UNITY FOR GAMES

E-BOOK

Image by Pete Mc Nally – Made with Unity

Get ready for photogrammetry

A beginner's guide to scan clean-up with Unity ArtEngine
Learn how you can use scanning workflows such as photogrammetry to create stunning 3D assets that breathe life into your game, movie or other creative projects.

unity

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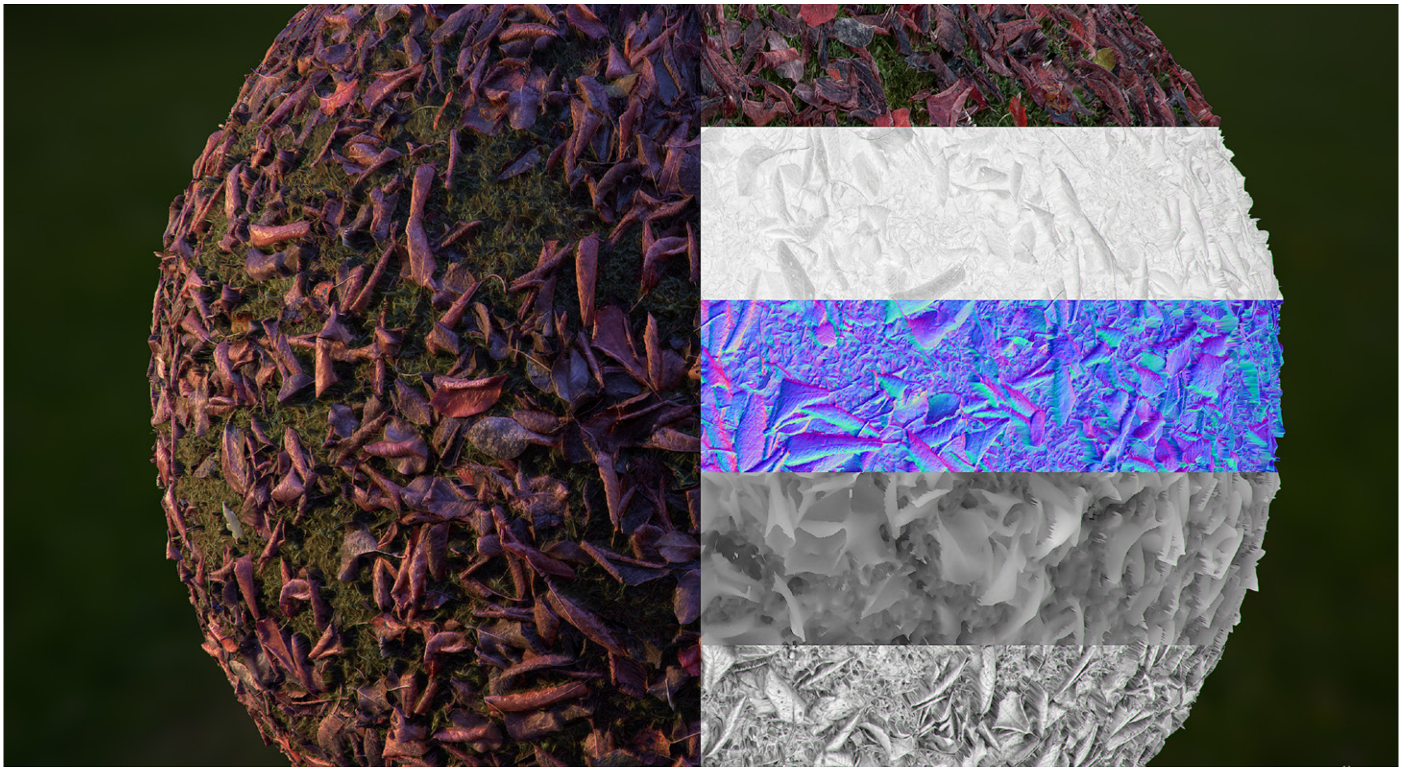
What’s inside

The word “photogrammetry” is intimidating at first glance. You can be forgiven for thinking it defines something complicated and uncomfortable, but the truth is that it can be an artist’s friend.

Photogrammetry is the process of turning real-world objects and environments into digital assets from photographs. It’s been around since the mid-nineteenth century, nearly as long as photography itself, and was first used for mapping and topography. Since then, unsurprisingly, it’s evolved from a purely analog process to a digital operation. Its measurements, algorithms, calculations, and clean-up – all the complicated stuff – are now handled by applications like ArtEngine.



Grass leaves, by Pete Mc Nally

Chapter one

Surface photogrammetry

Want to repurpose your cat's fur into a digital shag carpet?
Well, now you can.

