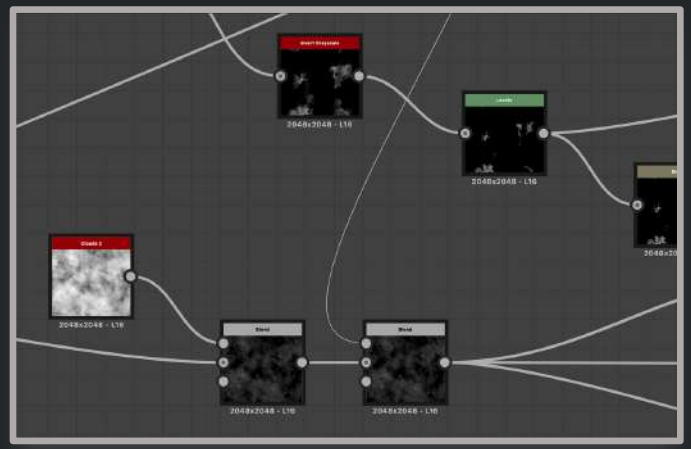
SUBSTANTIAL ADVICE

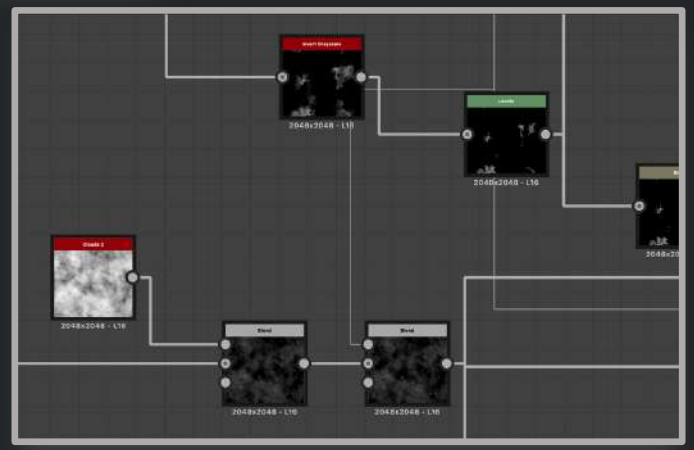
Clean up after yourself!
Select a set of nodes, hit spacebar, type in ‘Frame’ to unite them via a newly created, colored frame for a better overview.
Don’t forget to give descriptive titles afterwards, e.g. ‘Height’, ‘Pebbles’, ‘Planks’, ’Microsurface detail’ etc.
Consider establishing different colors for different kinds of map types or distinct parts of your material.
Tip: Alt- or Option-click on a link (noodle) and shape/move it the way you want it.



SUBSTANTIAL ADVICE

Spaghetti no(o)d(l)es!
Sometimes it’s hard to see how certain nodes are connected to others or you’re simply tired of moving nodes to the side for a better overview. Hit this tiny button on the very top of SD’s UI.





REACHING NEW HEIGHTS

Tile Sampler

THE generator node for literally **anything** you can make in terms of man-made **shapes**.
It's a great tile generator on steroids with many unique input types.

Flood Fills

Generates interesting **gradients** for different purposes to bump up the realism in **Height** information.
Worth looking up:

