HOUDINI FOUNDATIONS

SOLARIS MARKET

In this lesson, you will learn how to use the Solaris Lookdev, Layout and Lighting tools to create a market scene using existing assets. The Solaris environment converts everything into USD [**Universal Scene Description**] which is an open source initiative created by PIXAR. The Solaris/LOPS context allows you to work with USD natively using procedural nodes to manage key USD concepts.

You will learn how one artist can publish USD layers or files that can be picked up by the next artist. Changes can be added non-destructively to set up a scene or refine a shot. The way USD is used in this lesson is for artists who need to benefit from its power without getting mired in its technicalities.

LESSON GOAL

Create a Market scene using existing assets to set up the lookdev, layout and lighting of a shot.

WHAT YOU WILL LEARN

- Work with USD files at various stages of production. You will take on three roles to complete the shot.

Lookdev/Asset Prep Artist

- How to use the **Component Builder** to prepare and export assets to **USD**
- How to **Assign Materials** and set up **Proxy Geometry**
- How to use **Set up Variants** for assets that will be available during layout

Scene Assembly Artist

- How to use the **Stage Manager** to place assets
- How to work with **Instancing** to set up assets
- How to save out a **USD** file for the assembled scene

Layout/Lighting Artist

- How to set up a **camera** and **lights** and render a shot
- How to set up multiple shots with different lighting designs

LESSON COMPATIBILITY

Written for the features in Houdini 20.5

The steps in this lesson can be completed using the following Houdini Products:

Houdini Core	✔
Houdini FX	✔
Houdini Indie	✔
Houdini Apprentice	✔
Houdini Education	✔

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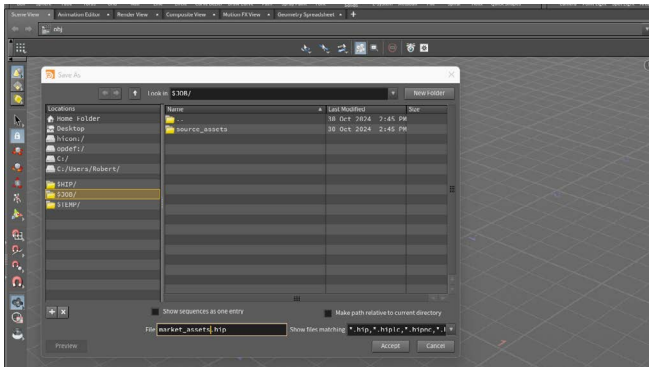
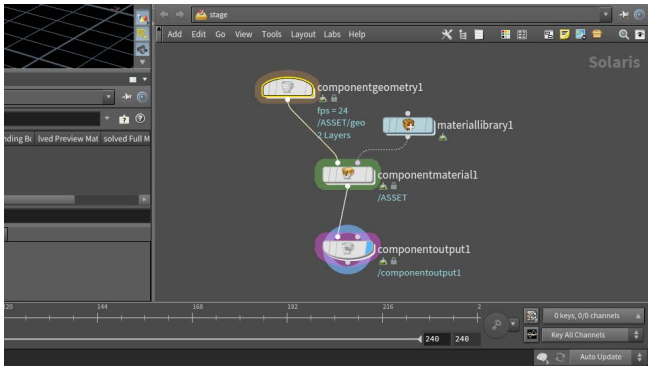
PART ONE:
The Component Builder

To start, you are going to focus on asset preparation. This is where you bring together the geometry and textures to create a USD-based asset. To do this, you will use the Component Builder which makes it easier for artists to create first class USD that will work reliably through-out all of the stages of the pipeline.



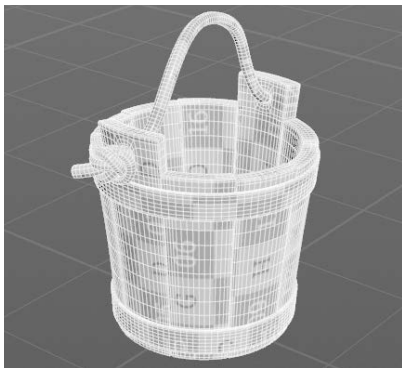
01 Select **File > Set Project.** Find the *market_lesson* directory that you downloaded and press **Accept**. This makes this project directory and its sub folders the place for all the files associated with this shot.

Select **File > Save As...** You should be looking into the new *market_lesson* directory. Set the file name to *market_assets.hip* and click **Accept** to save. Now you will be able to access the reference geometry and images in the *source_assets* folder.

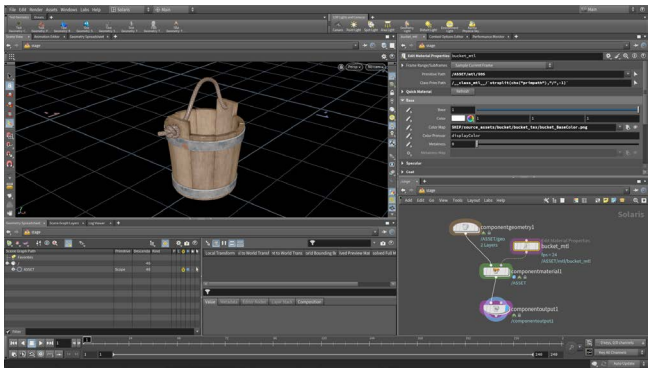


02 Use the **Desktop** menu at the top to choose the **Solaris** desktop. This layout reveals panes that are ideal for setting up and working with USD-based assets.

In the Network view, press **tab > Component Builder** and click to place the network down.



03 Double-click on the *componentgeometry* node to dive into it then press **tab > File** and click to place the node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/bucket* directory and get the *bucket.bgeo* file. Wire the *file* node into the *default* node.



04 Go back to the *Stage* level. Delete the *materiallibrary* node. Select the *componentmaterial* node. Click on the Add **Quick Material** button and select **Quick Surface Material. Select the new** node and name it *bucket_mtl*.

In the **Base** section, click on the icon on the left of the **Color Map** field and choose **Set or Create**. Next to **Color Map** click on the **File Chooser** button. Go to the $HIP/*source_assets/bucket/bucket_tex* directory and get the *bucket_BaseColor.png* file.

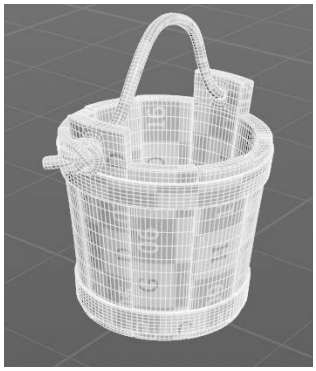
05

Set **Metalness** to **0.7** then use this same method to set the **Metalness Map** to *bucket_Metallic.jpg*.

Set **Specular > Roughness** to **0.5** then set the **Roughness Map** to *bucket_Roughness.jpg*.

Go to the Bump section and set **Bump Style** to **Height** then set the **Bump Normal Map** to *bucket_Height.jpg*. Leave **Bump Scale** set to **0.025**.

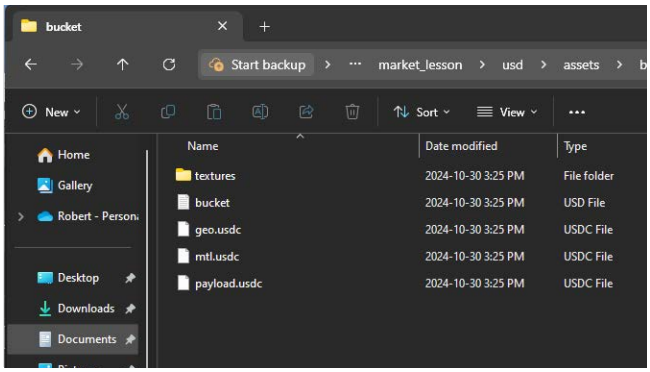
From the **Persp** menu in the Scene View, choose **Karma XPU**. This turns on the renderer in the viewport. When you tumble around the view will re-render quickly.



06

Rename *componentoutput* to *bucket*. Go back into *bucket* node and add a **PolyReduce** node just above the *proxy* node. Feed the file node into it then feed the *polyreduce* node into the *proxy* and *simproxy* outputs. Set the Display Flag on the *proxy* node.

On the *polyreduce* node, set **Percent to Keep** to **5** and turn on **Use Only Original Point Positions** and **Preserve Quads.** Now you have lower resolution geometry that can be used for optimizing viewport speed and to assist with using dynamics to layout your geometry.

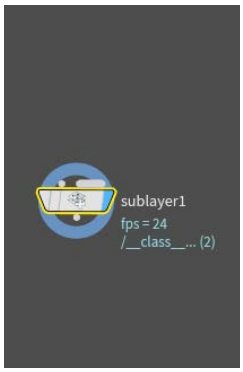


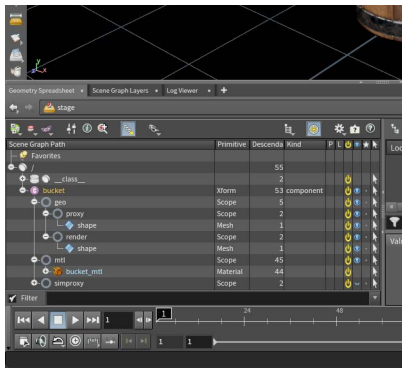
07

Set the Display Flag on the *default* node. Go back to the *stage* level . In the Scene Graph you can now see that Proxies have been added.

Select the *bucket* node and press on **Save to Disk**.

This creates a series of files on disk and copies over the texture files to consolidate all the parts of the asset. The geometry has now been saved out as usdc files.





08

Press **tab > Sublayer** and place the node . Click on the **File chooser** button and go to *usd/assets/bucket* and choose *bucket.usd*. Set this node's Display Flag and check out the Viewport and Scene Graph.