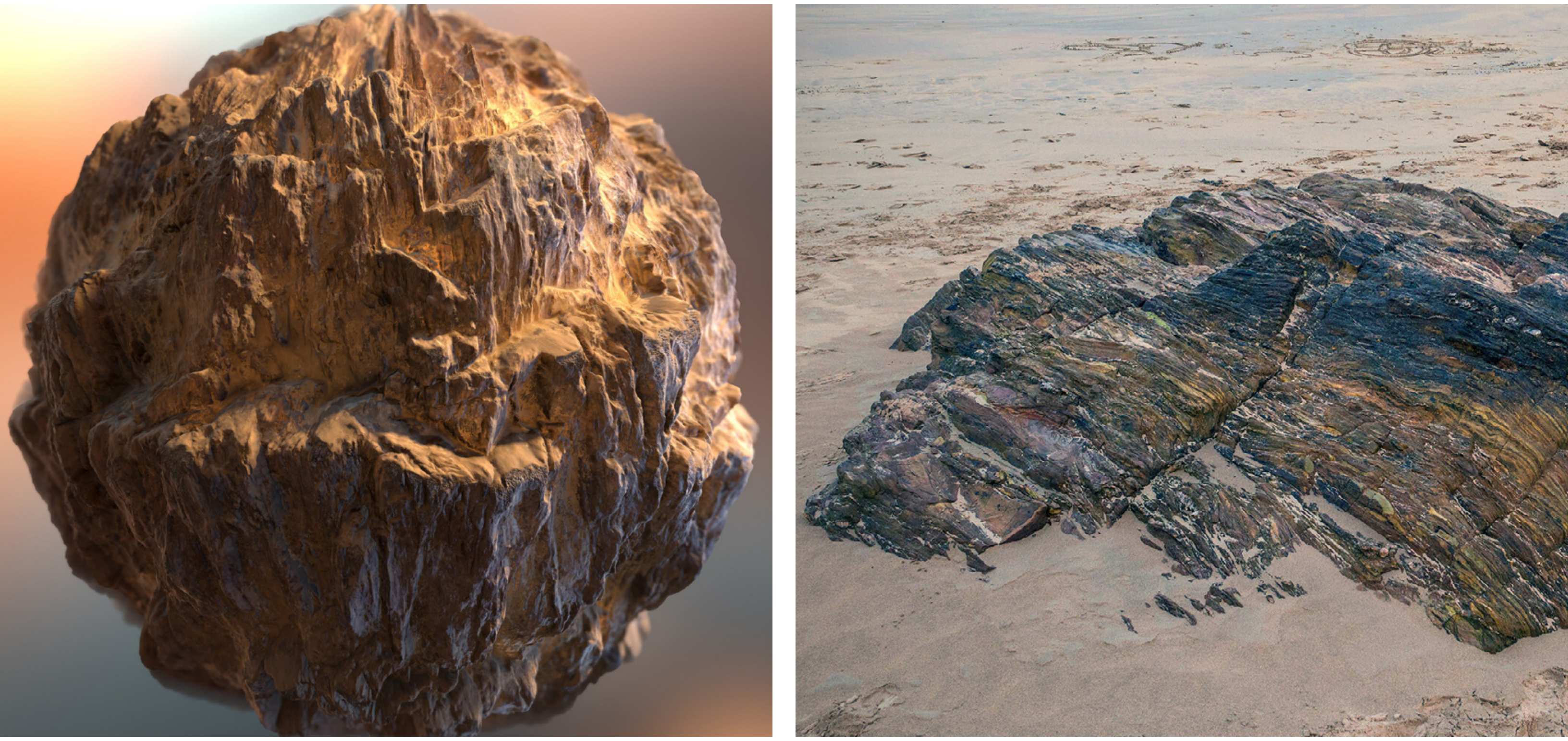
Getting started in photogrammetry, there are a few approaches to creating high-quality digital assets using photos of real-world objects. Surface photogrammetry refers specifically to the digitization of a flat plane, such as a patch of forest floor or stretch of pebbly beach, into a tileable material.

Grass leaves, by Pete McNally

Alexandre Rodrigue created environmental assets for *Far Cry: New Dawn* by leveraging photogrammetry.

Unity ArtEngine is a tool that helps you create ultra-realistic materials for your game, movie or any other digital art project. ArtEngine augments surface photogrammetry workflows by leveraging AI to help you quickly delight, remove seams, eliminate unwanted artifacts, and generate your full PBR material for use in Unity or your 3D program of choice. And anyone who has created 3D assets knows that less time spent fretting over a material that won't tile using traditional methods means more time focusing on the creative and artistic threads of your workflow.

Photogrammetry can be complex, and this e-book only covers the tip of the iceberg. But by its end, you'll see how even amateur snaps taken on your phone can yield slick, professional-looking results. If you'd like to dive deeper, we invite you to head over to the Unity Photogrammetry Hub, where you can read up on more advanced topics, such as those in this detailed field guide, and learn how companies like NVIDIA are using ArtEngine to digitize materials at scale.



Pete Mc Nally made a tiling canyon rock material (*left image*) by scanning a boulder (*right image*).

Chapter two

How photogrammetry powers creativity

ArtEngine is designed for artists of all skill levels, from professional movie editors to hobbyist game devs.

Dave Riganelli, a technical art director at Ubisoft Toronto, tends a digital garden of the kinds of artistry achievable with photogrammetry and photometric stereo scanning.

Riganelli is savvy about the versatility of photogrammetry. He explains how the technique has quickly gained popularity in video games:

> As recent as five years ago, photogrammetry wasn't mainstream. It was mostly reserved for characters, and it was done by specialized outsourcers. The first game that used it on a large scale was *Star Wars: Battlefront*, where they scanned all their terrain and organic assets. *Battlefront* was proof you could use scanning in a production pipeline, and it became the standard everyone looked up to. After that, more studios began adopting photogrammetry, and now it's pretty common.

But Riganelli also notes that photogrammetry isn't reserved for AAA game projects and blockbuster movies. "Scanning has never been easier to get into, and you can start today with equipment you have at home right now," he says.

A digital twin of a hockey glove, created by Dave Riganelli using 110 images taken around a turntable.

Pete Mc Nally, a 3D artist at Emmy Award-winning Havok (acquired by Microsoft several years ago), is another creator whose photogrammetry work inspires big ideas. From craggy stone textures to dry bark tiles that look realistic enough to give you a splinter, his gallery is a testament to the visual sorcery of photogrammetry.

Mc Nally became interested in game development while making graphics for a game. At the time, creating game graphics, especially in 3D, wasn't easy, and it wasn't terribly accessible, either.

"Back when I started, you were buying perpetual licenses for everything. There was quite a heavy cost to get started. You were looking at a couple of grand for 3ds Max or Maya," he recalls. "You couldn't really make a game without having a publisher on board to front some of the costs."

Inspired by the autumn colors, Pete Mc Nally used 48 photographs to create this leafy material.

Mc Nally is also happy to see AI-based material authoring software like ArtEngine gaining popularity. Developing graphics for games wasn't just expensive when he started out – it was also intensely time consuming. AI-based artistry does away with much of that slow, tedious process.

> *"I'm for anything that frees me up with more time to be creative, I get twice as much work done in one day by utilizing AI."*
>
> — Pete Mc Nally, 3D artist, Havok

The ArtStation gallery belonging to Montreal-based Ubisoft artist Alexandre Rodrigue showcases earthen textures like dirt, roots and pebbles. He used some of these "dirty" textures when designing environments for the 2019 first-person shooter game *Far Cry: New Dawn*. Rodrigue's gallery is a great example of photogrammetry's versatility – and, by extension, ArtEngine's ability to make this creative approach more accessible.

Rodrigue recalls how ArtEngine helped him process textures for Ubisoft's upcoming *Far Cry 6*, saying "it saved my life during that production." He has particular praise for ArtEngine's seam removal node, which he says spared him a great deal of work and tedium compared to making realistic landscape textures without the aid of AI. "A job that usually takes a couple of months was done in three weeks," he explains.