1. Flood fill to **Gradient**
2. Flood fill to **Grayscale**
3. Flood fill to **random Color**

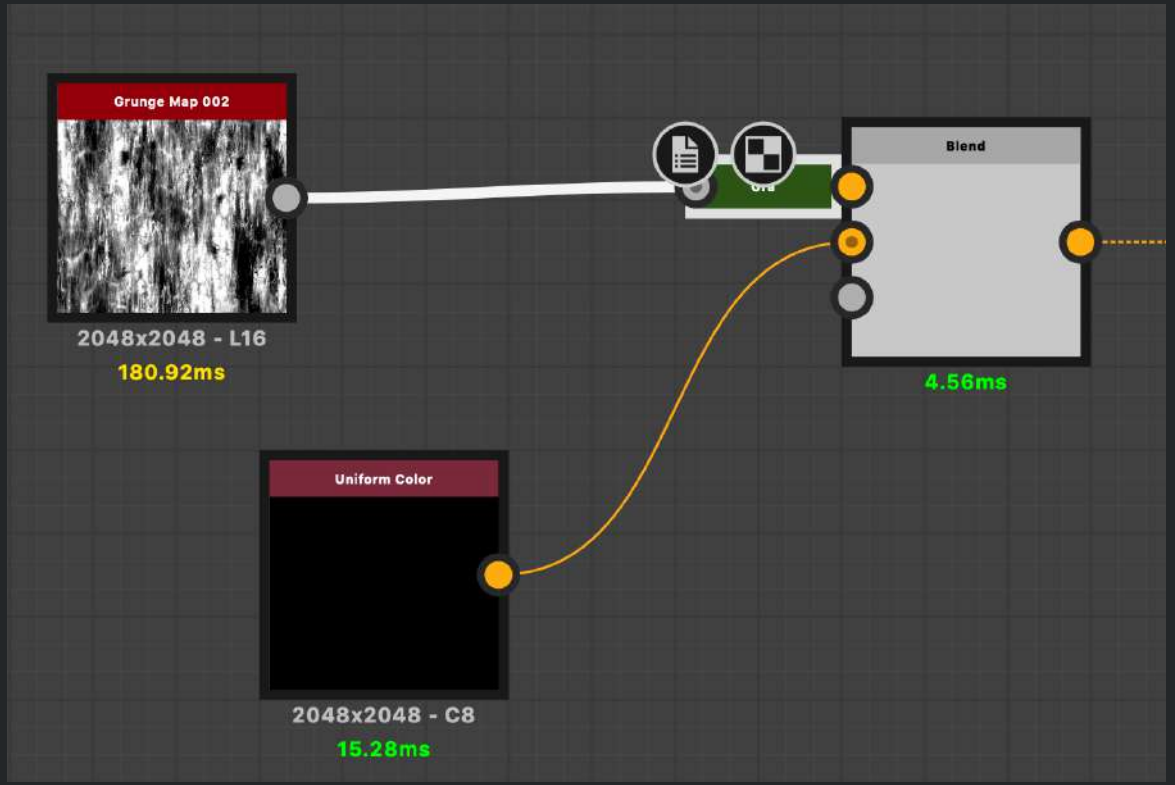
Curve (Node)

Great node for carving out shapes like window frames, doors and other interesting straight patterns and lines.
Works also well on Sci-Fi panels and other wall covering.

HONORABLE MENTIONS

Docking nodes
For the more common nodes that enable color correction and conversion such as Levels, Gradient Maps, Histogram Scan/Range, it is useful to dock these nodes for a cleaner node-flow.

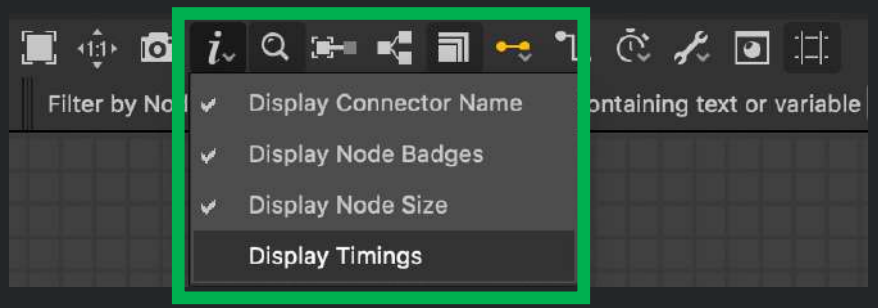
Hit D on your keyboard to dock a node to another one.