You will now see that the Scene Graph has the USD prims organized in the same way as you set it up with the component builder.

WORKING WITH USD IN SOLARIS?

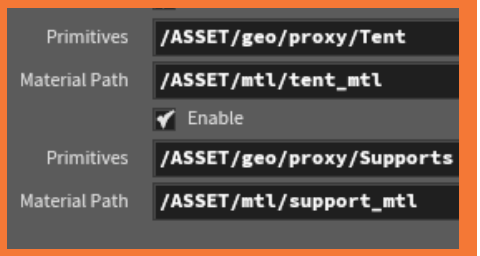
To access USD, you are now going to work to Solaris which is the Lighting Operator or LOP context in Houdini. The Solaris environment can be found in the `/stage` network.

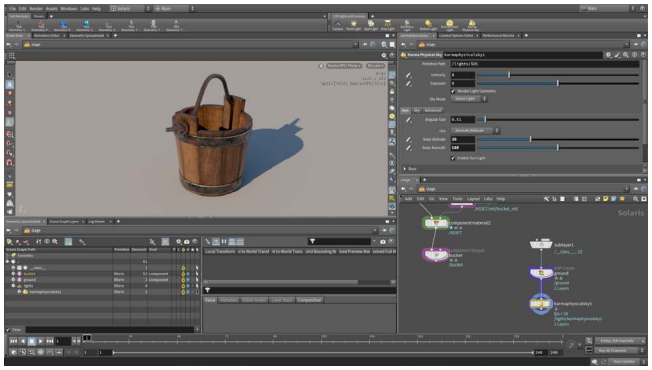
Here you will place nodes for bringing in geometry, assigning materials and adding lights and cameras. The Solaris environment converts everything into USD [**Universal Scene Description**] which is an open source format created by PIXAR. The Solaris/LOPS context allows you to work with USD which is needed to render to the Karma XPU renderer.

WHAT ARE PRIMS?

USD defines a Prim [Primitive] as "the primary container object in USD: prims can contain (and order) other prims, creating a "namespace hierarchy" on a Stage, and prims can also contain (and order) properties that hold meaningful data. Prims, along with their associated, computed indices, are the only persistent scenegraph objects that a Stage retains in memory."

In Solaris, the nodes often find the prims automatically but in some cases you need to point to the prim path explicitly.

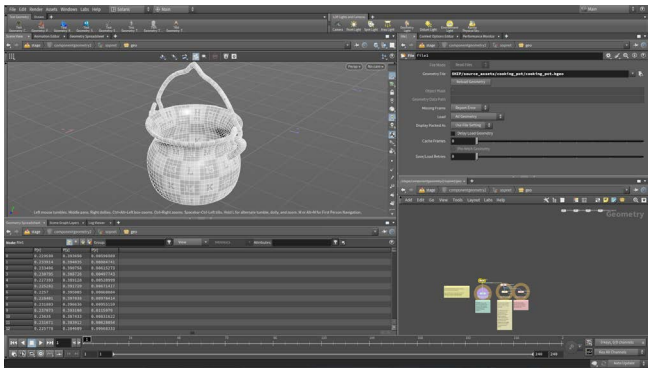




09 Add a **Grid** node and name it *ground*. Double click to dive down to the geometry level. Select the *grid* node and set **Size** to **100, 100**. **Press u** to go back to the *stage* level.

Add a **Karma Physical Sky** node and set **Intensity** to **2**, **Solar Altitude** to **30** and **Solar Azimuth** to around **180**.

Check out **Scene Graph** pane. You will see the *ground*, the *bucket* and *light*. These are all the parts being rendered. You will use this network to test all the assets as they are created.

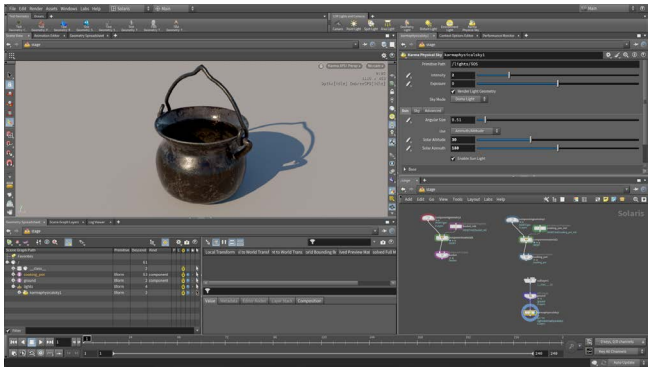


10 Lets set up a cooking pot asset. In the Network view, select the four component builder nodes and **Alt-drag** to make copies. Rename the **Edit Material Properties** node to *cooking_pot_mtl* and the **Component Output** node to *cooking_pot*. Set the Display flag on *cooking_pot*.

Dive into *componentgeometry* node and select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/cooking_pot* directory and get the *cooking_pot.bgeo* file. On the *Polyreduce* node, set **Percent to Keep** to **30**. This makes sure there is enough detail.

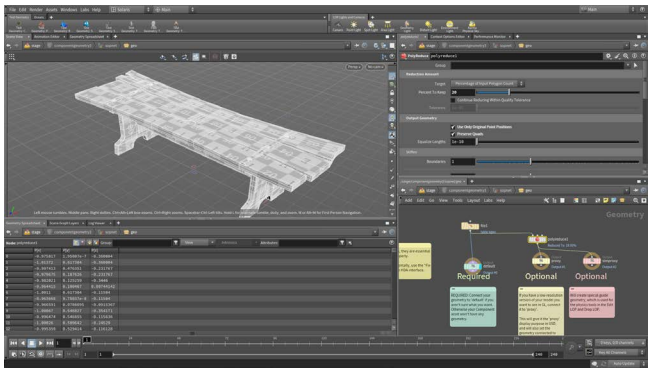
11 Go back to the *Stage* level. Change the *cooking_pot_mtl* with the following:

- **Base >Color Map** to *cooking_pot_BaseColor.jpg*
- **Base > Metalness** to **0.8**
- **Metalness Map** to *cooking_pot_Metallic.jpg*
- **Specular > Roughness** to **0.4**
- **Roughness Map** to *cooking_pot_Roughness.jpg*
- **Bump > Bump Style** to **Height**
- **Height Map** to *cooking_pot_Height.jpg*
- **Bump > Bump Scale** to **0.01**



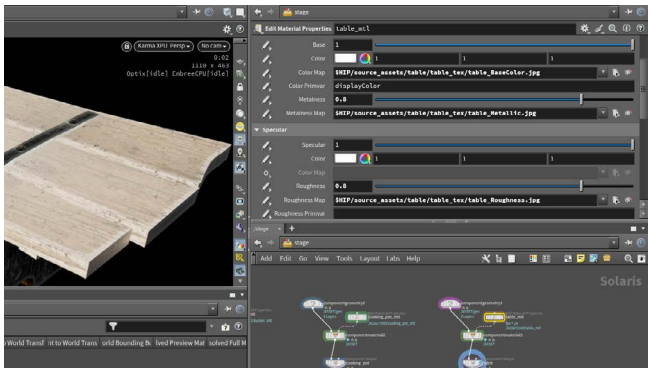
12 Select the *cooking_pot* node and press on **Save to Disk**.

Select the *Sublayer* node you used earlier to test the bucket. Click on the **File chooser** button and go to *usd/assets/cooking_pot* and choose *cooking_pot.usd*. Set the *karmaphysicalsky* node's Display Flag and check out the Viewport and Scene Graph.



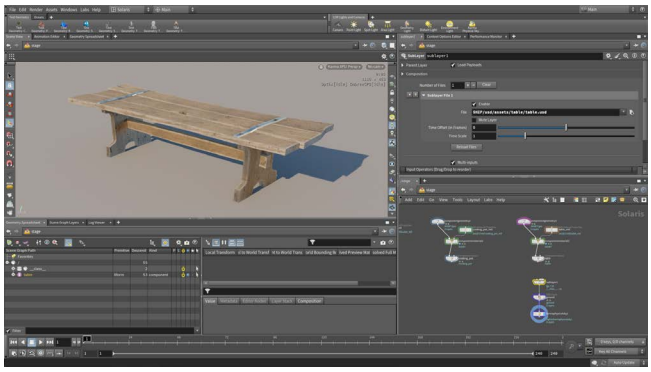
13 Lets set up a table asset using the same steps. In the Network view, select the four *cooking_pot* component builder nodes and **Alt-drag** to make copies. Rename the **Edit Material Properties** node to *table_mtl* and the **Component Output** node to *table*. Set the Display flag on *table*.

Dive into *componentgeometry* node and select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/table* directory and get the *table.bgeo* file. On the *Polyreduce* node, set **Percent to Keep** to **20**.



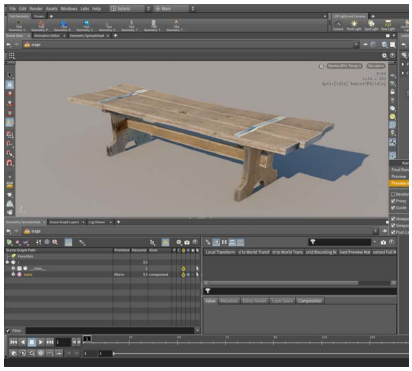
14 Go back to the *Stage* level. Set the Display Flag on the *table* node. Change the *table_mtl* with the following:

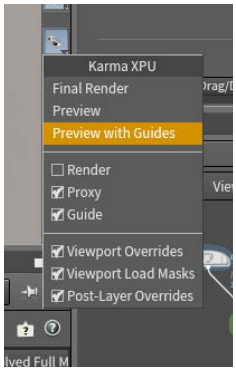
- **Base >Color Map** to *table_BaseColor.jpg*
- **Base > Metalness** to **0.8**
- **Metalness Map** to *table_Metallic.jpg*
- **Specular > Roughness** to **0.4**
- **Roughness Map** to *table_Roughness..jpg*
- **Bump > Bump Style** to **Normal**
- **Normal Map** to *table_Normal.jpg*
- **Bump > Bump Scale** to **2**



15 Select the *table* node and press on **Save to Disk**.

Select the *Sublayer* node you used earlier to test the bucket and cooking pot. Click on the **File chooser** button and go to *usd/assets/table* and choose *table.usd*. Set the *karmaphysicalsky* node's Display Flag and check out the Viewport and Scene Graph.