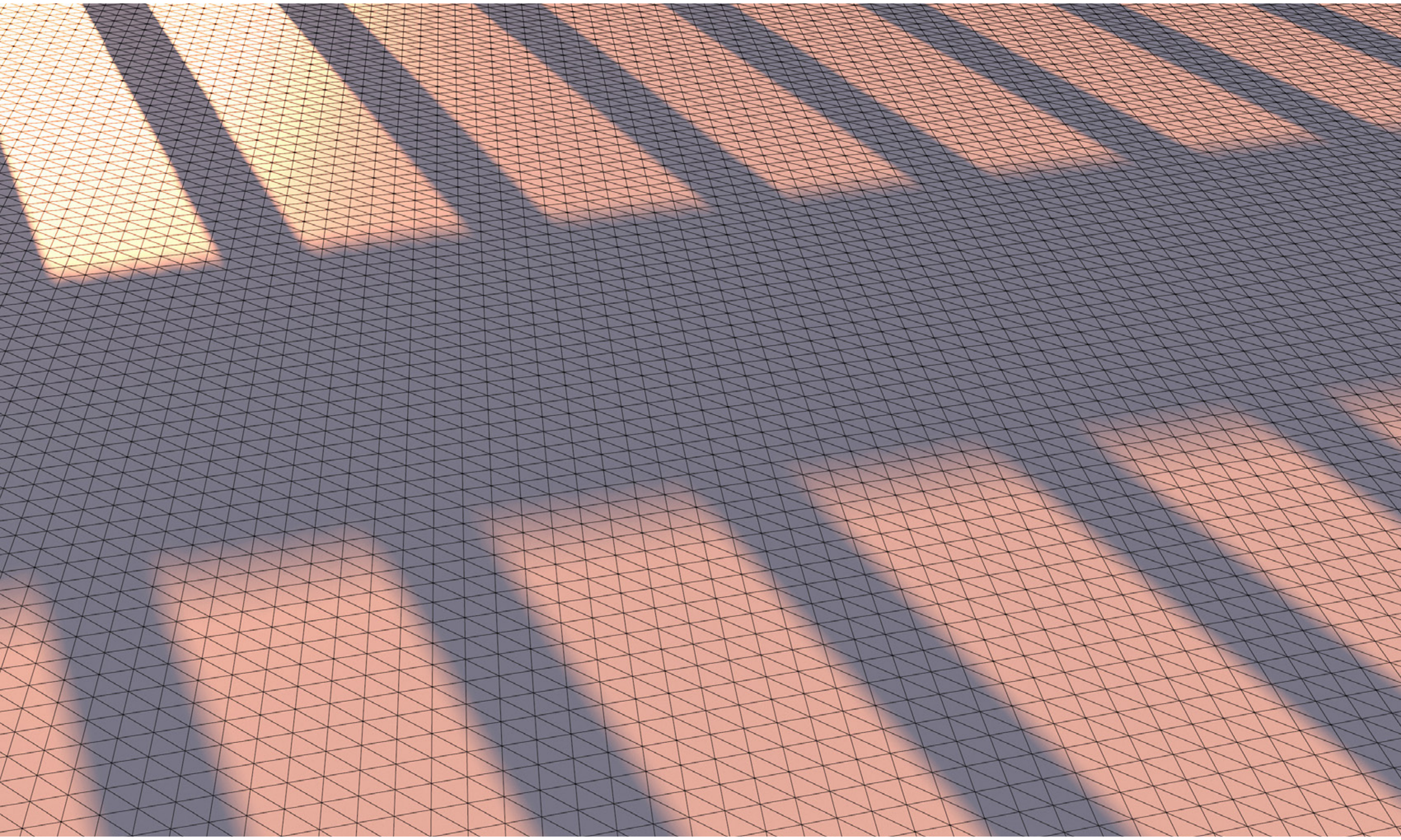
Part of the *Far Cry: New Dawn* biome team, Alexandre Rodrigue created environments using a hybrid approach that mixed scan data with procedural workflows.