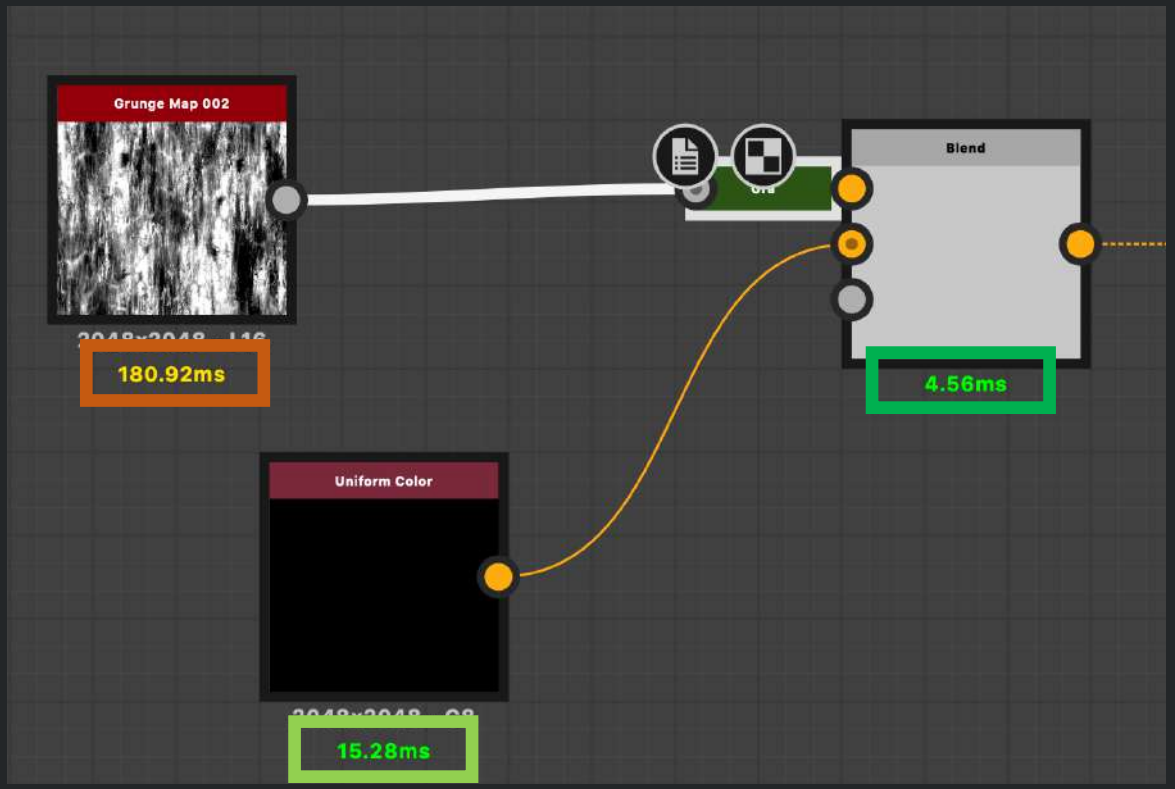


HONORABLE MENTIONS

Display the render time

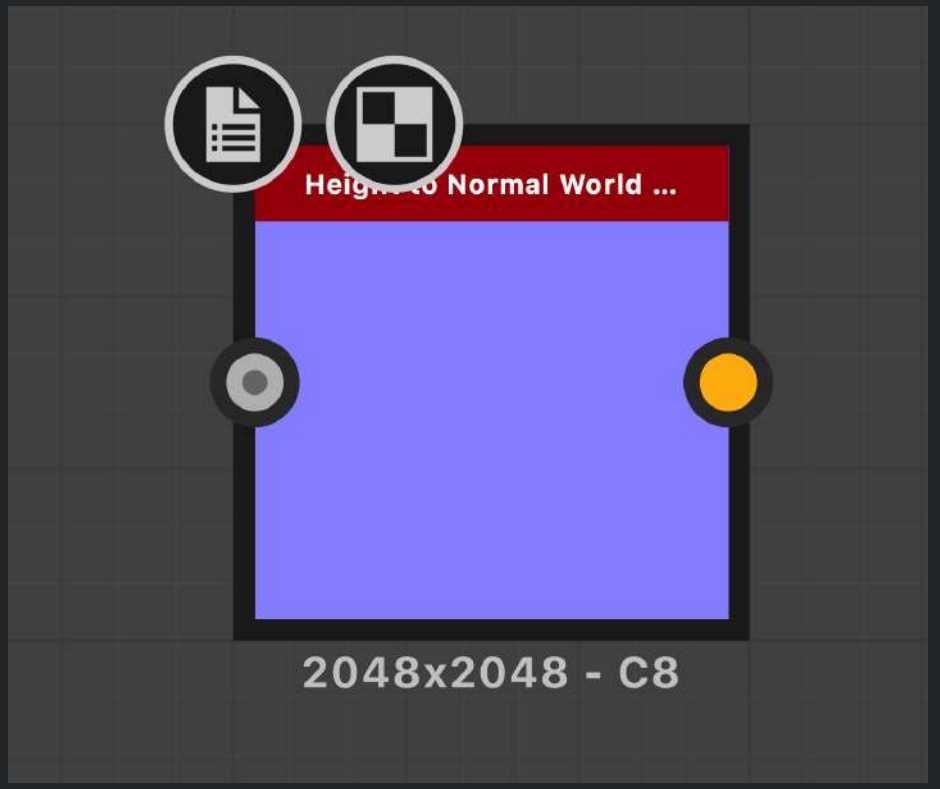
If you want to get the most out of your substances, optimize the nodes by using the least possible amount (and the lightest ones). Try to avoid heavy ones as much as possible, especially if you want to use a substance with real-time change of parameters in mind.