16 On the **Display Options** bar, click on the **Control Visibility of Primitives** button and choose **Preview** to look at the Proxy geometry and **Final Render** to show the higher resolution geometry. For now keep this at Final Render. The proxy geometry will become more important in the Layout stage.

QUICK SURFACE MATERIAL

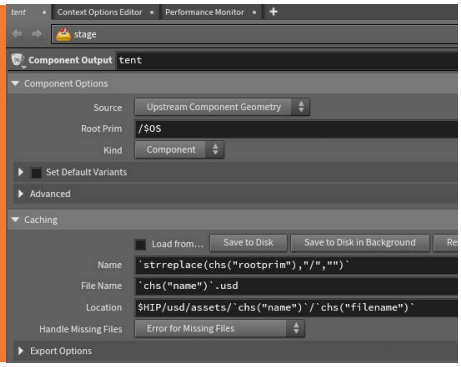
The Quick Surface material is a shader that was built up using MaterialX nodes then exported as USD. Because it is already USD, it processes efficiently when you render. The Quick Surface Material loads this USD file into an edit node where you can change its name and assign different values and texture maps.

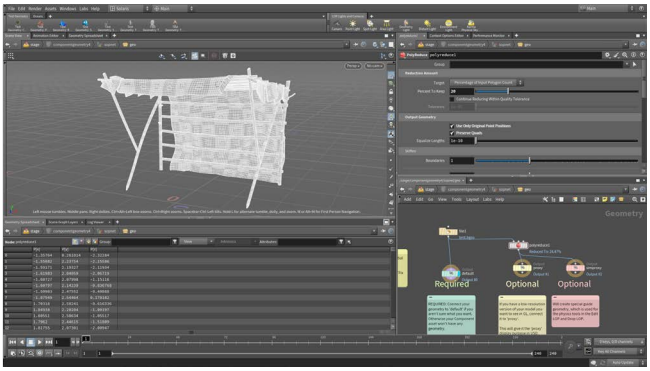
For assets that have texture maps prepared, this is the best material to use because of its efficiencies. If you need a material that is more complex then you can build it up yourself using the Karma/MaterialX Builder nodes in VOPS.

WHAT'S IN A NAME?

The name you give the Root prim is set based on and expression. On the Component Output node you will see the Root Prim set to /$OS - this means it is using the node name to create /tent.

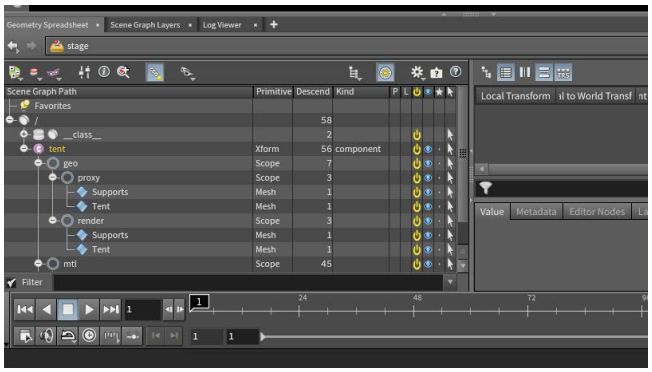
In the Caching section, the rootprim is then used to create the Name and file name of the USD file. This is all managed with expressions so you don't need to change any of the names yourself. Just name the node and the expressions set things up for you.





17 Now lets set up a tent asset which is has a couple extra steps. In the Network view, select the four component builder nodes belonging to the *table* and **Alt-drag** to make copies. Rename the **Edit Material Properties** node to *tent_mtl* and the **Component Output** node to *tent*. Set the Display flag on *tent*.

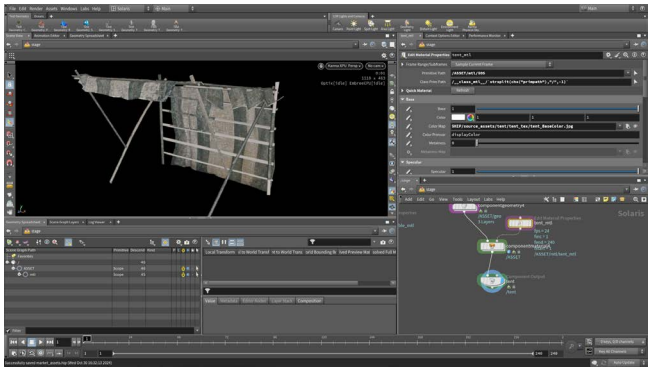
Dive into *componentgeometry* node and select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/tent* directory and get the *tent.bgeo* file. If you can't see the file just type *tent.bgeo* and press **Enter**.



18 Go back to the stage level and check **Scene Graph**. Just like the *table* there is only one prim. But the tent has two parts, the cloth and the supports.

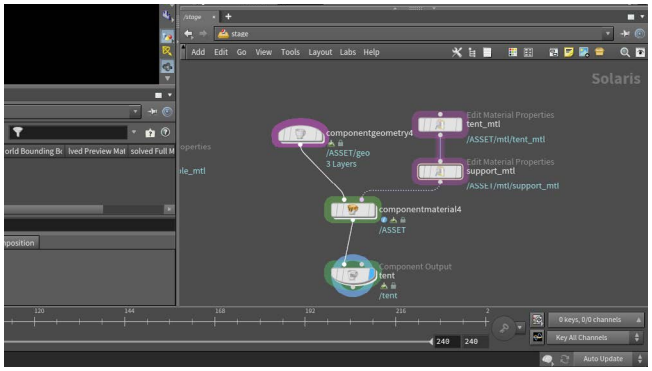
Dive into *componentgeometry* node and **MMB** on the *file* node. You will see that there are groups for these two parts. Press tab > **Names from Groups** and place the node after the *file* node. Set the **Group Mask** field to *. Feed this node into the *polyreduce* node.

Go back up and check **Scene Graph**. Now you will see two prims that will allow you to assign different materials to the parts of the tent.



19 Select the *tent_mtl* node and set the following:

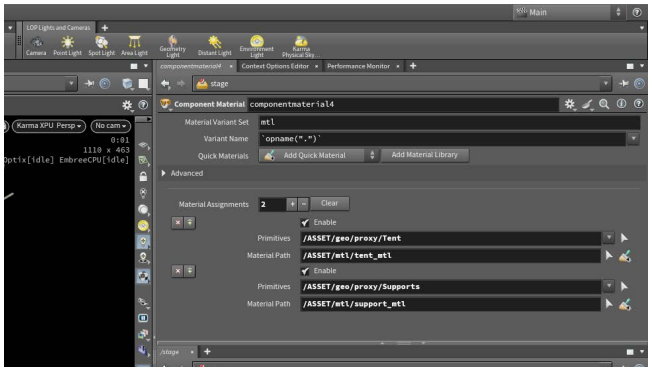
- **Base > Color Map** to *tent_BaseColor.jpg*
- **Metalness** to **0** - Remove the texture map
- **Specular > Roughness** to **0.6**
- **Roughness Map** to *Tent_Roughness.jpg*.
- Remove the Normal map



20 Select the *componentmaterial* node. Click on the **Add Quick Materials** button and select **Quick Surface Material** to add a second one. Rename it *support_mtl*.

Select the *support_mtl* node and set the following:

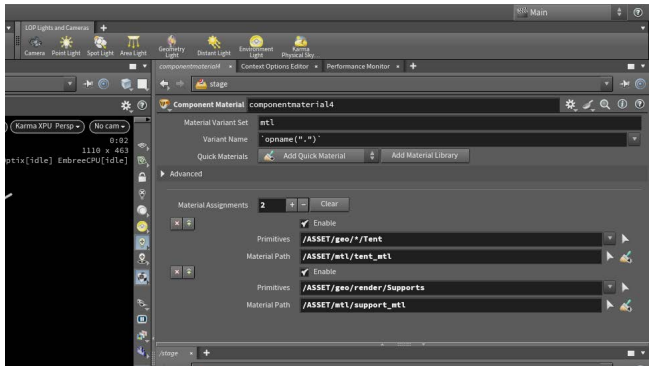
- **Base > Color Map** to *supports_BaseColor.jpg*
- **Metalness** to **0.8**
- **Base > Metalness Map** to *supports_Metallic.jpg*
- **Specular > Roughness** to **0.5**
- **Bump > Normal Map** to *supports_Normal.jpg*
- **Bump Scale** to *1*



21 The *componentmaterial* node automatically assigns the right and left inputs. That is what the *lopinputprims* expression is doing. Because you have two materials, you need to assign the primitives directly.

Click on the arrow next to **Primitives** and in the Scene View set **Kind** to **Leaf Primitives**. Click on the ground to deselect then click on the fabric part of the tent and press **Enter**. Click on the arrow next to **Material Path.** Choose *mtl* > *tent_mtl* and press **Enter**.