Chapter three

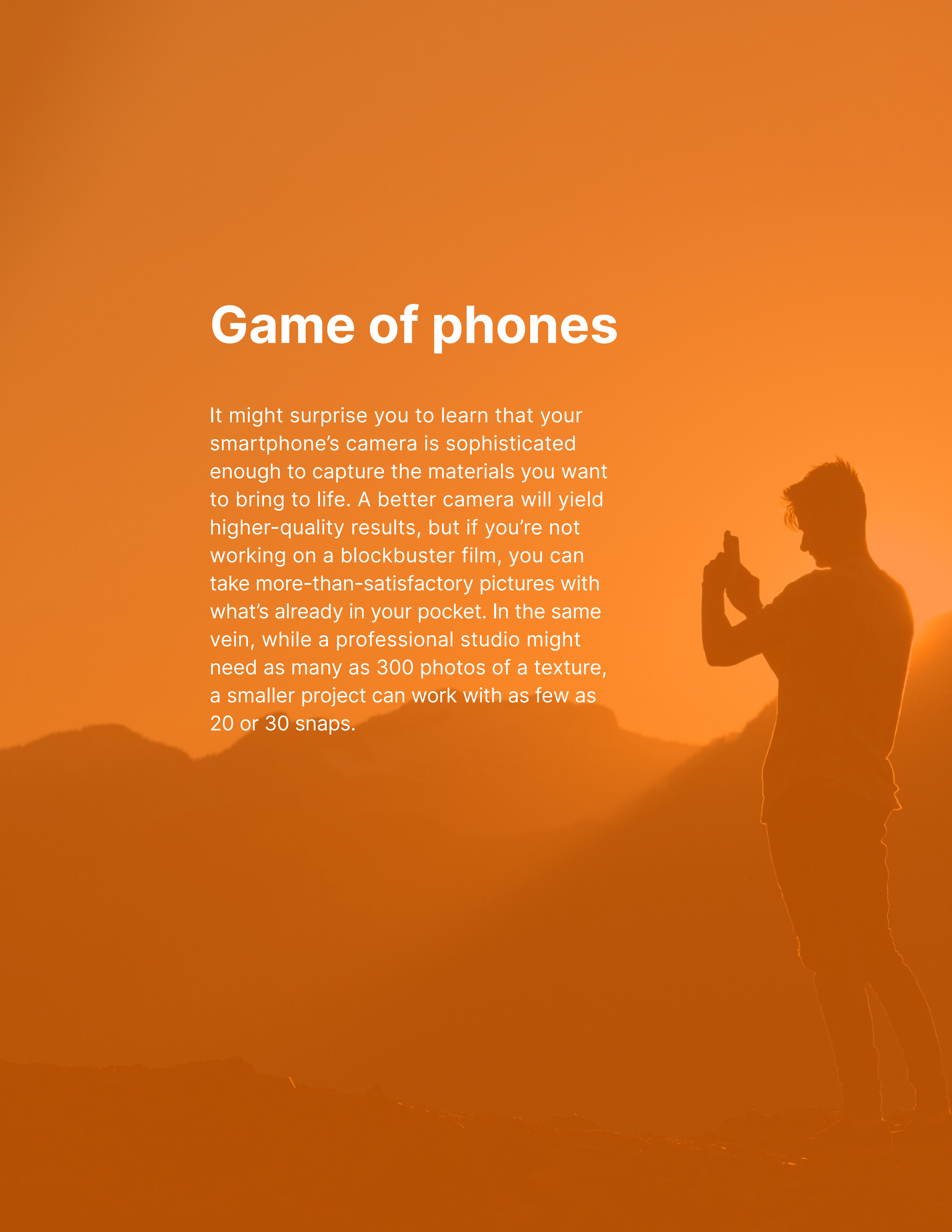
Digitization tips

The first step? Capturing your chosen surface in enough detail that you can start on the digitization process. You don't need a lot of fancy samples and high-tech gadgets, but these rules of thumb will help you achieve great results.

The steps below detail one possible, tried-and-true photogrammetry workflow, but you can also use photometry or single images to capture your subject before bringing it into ArtEngine.



A tessellated plane, necessary for displacement from a height map, by Pete Mc Nally.



Game of phones

It might surprise you to learn that your smartphone's camera is sophisticated enough to capture the materials you want to bring to life. A better camera will yield higher-quality results, but if you're not working on a blockbuster film, you can take more-than-satisfactory pictures with what's already in your pocket. In the same vein, while a professional studio might need as many as 300 photos of a texture, a smaller project can work with as few as 20 or 30 snaps.

Gloomy days rule

Creating 3D assets with photogrammetry eliminates the need for a studio and special lighting. It’s best to film on an overcast day so harsh shadows don’t interfere with importing and editing textures. Note that it’s also a good idea to avoid photographing reflective textures, including wet surfaces. Indoor photography is also fine, as long as your photos aren’t taken in direct lighting, which can create shadows and reflections that make it hard to stitch the final vision together.

Shoot to kill it

Scout the area with the texture you want to capture, and get to it. Take photos that are perpendicular to the surface, and try to have a 70% to 80% overlap with each snapshot. Grab as many pictures as you need – again, more photos yield better output – but you don't have to go bananas if you're not working on a top-tier blockbuster project.

Any decent camera will give you perfectly usable images right off the bat, so feel free to use your phone if that's what you're most comfortable with. If you're using a DSLR (digital single-lens reflex camera) and want your digital asset to match the real-world object and its colors as closely as possible, shoot in RAW mode and consider using a ColorChecker Passport or white balance card.

Image by Victor Kam

Chapter four

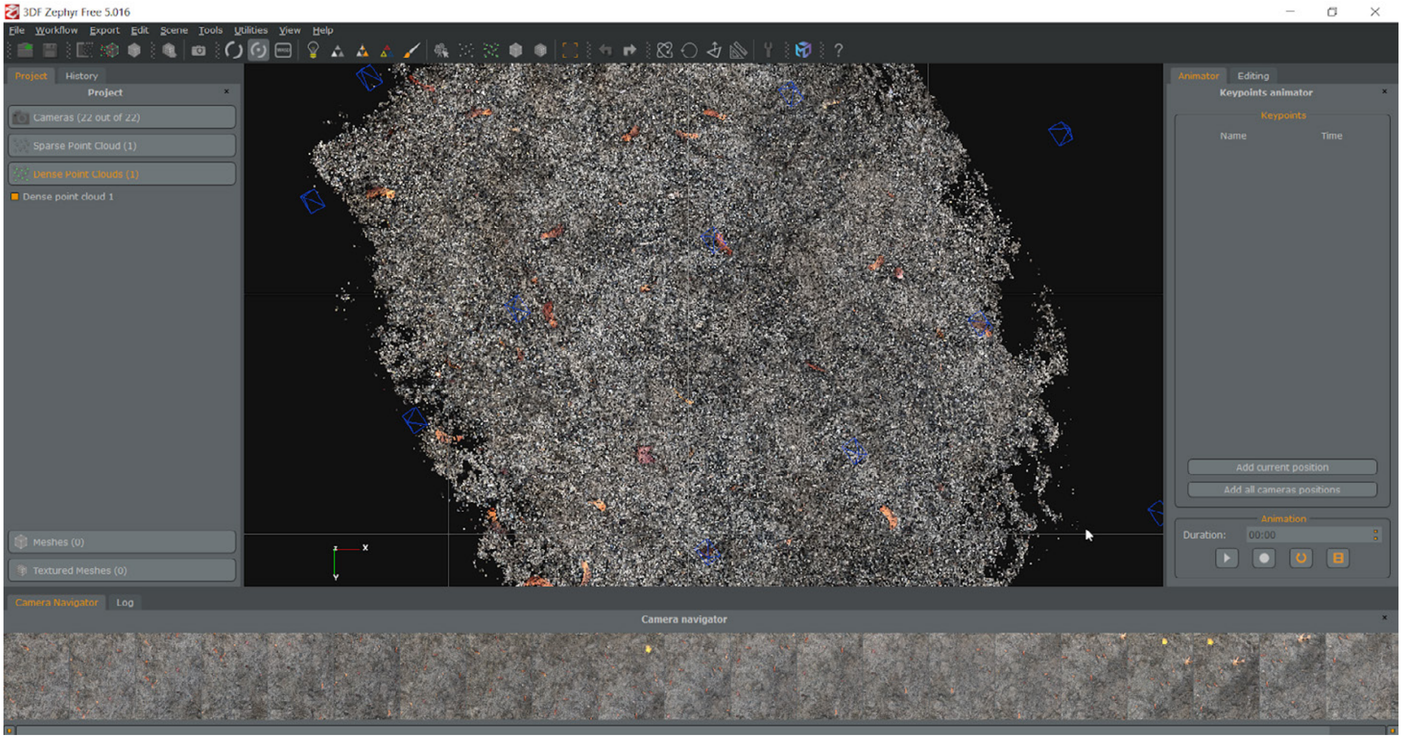
Let’s get (a little) technical

Once you’ve captured your textures, the digital twinning process begins. With ArtEngine and a few other tools, you’ll be creating realistic 3D assets in no time (and maybe even have a little fun along the way).