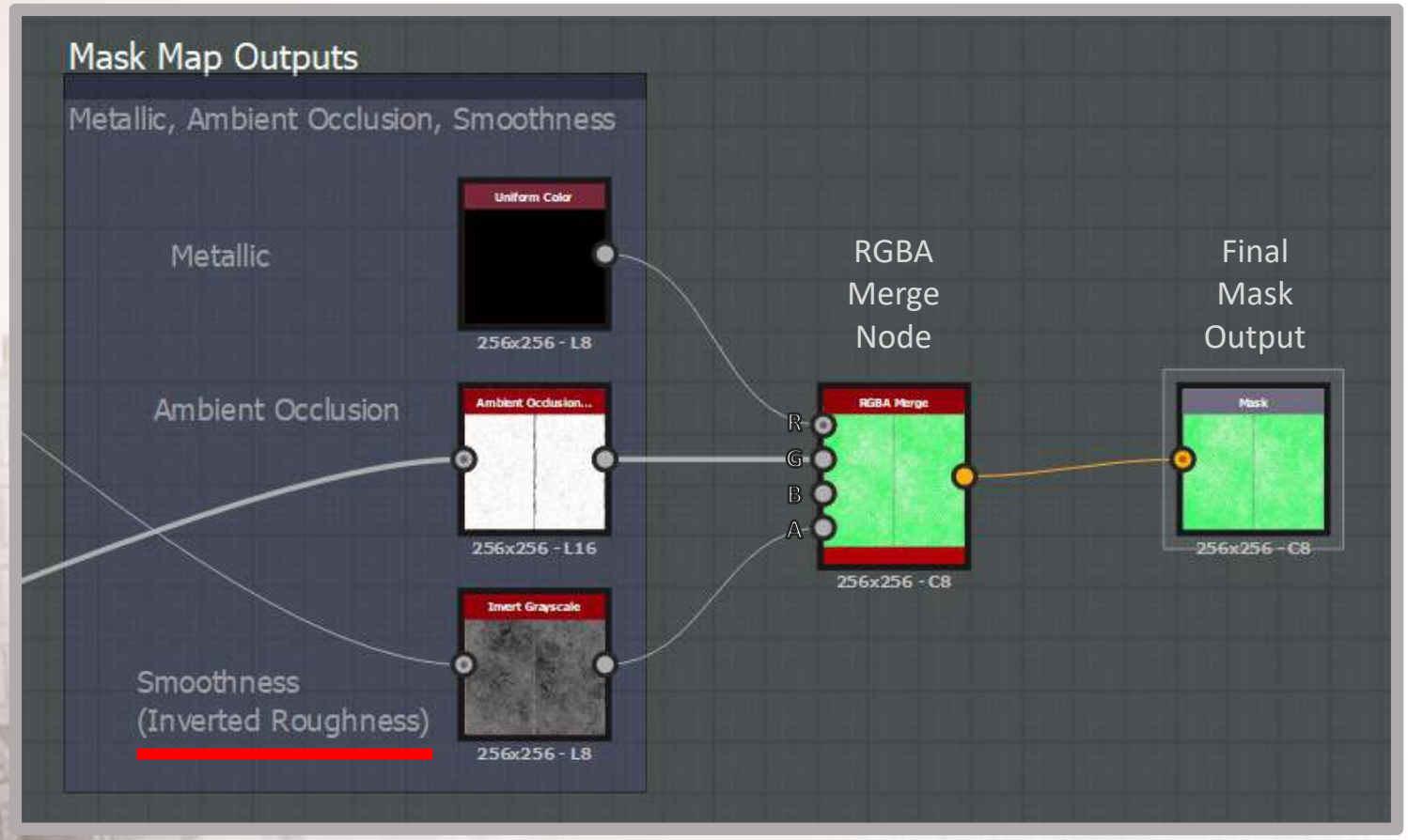


HONORABLE MENTIONS

Going from height to normal?
Do not use the regular normal-node for height-map conversion. Whenever your height map information is done, resist the urge! Search for ‘height to’ and use the ‘**Height to Normal World Units**’ node eventually. It has more parameters and overall better-looking results for a proper normal map relief.



ONE MAP TO (POTENTIALLY) SCREW THEM ALL



Mask Map Output setup for the URP & HDRP in case you're running into problems.

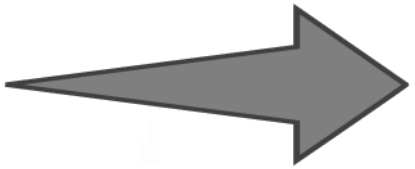
The manual **setup** in Designer is usually **only necessary** for **older Unity-** and '**Substance in Unity**' plugin versions (Unity 2019.3 and lower).

Your final **Metallic**, **AO** and **Roughness** all need to be put into the respective slots of a so-called **RGBA Merge Node** and then into a manually created **Output** set to type **Mask**.