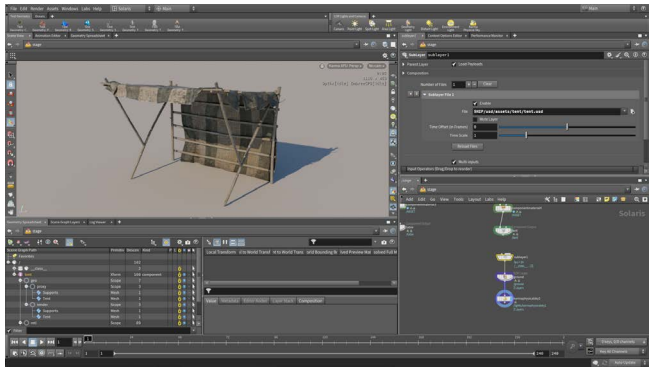
Click the **Plus sign** next to **Material Assignments** and set **Primitives** to *Supports* and the **Material Path** to *mtl* > *support_mtl*.



22 On the **Display Options** bar, click on the **Control Visibility of Primitives** button and choose **Preview** to look at the Proxy geometry The textures are not assigned because they are only assigned to the Render prims.

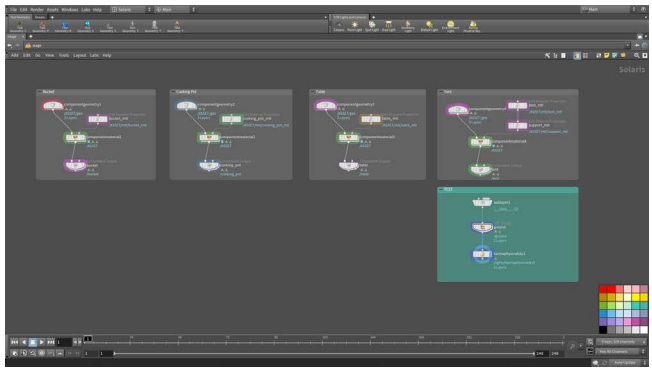
Edit the **Primitives** paths to */ASSET/geo/*/Tent* and */ASSET/geo/*/Supports*. This will work for both the Proxy and Render leafs.

Click on the **Control Visibility of Primitives** button and choose **Final Render** to go back to full resolution geometry.



23 Select the *tent* **Component Output** node and press on **Save to Disk**. Again you are saving files to disk in the proper USD format.

Select the **Sublayer** node you created earlier . Click on the **File chooser** button and go to *usd/assets/tent* and choose *tent.usd*. Set the *karmaphysicalsky* node's Display Flag and check out the Viewport and Scene Graph.



24 Expand the Network view to full screen by clicking on the button in the top right. Now select all the nodes for the bucket and click on the **Network Box** button. **Double click** on the title bar and name it *Bucket*. Repeat for the table, tent and cooking pot. You can also create a Network box for the *sublayer*, *ground* and *karmaphysicallight* and name it *Test*.

It is always a good idea to keep your network organized to help find the right nodes later.

Save your work.

INSPECTING THE USD

Right-click on the Component Output node, open the LOP Actions sub-menu, and choose **Inspect active layer**. This opens a viewer window showing the layer as usda code. This is an example of the USD that you will be saving to disk when you press the **Export** button.

Artists don't need to know about this level of USD. The Solaris nodes in Houdini will set this up for you. But if you want to take a deeper dive into the USD code then this gives you a preview.

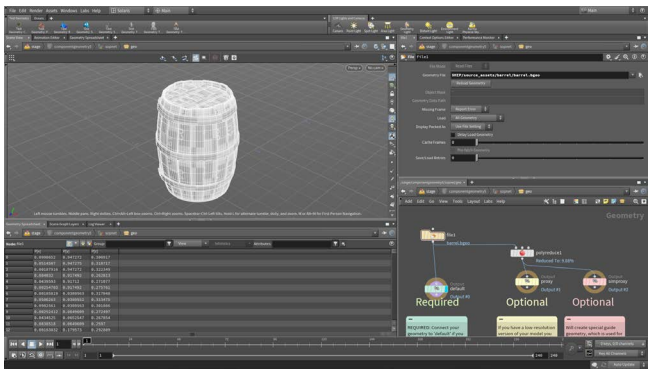
Inspect Active Layer: /stage/tent

```
#sdf 1.4.32
(
    defaultPrim = "tent"
    framesPerSecond = 24
    metersPerUnit = 1
    timeCodesPerSecond = 24
    upAxis = "Y"
)

def HoudiniLayerInfo "HoudiniLayerInfo" (
    customData = {
        int HoudiniCreatorNode = 1154
        int[] HoudiniEditorNodes = [1154, 1125, 1147, 1
        string HoudiniSaveControl = "Explicit"
        string HoudiniSavePath = "C:/Users/rmagee/Docum
market_lesson/usd/assets/tent/tent.usd:SDF_FORMAT_ARGS:
        bool HoudiniSavePathIsTimeDependent = 0
```

PART TWO:
Create Assets with Variants

The next few assets will be set up using Variants. Variants are different versions of an asset which have unique geometric or material qualities. The component builder lets you set up all the different variants then incorporate them into the USD file. Later you will have access to the variants during scene assembly and layout.



01

Lets set up a barrel asset that uses variants. In the Network view, select the *bucket* network box and **Alt-drag** to make a copy of the box and the nodes inside the box. Rename the **Edit Material Properties** node to *barrel_mtl* and the **Component Output** node to *barrel*. Rename the network box to Barrel. Set the Display flag on *barrel*.

Dive into *componentgeometry* node and select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/barrel* directory and get the *barrel.bgeo* file. On the *Polyreduce* node, set **Percent to Keep** to **10**.

02

Go back to the *Stage* level. Select the *barrel_mtl* **Quick Surface Material** node and set the **Base > Color Map** to:

- *barrel_1001_BaseColor.jpg*

This looks a bit strange because the barrel uses UDIM textures. You need to edit the texture name to grab both of the textures. Change the name to:

- *barrel_<UDIM>_BaseColor.jpg*

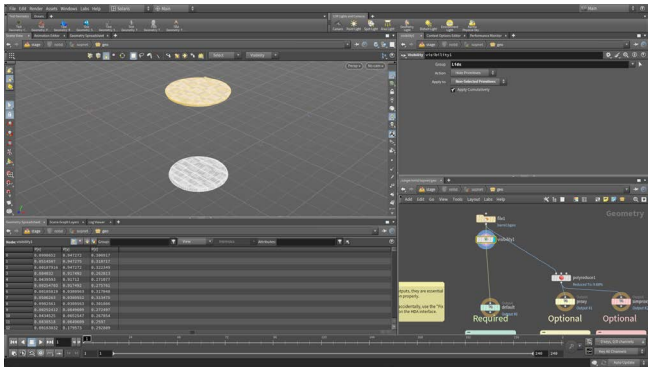
Note that the UDIM textures don't display properly in Houdini VK therefore you should preview these with **Karma XPU**.

03

For the rest of the textures, load the *1001* version then edit it to *<UDIM>*.

Set the following:

- **Base > Metalness** to **0.8**
- **Metalness Map** to *barrel_<UDIM>_Metalic.jpg*
- **Specular > Roughness** to **0.6**
- **Roughness Map** to *barrel_<UDIM>_Roughness.jpg*
- **Bump > Bump Style** to **Height**
- **Roughness Map** to *barrel_<UDIM>_Height.jpg*
- **Bump > Bump Scale** to **0.05**



04

Rename the **Component Geometry** node to *lid*. Alt-drag the *lid* node to create a second node.

Name this one *nolid*. Double-click to dive into this node and after the file node, add a **Visibility** node and set:

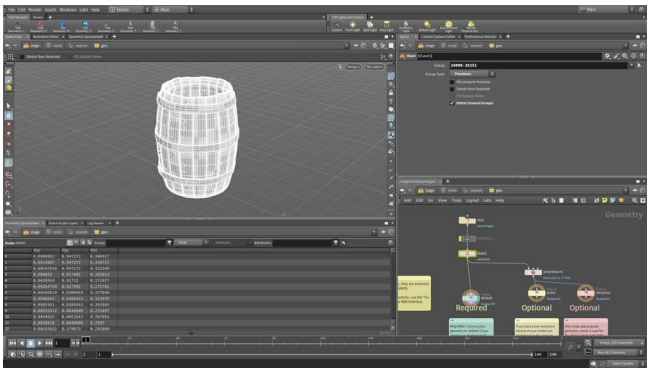
- **Group** to **Lids**
- **Apply to** to **Non-Selected Primitives**

With the **Select** tool, box select the top lid of the barrel.

UDIM TEXTURES

UDIM is a system for dividing texture space into multiple “tiles” in UV space, with each tile represented by a separate texture file on disk. You can specify a texture name like ***foo<UDIM>.exr*** and any UDIM-aware renderer or image loading node will know to replace the ***<UDIM>*** token with the address of the UV tile.

Separating UV space into different texture files lets you use high-resolution files for large, detailed islands, and low-resolution files for small or simple islands. It can also have benefits for file and memory cache locality.

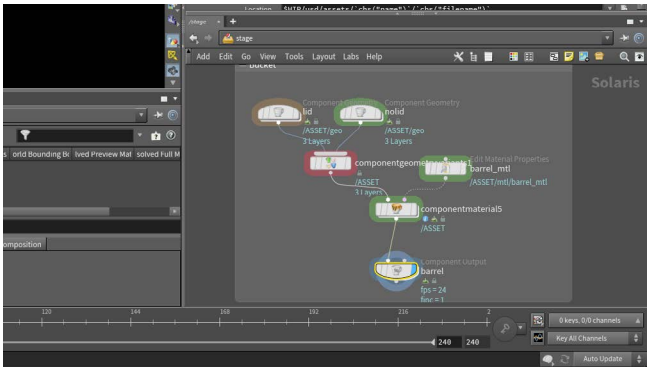


05

Press **Delete** to blast that geometry. Set the Bypass Flag on the *visibility* node to bring back the rest of the barrel

The *visibility* node lets you hide geometry without changing the point and primitive numbers. This way you can hide parts of the barrel to make it easier to delete the top lid. When you bypass the node, the sides come back.