1. Preparing your work: Reconstruction and baking

As an optional first step, you can color correct your photos using software like Lightroom or PhotoLab.

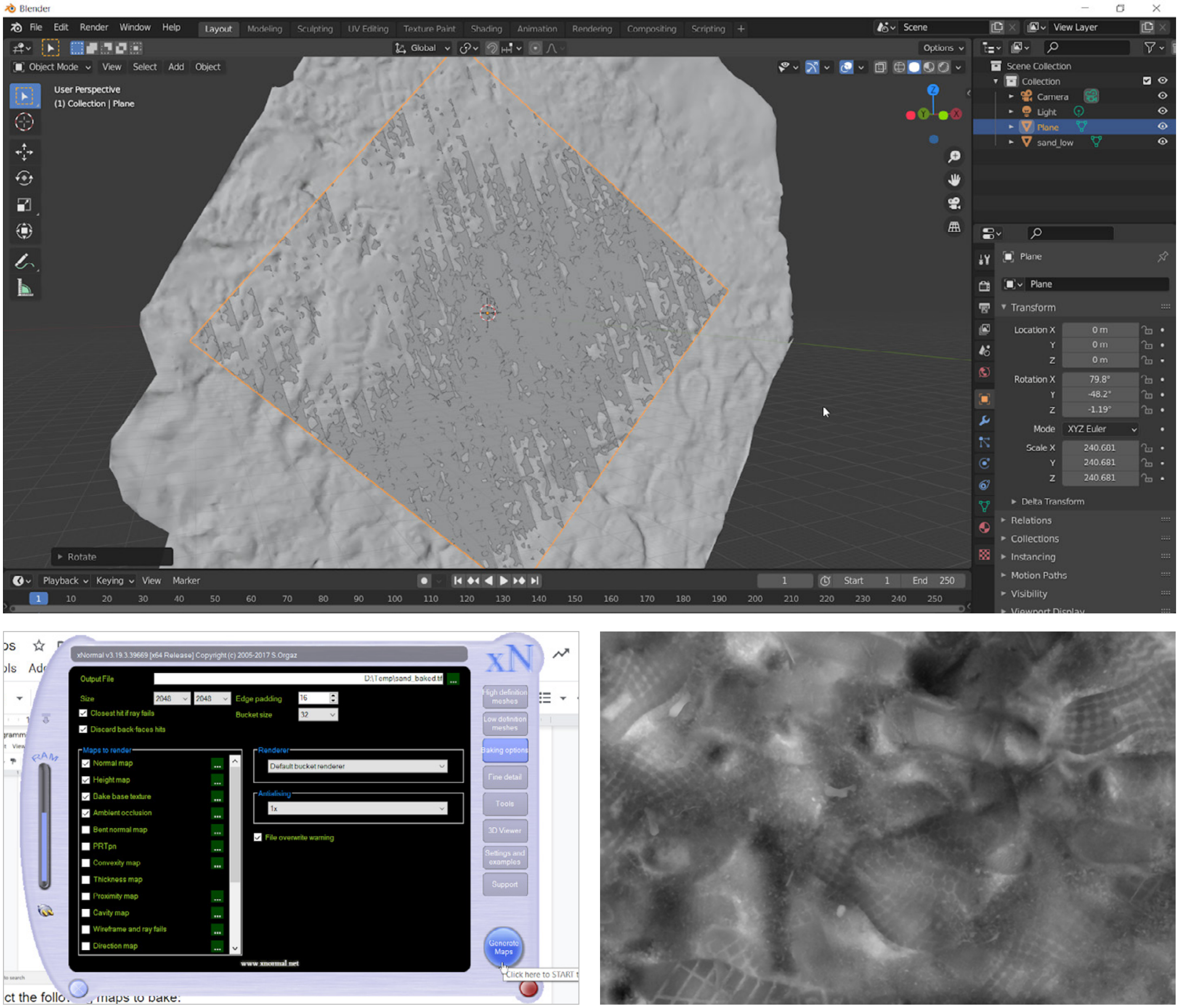
Next, you’ll need to reconstruct the pictures you’ve taken using photogrammetry software. In other words, you need to restore the depth information that’s lost when you take a 2D picture of a 3D object. Two good, free reconstruction options are the open source Meshroom and 3DF Zephyr Free applications.



Next, you will need to create a baking plane. This involves outputting your reconstructed mesh into a 3D graphics workspace and building a simple surface onto which you can project details. Again, there are many software toolsets for this purpose: Blender is a good choice that's free, while professional for-pay options include Maya and 3ds Max.

When your 3D reconstruction and baking plane are assembled, you're ready to bake. Load your reconstruction and plane into a baking software (xNormal is one free option), and bake the required maps.

Pay special attention to your Albedo and Height maps. Albedo (i.e., color) is difficult to recreate from scratch. Other maps, including Normal and Ambient Occlusion, can be derived from your Height map and recomputed in ArtEngine.