Note: Unity requires a **Smoothness** map, which is your final **Roughness** output simply **inverted** (invert grayscale).

In recent versions of Substance 3D Designer, the plugin and Unity **don't require** the **user** to **do anything** and it should be fine, theoretically.

LET‘S GET CONCRETE



Link to Blackboard’s substance resources page:
https://leren.saxion.nl/webapps/blackboard/content/listContent.jsp?course_id=_45231_1&content_id=_3245032_1

Workflow

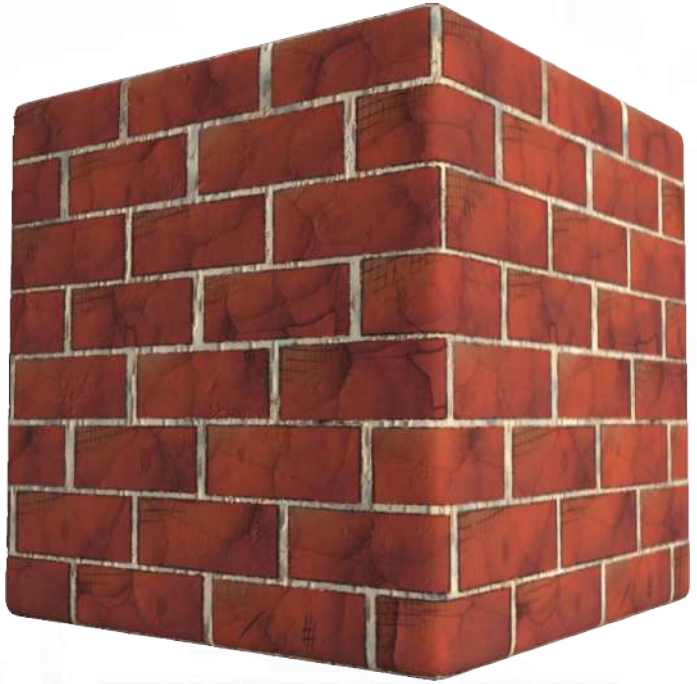
LET‘S GET CONCRETE

Workflow

NODE-WORTHY REFERENCE

Freebies from us

A_Concrete_Foundation.sbs



BrickWall_Stylized_TheDarknessII.sbs

+ Pure_Rust.sbs

Metal_Rusty_Wallpanels.sbs

https://leren.saxion.nl/webapps/blackboard/content/listContent.jsp?course_id=_45231_1&content_id=_3245032_1

Fully commented substances for reference and use in your scene!

Workflow

NODE-WORTHY REFERENCE

Freebies from us

Coming to Blackboard soon as yet another reference material!