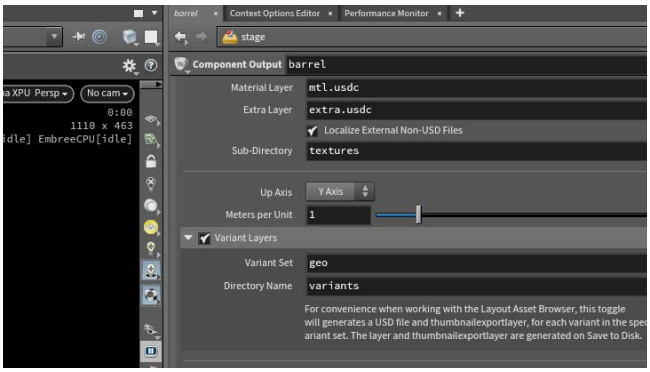
This new geometry should feed into the *polyreduce* and therefore works the same as the barrel with the lid.



06

Go back to the stage level. Add a **Component Geometry Variants** node after the *lid* node. Feed *nolid* into this node.

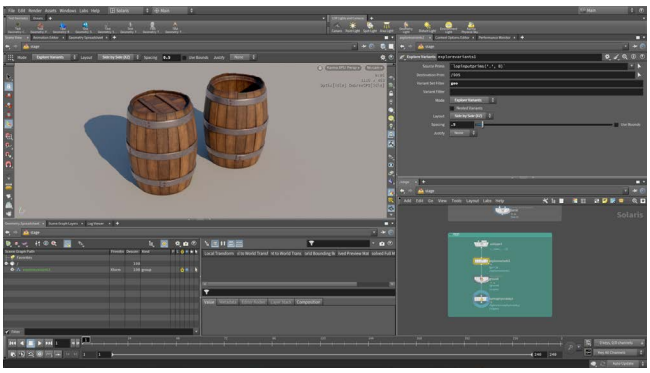
Set the Display Flag on the *barrel* node. Turn on **Set Default Variants** and use the menu on the right to set **Geometry** to *nolid* or *lid*. You can see the variant changing in the Scene view. Choose *lid* as the default.



07

Open up the **Export Options** section and turn on **Variant Layers**. Make sure **Variant Set** is set to *geo*. This adds a directory for your variants and store them as individual USD files. Press **Save to Disk.**

Select the *sublayer* node you created earlier. Click on the **File** chooser button and go to *usd/assets/barrel* and choose *barrel.usd*.



08

Add an **Explore Variants** node and feed the *sublayer* node into it. Set the following:

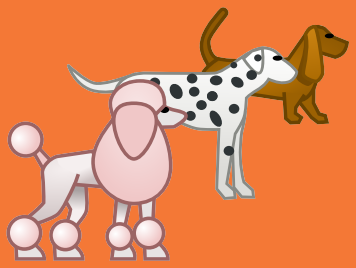
- **Variant Set Filter** to *geo*
- **Mode** to **Explore Variants**
- **Layout** to **Side by Side**
- **Spacing** to **0.5**

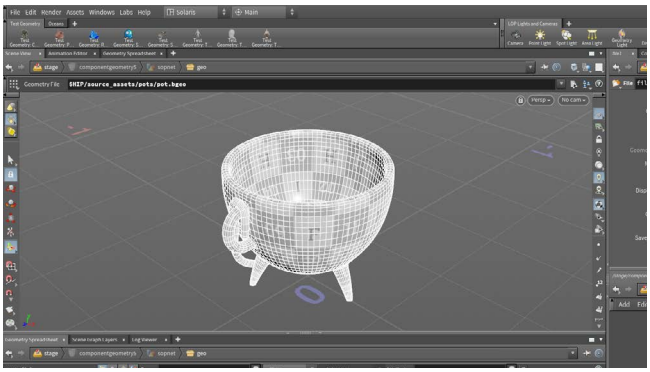
Wire the *explorevariants* node into the existing *ground* surface and *karmaphysicalsky*. Here you can review the two variants. You will use the variants later in the layout stage of the project.

EXPLORE VARIANTS

USD allows primitives to have variants: separate named groups of properties you can switch between. This is often used to switch between different geometry rand material representations of a prim. For example, a Lamp prim might contain variants representing different sizes and styles of lamp, allowing the layout artist to choose one appropriate to the scene.

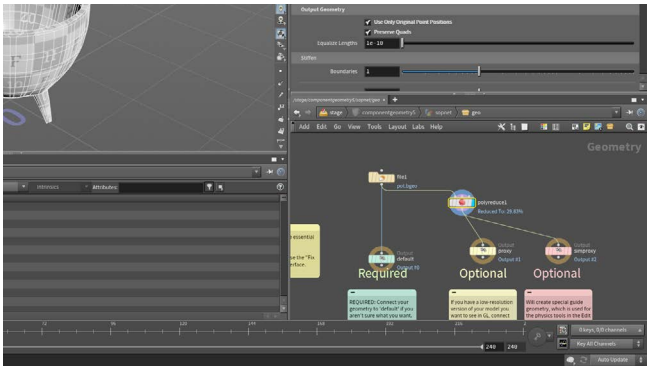
The explore variants node lets you expand out the variants and see them side by side. This helps you determine if they were set up properly.





09 Now let's create a pot asset where the variation is in the material not the geometry. In the Network view, select the *bucket* network box and **Alt-drag** to make copies of all the nodes. Rename the **Edit Material Properties** node to *clay_mtl* and the **Component Output** node to *pot*. Set the Display flag on *pot*. Rename the network box to *Pot*.

Dive into *componentgeometry* node and select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/pots* directory and get the *pot.bgeo* file.



10 On the *polyreduce* node, set **Percent to Keep** to **30.** If you go lower with this then to much detail is lost on the pot.

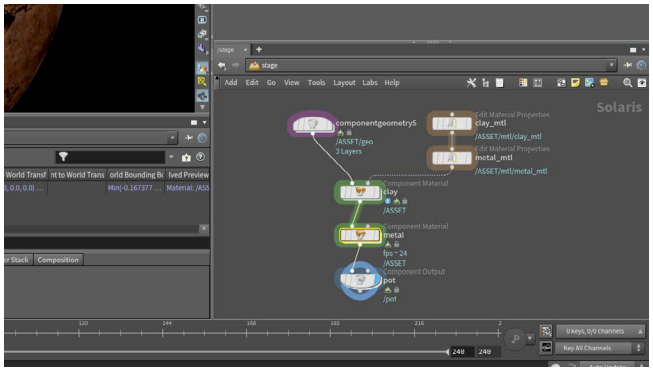
Set the Display Flag on the *default* node.

11 Go back to the *Stage* level. Select the *clay_mtl* node and set the following:

- **Base > Color Map** to *pot_clay_BaseColor.png*
- **Base > Metalness** to **0.5**
- **Metalness Map** to *pot_clay_Metallic.png*
- **Specular > Roughness** to **0.4**
- **Roughness Map** to *pot_clay_Roughness.png*
- **Bump > Bump Style** to **Height**
- **Roughness Map** to *pot_clay_Height.png*
- **Bump > Bump Scale** to **0.1**

12 Alt drag on the material node to create a second **Quick Surface Material** node and rename it *metal_mtl*. Place it between the *clay_mtl* node and the *componentmaterial* node. Change the following:

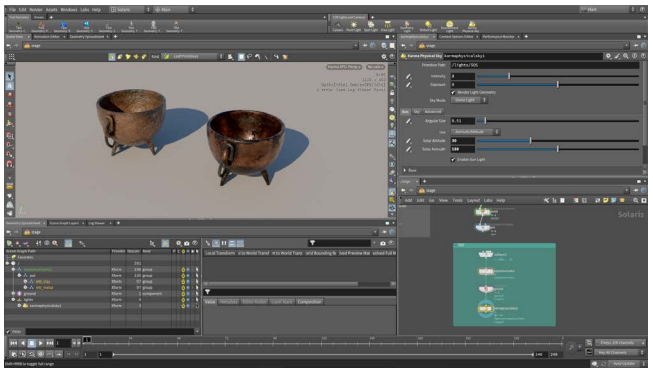
- **Base > Color Map** to *pot_metal_BaseColor.png*
- **Base > Metalness** to **0.8**
- **Metalness Map** to *pot_metal_Metallic.png*
- **Roughness Map** to *pot_metal_Roughness.png*
- **Height Map** to *pot_metal_Height.png*
- **Bump > Bump Scale** to **0.25**



13 Rename the **Component Material** node to *clay*. Click on the arrow next to **Material Path** and choose *clay_mat*.

Alt-drag on this node to create a second **Component Material** node and place it after the first one. Rename it to *metal*. Click on the arrow next to **Material Path** and choose *metal_mat*.

Rename *componentoutput* to *pot*. Set the Display Flag on this node. Turn on **Set Default Variants** and set **Material** to *metal*.