Blender
File Edit Render Window Help
Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Rendering Compositing Scripting
Scene
View Layer
Object Mode View Select Add Object
Global
Options
User Perspective
(1) Collection | Plane
Scene Collection
Collection
Camera
Light
Plane
sand_low
Rotate
Playback Keying View Marker
Start 1 End 250

Plane

Transform

Location X	0 m
Y	0 m
Z	0 m
Rotation X	79.8°
Y	-48.2°
Z	-1.19°
Mode	XYZ Euler
Scale X	240.681
Y	240.681
Z	240.681

xNormal v3.19.3.39669 [x64 Release] Copyright (c) 2005-2017 S.Orgaz

Output File D:\Temp\sand_baked.tif

Size 2048 2048 Edge padding 16

☑ Closest hit if ray fails Bucket size 32

☑ Discard back-faces hits

Maps to render
- ☑ Normal map
- ☑ Height map
- ☑ Bake base texture
- ☑ Ambient occlusion
- □ Bent normal map
- □ PRTpn
- □ Convexity map
- □ Thickness map
- □ Proximity map
- □ Cavity map
- □ Wireframe and ray fails
- □ Direction map

Renderer: Default bucket renderer

Antialiasing: 1x

☑ File overwrite warning

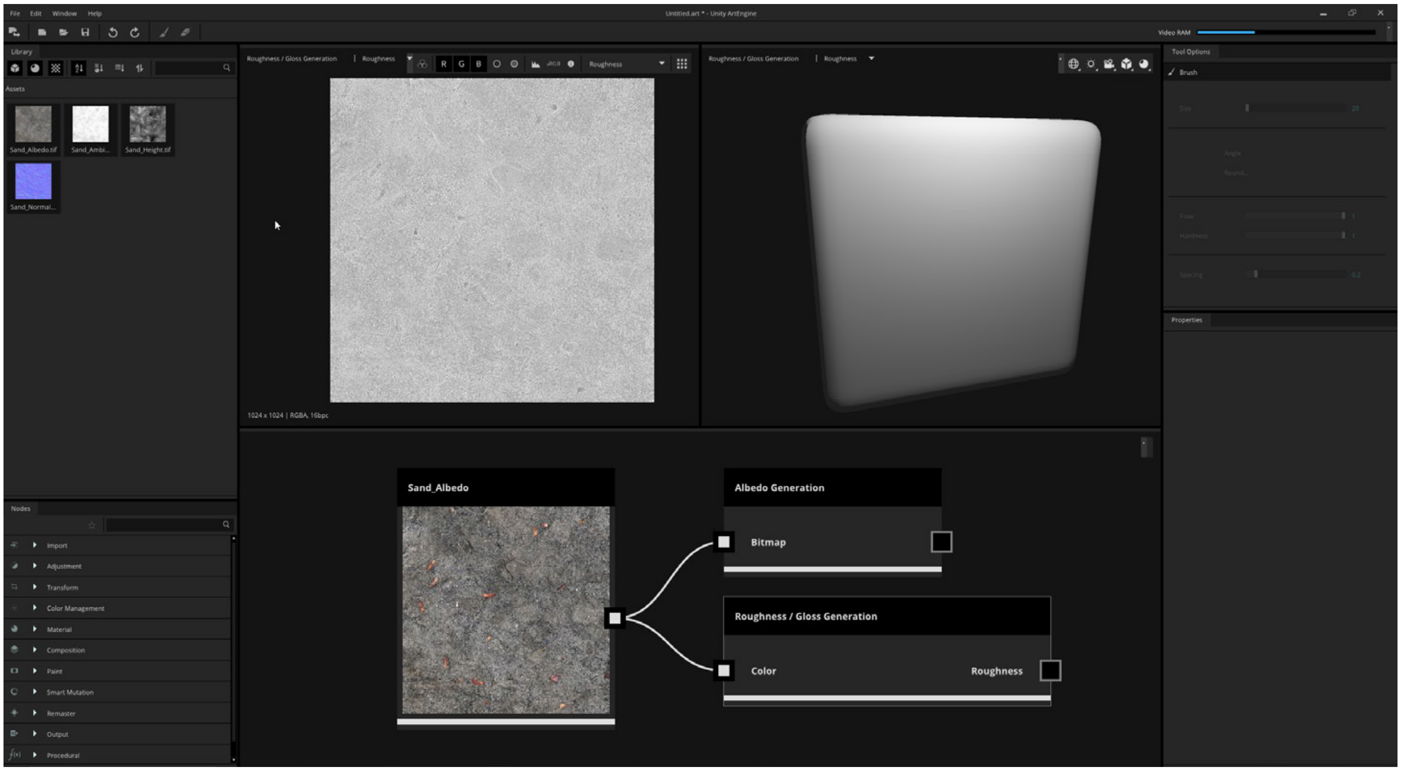
Creating a baking plane (*top image*), baking setup (*left image*), baking result (*right image*)

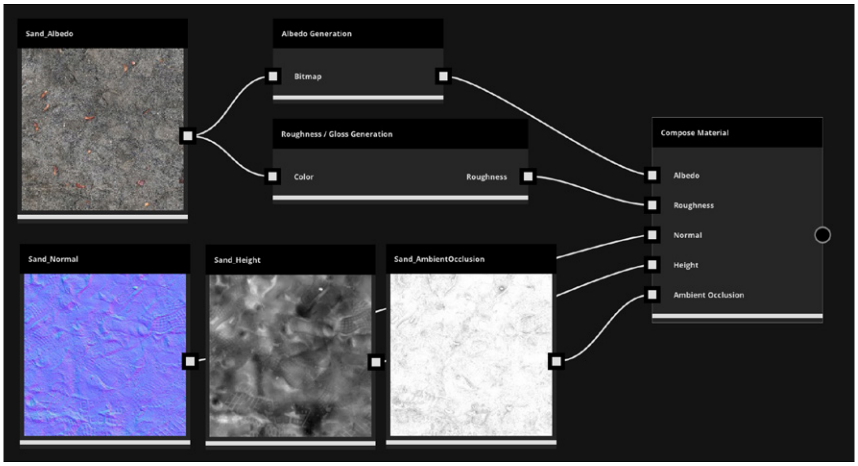
2. Delighting, removing seams and exporting to Unity

After importing your material into ArtEngine, the first step is delighting. ArtEngine's delighting nodes help you to modify lighting behaviors in your material. Use one or more of the following nodes, depending on your image's characteristics:

- **Albedo Generation:** Levels out harsh highlights and dark spots
- **Gradient Removal:** Modifies gradients caused by lighting
- **Hard Shadow Removal:** Strikes out any direct shadows on your material