Concrete_Wall_Heavy_Damage.sbs

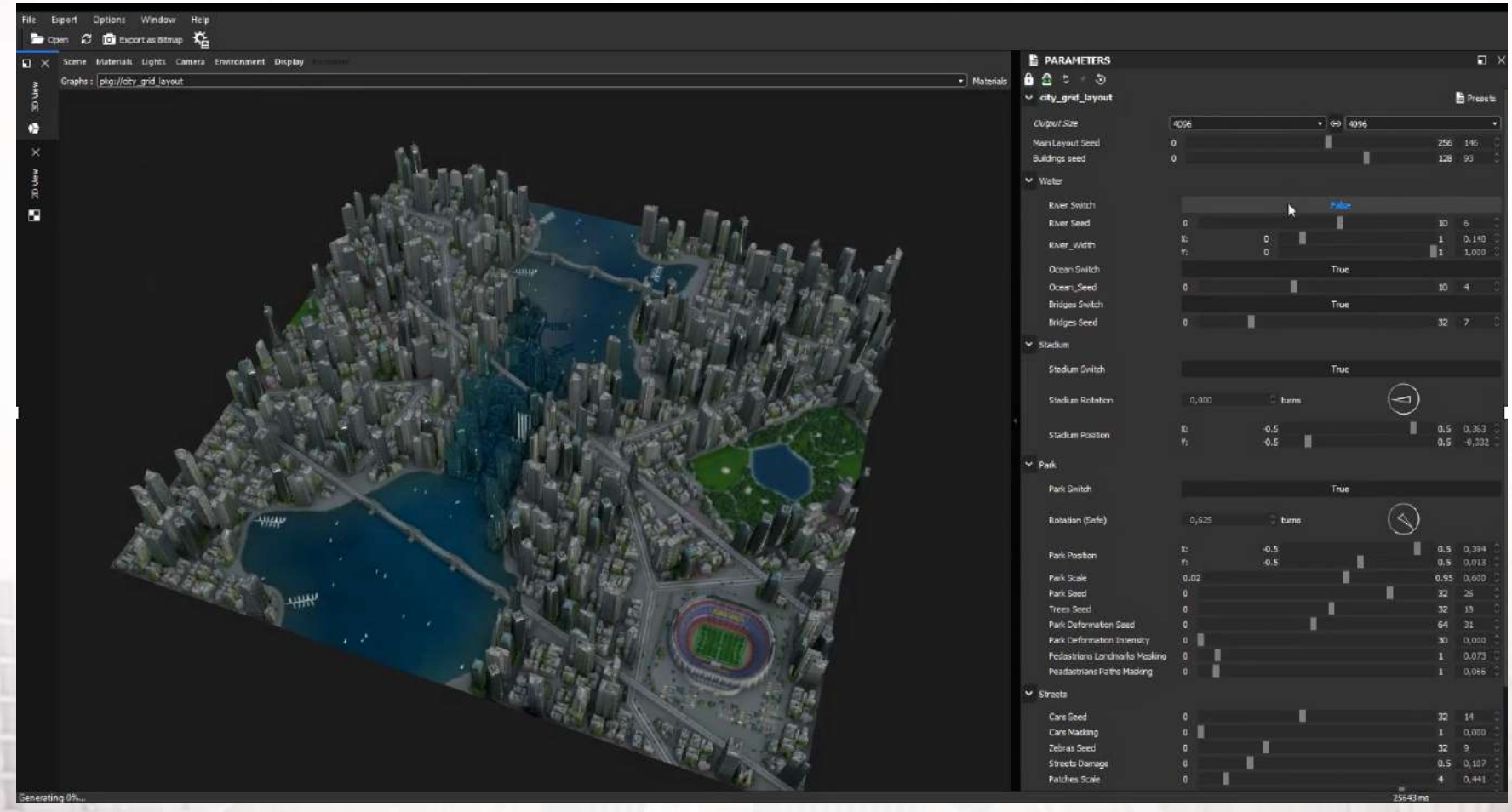
Resources

REFERENCE LIST

- The High Definition Render Pipeline: Getting Started Guide for Artists – Unity Blog. (n.d.). Retrieved from https://blogs.unity3d.com/2018/09/24/the-high-definition-render-pipeline-getting-started-guide-for-artists/.
- Substance Academy (n.d.). Retrieved from https://academy.substance3d.com/
- *Technologies, U. (n.d.). Optimizing graphics performance. Retrieved from https://docs.unity3d.com/Manual/OptimizingGraphicsPerformance.html.*
- *10 power tips for Substance Painter and Substance Designer. (n.d.). Retrieved from https://www.gnomon.edu/blog/10-power-tips-for-substance-painter-and-substance-designer.*