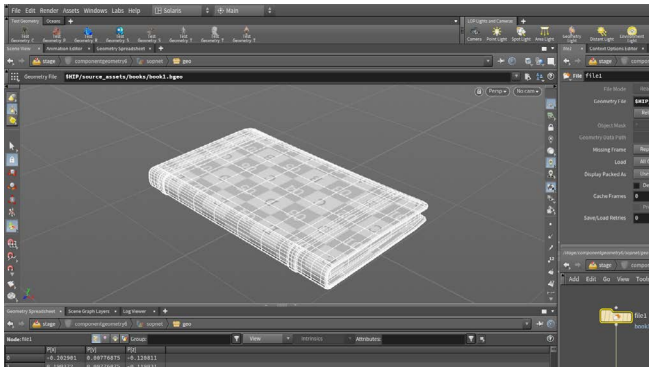


14 Select the *pot* node. Open up the **Export Options** section and turn on **Variant Layers**. Open this section and set **Variant Set** to *mtl*. Press **Save to Disk.**

Select the *sublayer* node you created earlier. Click on the File chooser button and go to *usd/assets/pot* and choose pot.*usd*. This will feed into the **Explore Variants** node you set up earlier. Set the following:

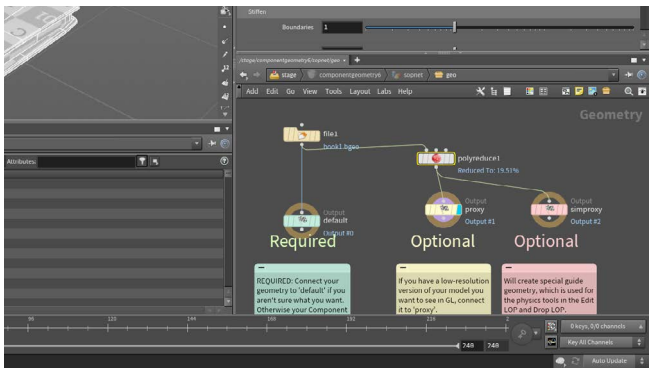
- **Variant Set Filter** to *mtl*
- **Spacing** to **0.3**

You can review the two variants.



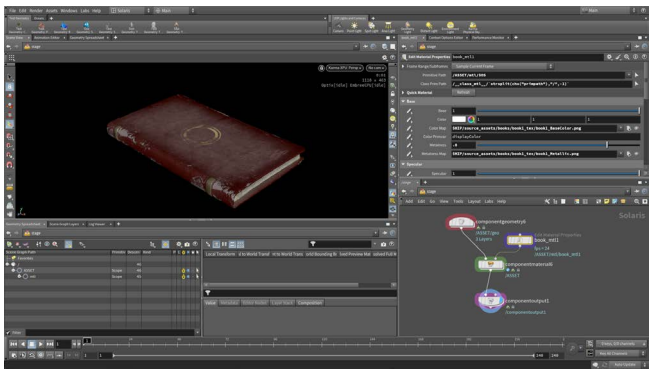
15 Now let's create variants of books that have different shapes and different texture maps. In the Network view, select the *bucket* network box and **Alt-drag** to make copies of all the nodes. Rename the **Edit Material Properties** node to *book_mtl1* and the **Component Output** node to *book*. Set the Display flag on *book*. Rename the network box to *Book*.

Dive into *componentgeometry* node select the *file* node. Next to **Geometry File** click on the **File Chooser** button. Go to the $HIP/*source_assets/books* directory and get the *book1.bgeo* file.



16 On the *polyreduce* node, set **Percent to Keep** to **10** and turn on **Use Only Original Point Positions** and **Preserve Quads.** Now you have lower resolution geometry that can be used for optimizing viewport speed and to assist with using dynamics to layout your geometry.

Set the Display Flag on the *default* node.



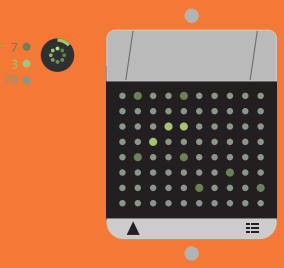
17 Go back to the *Stage* level. Select the *book_mtl1* node and set the following:

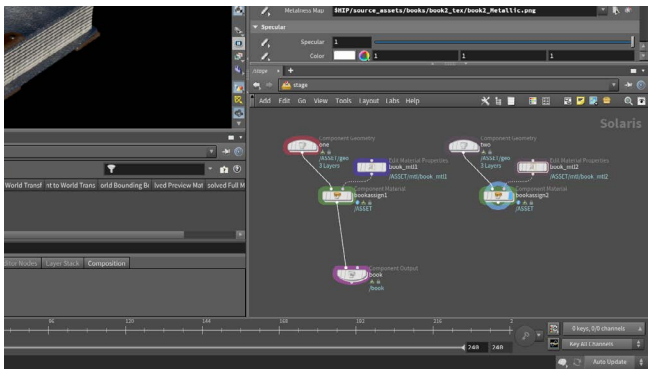
- **Base > Color Map** to *book1_BaseColor.png*
- **Base > Metalness** to **0.8**
- **Metalness Map** to *book1_Metallic.png*
- **Specular > Roughness** to **0.4**
- **Roughness Map** to *book1_Roughness.png*
- **Bump > Bump Style** to **Height**
- **Height Map** to *book1_Height.png*
- **Bump > Bump Scale** to **0.025**

ASSET AUTOMATION

For this lesson, you are creating each asset using the Component builder nodes. This means importing geometry and setting up the Quick Surface material. A more advanced technique would be to automate this using **PDG** or **Task Operators**. This would need to be set up to match the particular nature of your asset pipeline but has the possibility to let you rapidly process multiple assets.

This is something you can learn down the line. For now it is a good idea to set up each of the assets directly so that you understand how this process works.

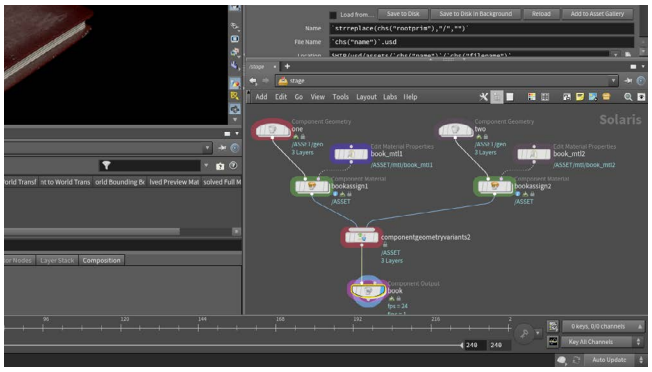




18 Rename the **Component Geometry** node to *one* and the **Component Material** node to *bookassign1*.

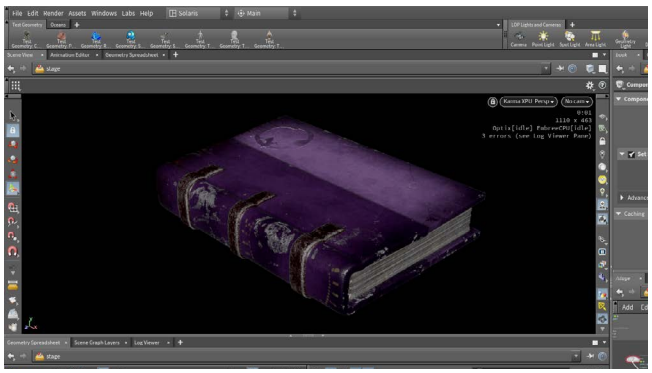
Select the *1*, *book1*_mtl and *bookassign1* nodes. Alt-drag to create copies of all of these nodes. Name these new nodes *two*, *book2_mtl* and *bookassign2*.

Double-click to dive into the *two* node and change the file node to *book2.bgeo*. Go back to the *stage* level. On *book2_mtl*, change the maps to the *book2* maps in the *book2_textures* folder.



19 Add a **Component Geometry Variants** node after the *bookassign1* node. Feed *bookassign2* into this node.

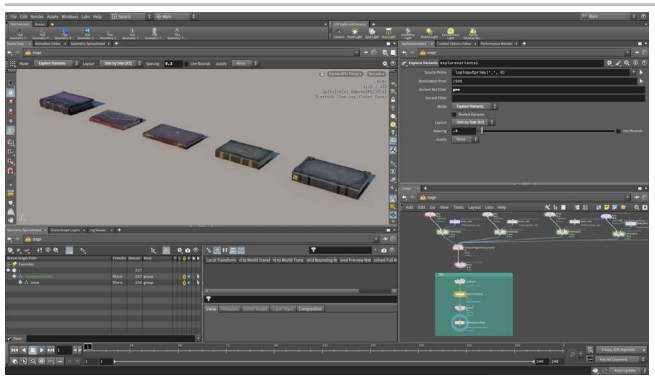
On the *book* **Component Output** node, turn on **Set Default Variants** and use the menu on the right to set **Geometry** to *one* or *two*. You can see the variant changing in the Scene view. Choose *one* as the default.



20 Select the *two*, *book_mtl2* and *bookassign2* nodes. Alt-drag to create three more copies of all of these nodes. Name these new nodes to numbers *three*, *four* and *five*.

Double-click to each **Component Geometry** node and change the file node to the related number. Book *five* is oriented differently. At the *stage* level, add a **Transform** node after the Component Geometry node, set Primitives to */ASSET/geo/*/shape* and then set **Rotate Y** to **90**. This will align it to the other books

Change the texture maps on the **Edit Material Properties** nodes. Feed the new *bookassign nodes* into the **Component Variant** node.

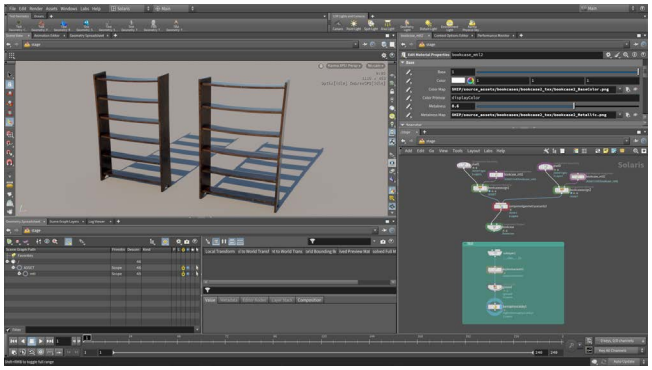


21 Select the *book* node. Open up the **Export Options** section and turn on **Variant Layers**. Press **Save to Disk.**

Select the *sublayer* node you created earlier. Click on the **File** chooser button and go to *usd/assets/book* and choose *book.usd*.