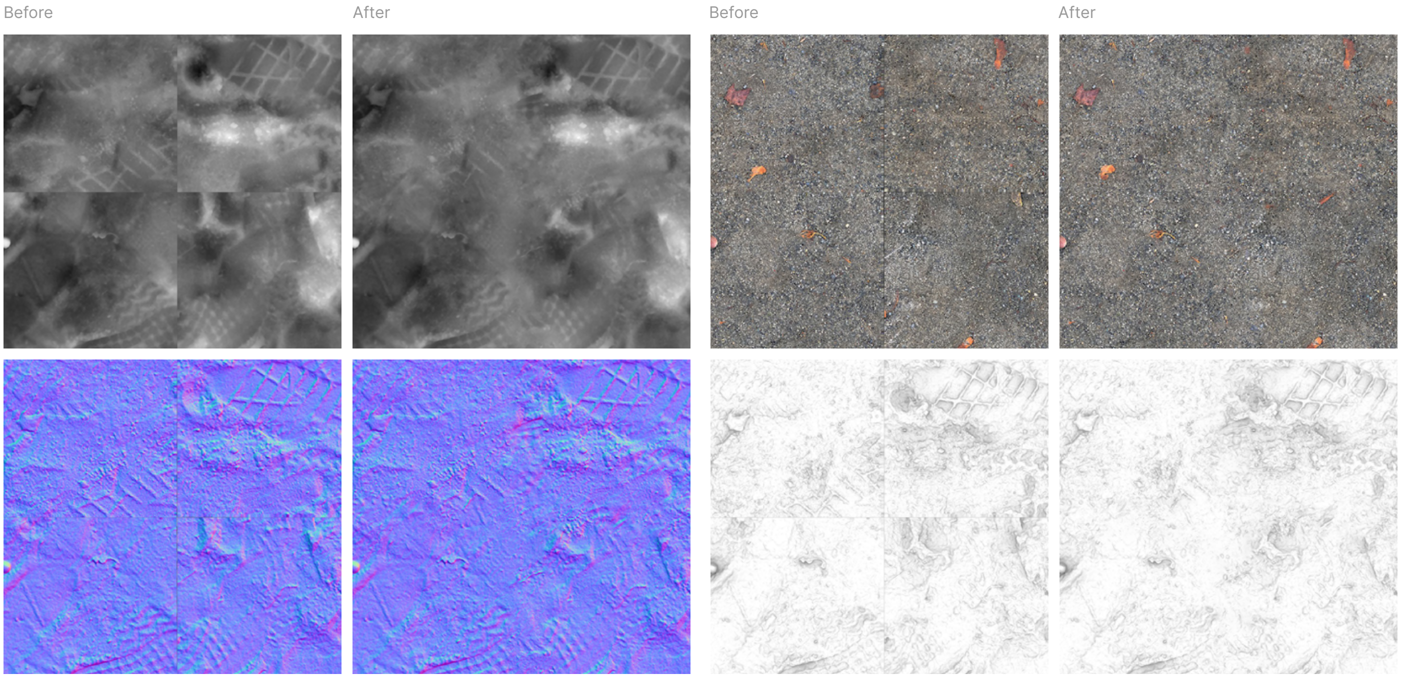
After delighting, use the Roughness Generation node to build a basic Roughness map for use in the following steps.





Use the Compose Material node to start working with a full texture set. Since ArtEngine is node-based software, you can go back and forth between edits in a nondestructive, nonlinear fashion. By contrast, layer-based software only allows for linear edits.

When you initially baked your data set, you likely noticed it doesn't tile. Applying ArtEngine's Seam Removal node will correct this problem across all your maps.