- *The PBR Guide - Part 1 on Substance Academy. (n.d.). Retrieved from https://academy.substance3d.com/courses/the-pbr-guide-part-1.*
- *The PBR Guide - Part 1 on Substance Academy. (n.d.). Retrieved from https://academy.substance3d.com/courses/the-pbr-guide-part-2*
- Substance for Unity by Allegorithmic. (n.d.) Retrieved from *https://learn.unity.com/tutorial/substance-for-unity-by-allegorithmic#*

Node-worthy share

WHO NEEDS SCRIPTING ANYWAY?



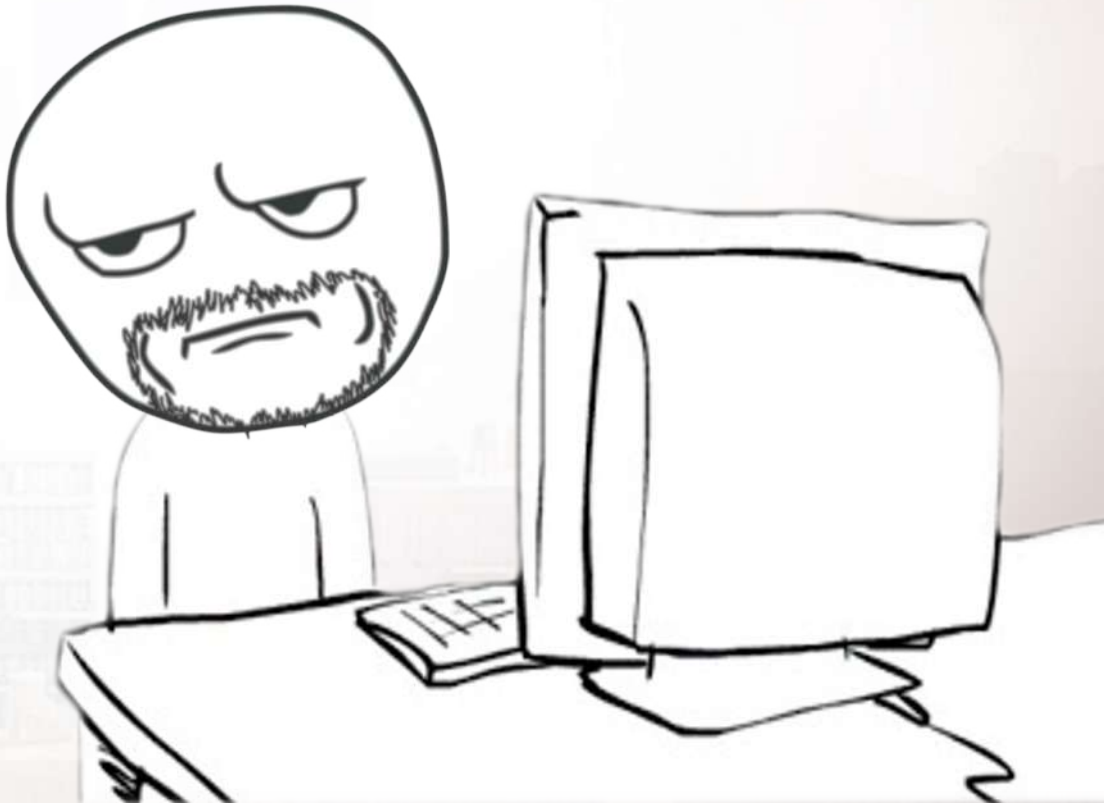
https://youtu.be/pMQc3dFbHIs

Node-worthy share

WHO NEEDS SCRIPTING ANYWAY?

JUST KIDDIN‘!

LEARN AND PRACTICE SCRIPTING!



See you in the next lab!