On the **Explore Variants** node, set the following:

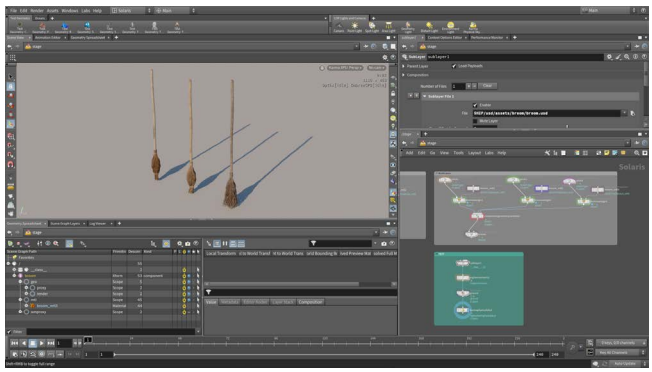
- **Variant Set Filer** to *geo*
- **Layout** to **Side by Side**
- **Spacing** to **0.3**



22 Use the techniques taught in previous steps to set up these two shelves. This setup will be similar to the setup used with the books.

Set the **Component Output** node's name to *bookcase* and the two **Component Geometry** nodes to *shelf1* and *shelf2*.

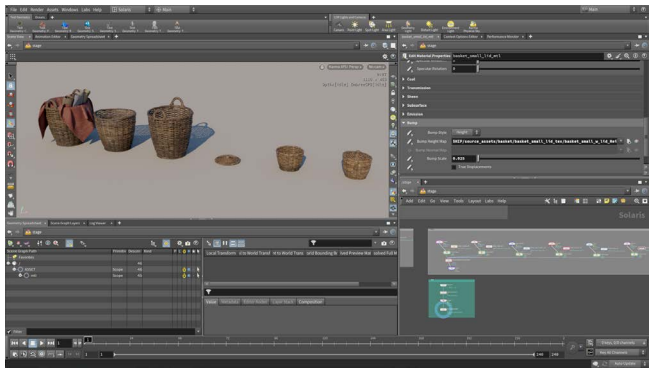
When you test the asset using the *sublayer* node setup, you will need to increase the **Spacing** on the **Explore Variants** node.



23 Next set up these three broomsticks. This setup will again be similar to the one used with the books.

Set the **Component Output** node's name to *broom* and the three **Component Geometry** nodes to *stick1*, *stick2* and *stick3*.

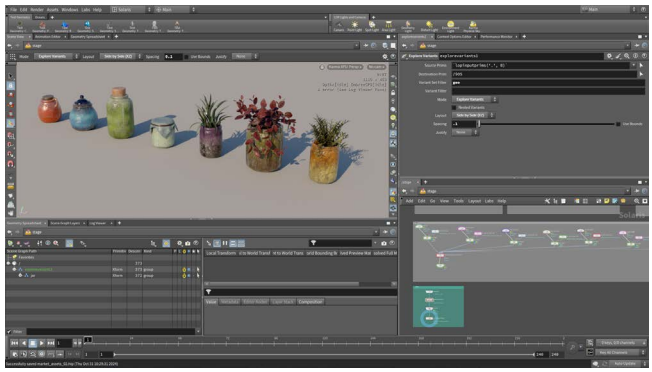
When you test the asset using the *sublayer* node setup, you will need to adjust the **Spacing** on the **Explore Variants** node.



24 Next set up these baskets. This setup will again be similar to the setup used with the books.

Set the **Component Output** node's name to *basket* and the **Component Geometry** nodes to *carpets*, *large*, *large_handles*, *lid_only*, *small* and *small_lid*.

When you test the asset using the *sublayer* node setup, you will need to adjust the **Spacing** on the **Explore Variants** node.



25 Next set up these jars. This setup will again be similar to the setup used with the books.

Set the **Component Output** node's name to *jar* and the **Component Geometry** nodes to *tall-lid*, *tall_lid_cloth*, *tall_lid_herbs1*, *tall_lid_herbs2 tall_lid_herbs3 small_handle*, and *small_lid1*. When setting up the textures note that some jars use UDIMS and will need <*UDIM*> in place of the texture number.

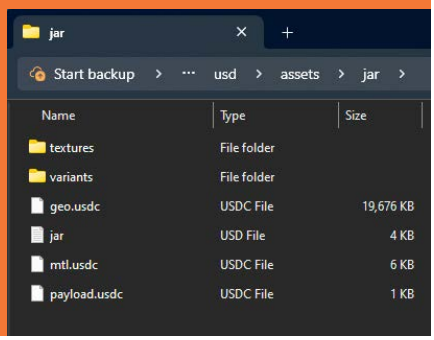
When you test the asset using the *sublayer* node setup, you will need to adjust the **Spacing** on the **Explore Variants** node.

Save your work.

USD FILES ON DISK

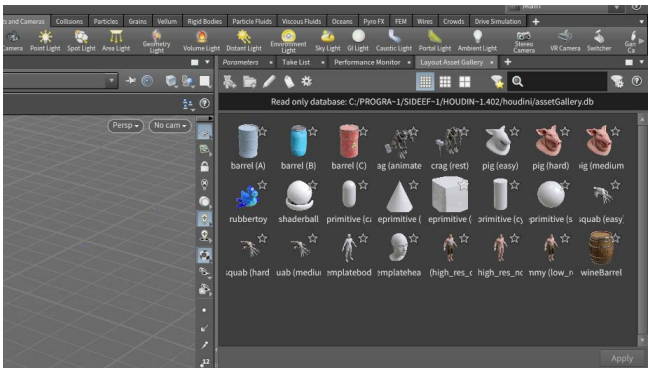
The assets you have prepared have been stored on disk in the project directory in ***usd > assets***. Each asset has a directory with all the files necessary to properly represent the geometry, materials, payloads and variants.

The texture files have been moved into this directory structure. The main USD file is the one you have been using with the Sublayer node and it is the root of the whole asset.



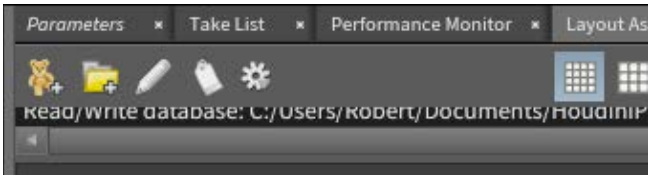
PART THREE:
Work with the Layout Gallery

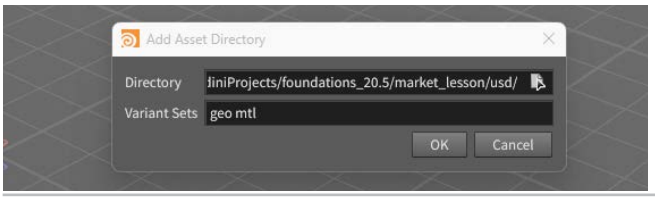
You now have assets that have been properly set up as first-class USD. For this part of the lesson, you will play the part of an assembly artist who is going to create a scene out of the kit of parts you just prepared. This will give you a sense of how different artists on the same team can work together using USD in Solaris.



01 Select **File > New**. Select **File > Set Project.** Find the *market_lesson* directory and press **Accept**. Then Select **File > Save As**. Click on *$JOB* to get the project directory and set **File** to *market_scene_assembly.hip* and then press **Accept**. You are now going to work with the assets created earlier as a scene assembly artist.

In the top right pane, click on the plus sign next to the tabs and select **New Pane Type > Solaris >Layout Asset Gallery**. This brings up a gallery with some default assets.

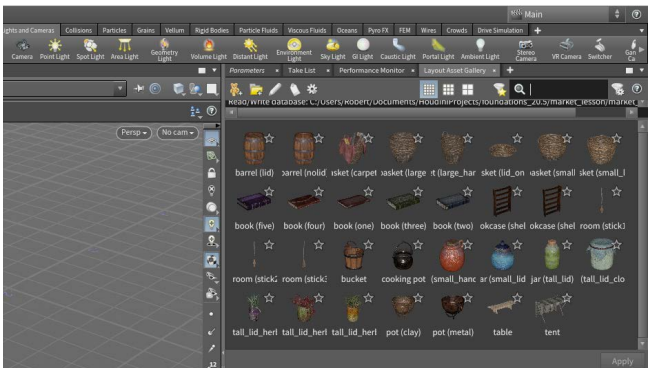




02 Click on the **gear** icon and choose **Create New Asset Database File**. Name the database **File** to *market_usd_assets* and press **Accept**.

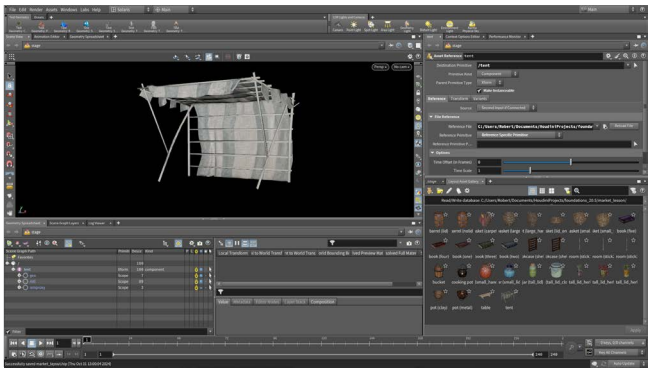
Now click on the **Add Asset Directory** button. Click on the **File** selector button next to **Directory**. Go into the *USD* directory and press **Accept**. In the **Variant Sets** section enter *geo mtl*. Press **OK**.

Houdini is going to go and create thumbnails for all the assets in that directory and add them to the gallery.