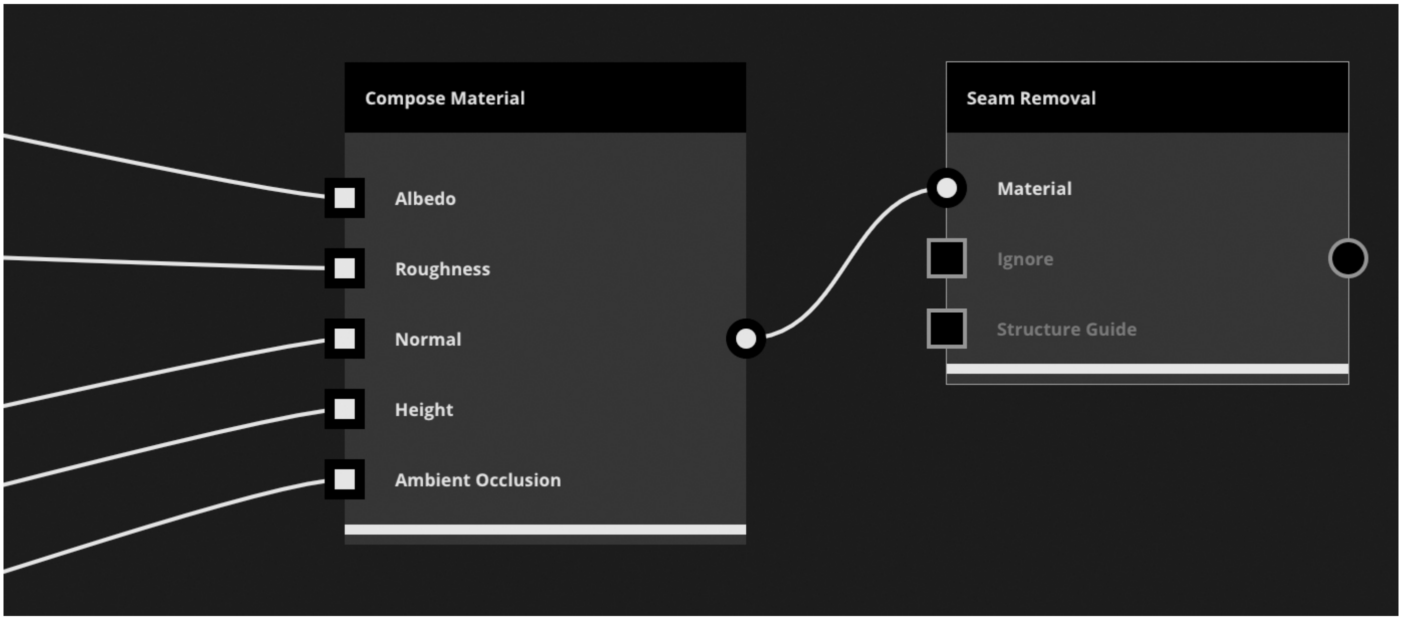

Before

After

Before

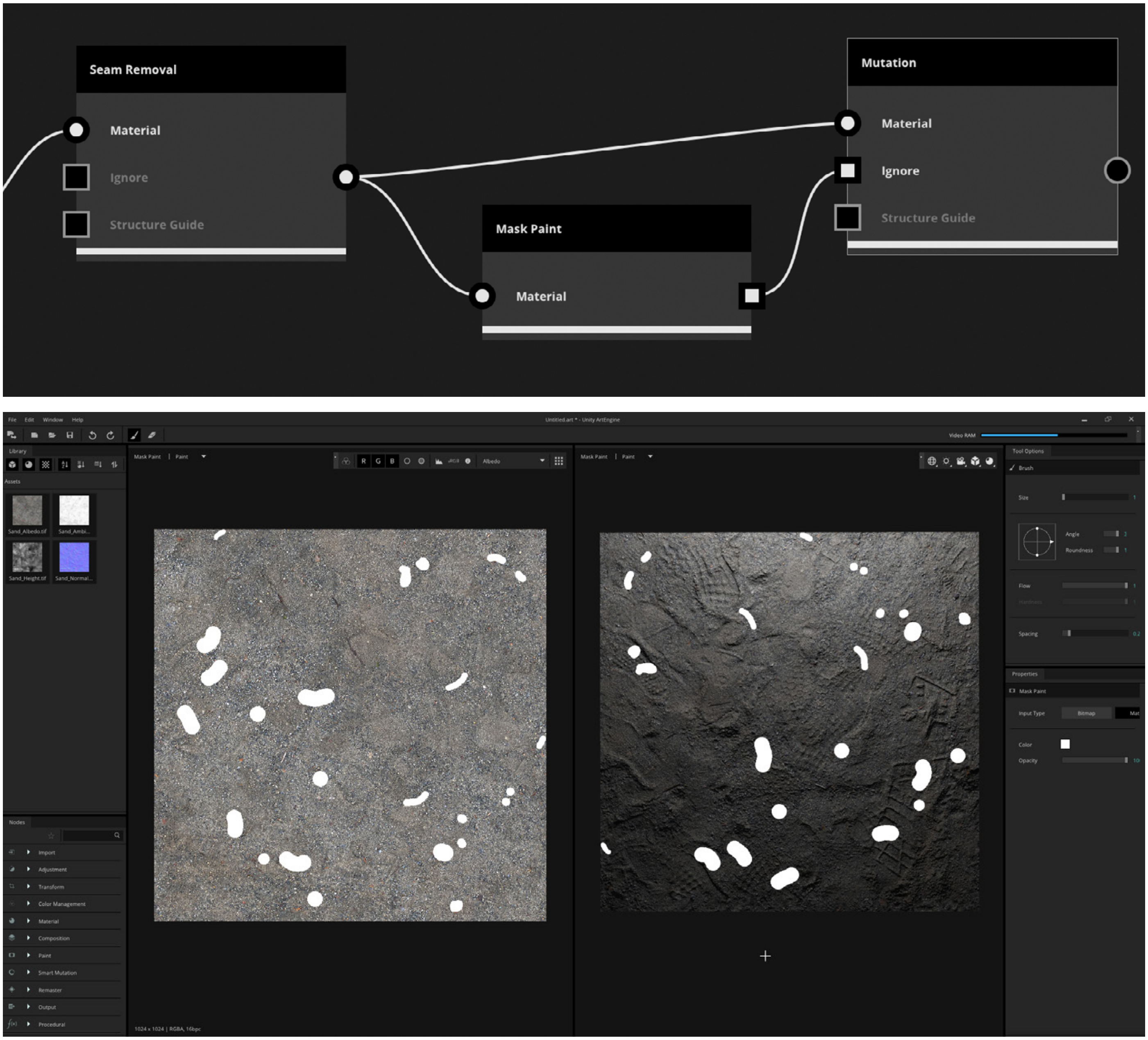
After

Our original baked data set was full of seams. We can use the Seam Removal node and correct this across all maps.



At this point you have a fully tileable material that is ready to use.

Use the Mask Paint node to do further cleanup, such as painting out undesirable areas, then use the node as the Ignore input into a new Mutation node. Adjust the World Scale parameters in the Mutation node to scale up to the real-world size of your material.



Node detail (*top image*), result (*bottom image*)

Ta-da! You now have a fully tileable material that's ready to export to Unity. Visit the Unity Asset Store to grab the plug-ins you'll need to start playing with your art in Unity, including the free ArtEngine Importer.

Glossary

Terms you should know

If you're new to ArtEngine and photogrammetry, you're bound to run into some strange vocabulary. Here's a small cheat sheet to help you find the information you'll need to achieve amazing results.

Baking – Reprojecting data from one source onto another. In this context, it means putting a high-resolution piece of geometry onto a low-resolution target.

Color correction – Adjusting the colors of a photo to make them reflect the source as accurately as possible.

Delighting – Removing shadow information (gradients, hard shadows, etc.) from an image.

Node-based software – Lets you go back and forth between edits in a nondestructive, nonlinear fashion.

Photogrammetry – Reconstructing a 3D real-world sample using photographic data.

Physically based rendering (PBR) – Using realistic shading/lighting models along with measured surface values to accurately represent real-world materials. PBR is now the standard used by material libraries, content authoring, scanning applications and more to refer to realistic-looking digital materials.

Each **PBR map**, defined:

Albedo – Refers to the color of a texture.

Normal – Represents an approximation of surface depth. Used for faking the lighting of bumps and dents, i.e., adds details without using more polygons.

Roughness/gloss – Represents the microsurface detail of a surface. The smoother a surface is, the more reflective (e.g., a mirror), while rougher surfaces are less reflective (e.g., pavement). *Note: Unity uses a Smoothness map, which is equivalent to a Gloss map*.

Ambient occlusion – Represents how objects and surfaces react to ambient light.

Height – While both the Normal and the Height maps create an illusion of depth, the height map actually creates depth and usually displaces geometry (i.e., it moves polygons in 3D space), whereas the Normal map only affects the lighting of the geometry.

White balancing – Adjusting the colors of a photo to make them reflect the source as accurately as possible by making the colors that appear white in-person display as white in the photo.

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