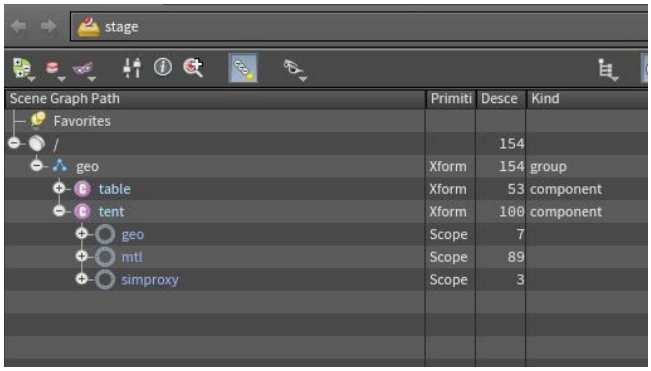
03 When they are ready, you will see all the assets and variants in the gallery for you to use to layout the scene. In this panel, you can star assets that you think are important and filter by name in the top right.

This gallery can be loaded into any scene as you need it. This way multiple artists can access the same USD files.



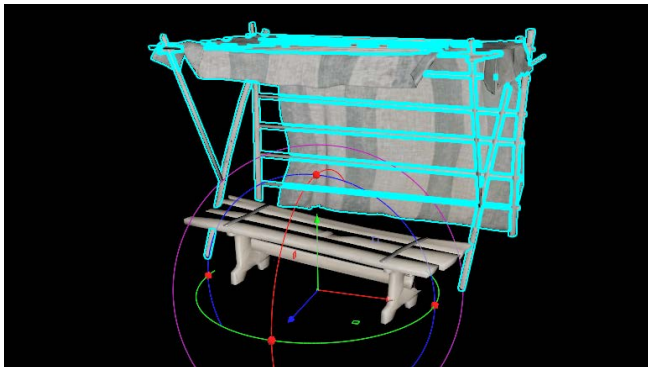
04 Change your desktop to **Solaris**. Bring back the **Layout Asset Gallery** in the bottom right pane. Drag the *Tent* asset from the gallery to the Scene View. Turn off the **Reference Grid** and **press D** and set the background to dark. Use the view tools to focus on the *Tent*.

The Visibility of this scene is focused on the Proxy geometry you set up earlier. That can be changed later. The scene will be set up quicker with the proxies.



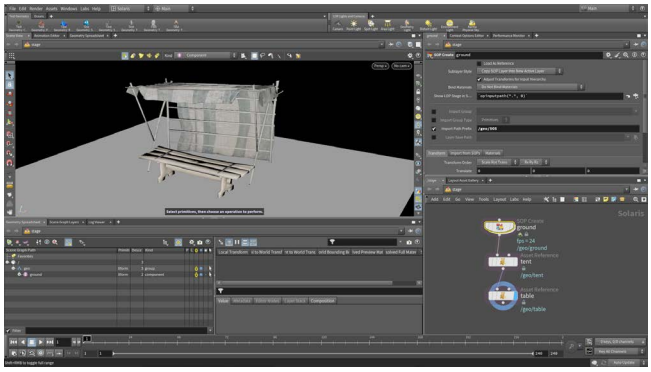
05 In the Parameter pane, set **Destination Primitive** to */geo/tent*. In the Scene Graph, you can see that the tent is now part of a *geo* group.

Drag the *table* from the gallery into the Scene view and set its **Destination Primitive** to */geo/table*. You now have two assets inside the geo group.

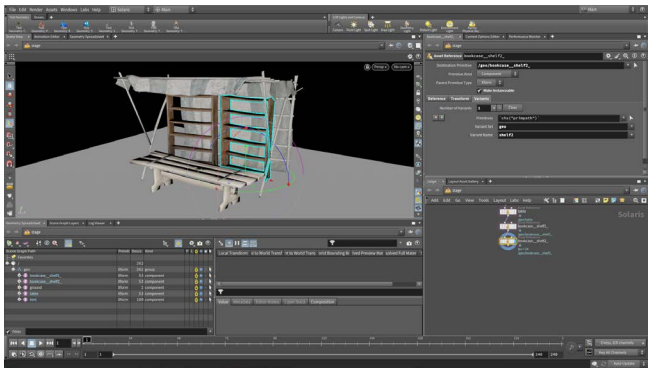


06 In the Network view, select the *tent* node then get the **Handle** tool. Now you can transform the tent to rotate it a little. Be sure not to lower the tent below the ground.

This *reference* node lets you change the transforms on the asset.



07 Add a **Grid** node. Name it *ground* and feed it into *tent* node. Set the **Import Path Prefix** to */geo/$OS*. This will give you a surface to work off of when you start adding more assets.



08 From the **Layout Gallery**, drag the two *bookcases* into the scene Select them in the Network view with the Handle tool active and move them to the back of the tent. You need to have the node for each of then selected when you move it,

Add the *geo* group to both of their **Destination Paths**.

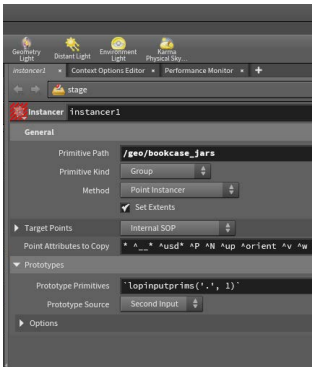
REFERENCE VS SUBLAYER

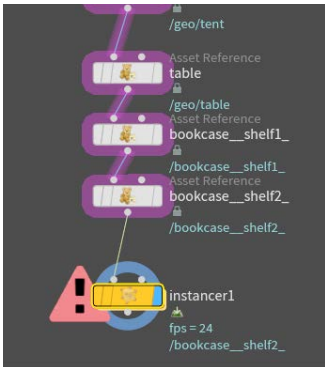
USD has two different approaches to loading the contents of another USD file: sub-layering overlays the tree of the imported file over the current tree, while referencing attaches the contents of the imported tree as a branch on the existing tree.

Sublayering composes different versions of the whole scene. For example, overlaying the lighting department's version of the scene with final lighting over the layout department's version of the scene with scratch lighting. Referencing adds a part to the scene. For example, importing props to begin layout like you just did with the market assets.

PART FOUR:
Instance Jars on the Bookcases

You now have two bookcases that are sitting empty. You are going to populate these shelves with jars using instancing. You will start by pulling the shelves into the geometry level where you will scatter points on the shelves. This provides a very efficient workflow for dealing with many similar objects. You will also add some variation to the size and orientation of the jars..

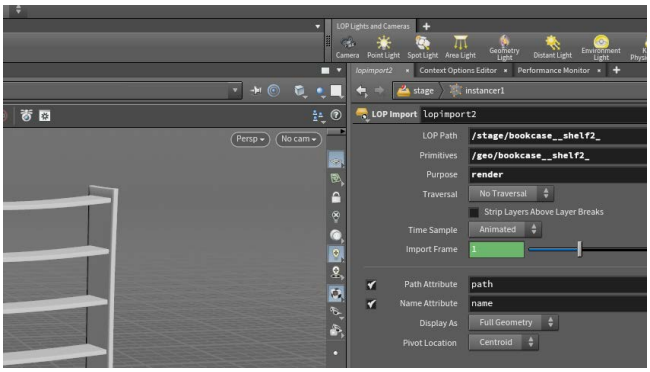




01 In the Network view, press **tab > Instancer** and place the node at the end of the chain then feed the output of the *bookcase__shelf2_* node into it and set its Display Flag.

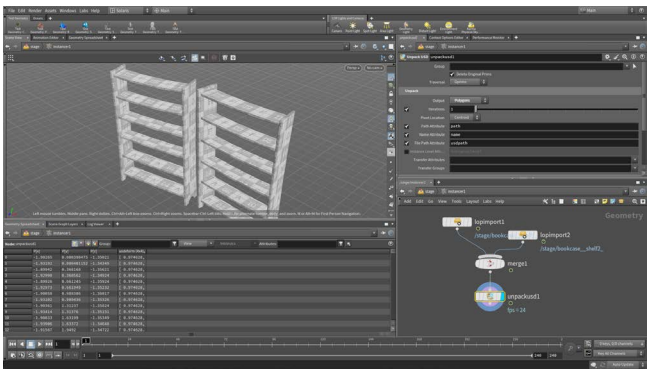
Set its **Primitive Path** to */geo/bookcase_jars*.

There is an error right now because all the parts are not hooked together. You will set up points inside this node to copy the jars.



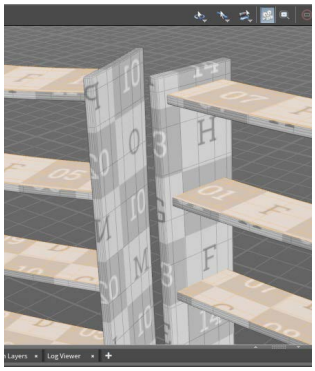
02 **Double-click** on the *Instancer* node to dive into it. Press **tab > LOP Import** and place down the node. You are at the geometry level and need to bring the bookshelves into this node. Click on the node selector next to **LOP Path** and choose the *bookcase__shelf1_* node. Click on the **Arrow** next to **Primitives** and select */geo/bookcase__shelf1_*.

Right now you can see the whole scene. Click on the **Visibility** pull down in the top right of the Scene View and choose **Hide Other Objects**. This will isolate the bookcase from the rest of the scene.



03 Select the *lopimport* node and Alt-drag to create a second one. Edit the **LOP Path** to *bookcase__shelf2_* and **Primitives** to */geo/bookcase__shelf2_*. Add a **Merge** node to the network and feed the two *lopimport* nodes into it then set its Display Flag.

Next press **tab > Unpack USD to Polygons**. This will convert the USD into polygons that you can use to set up the instancing points.



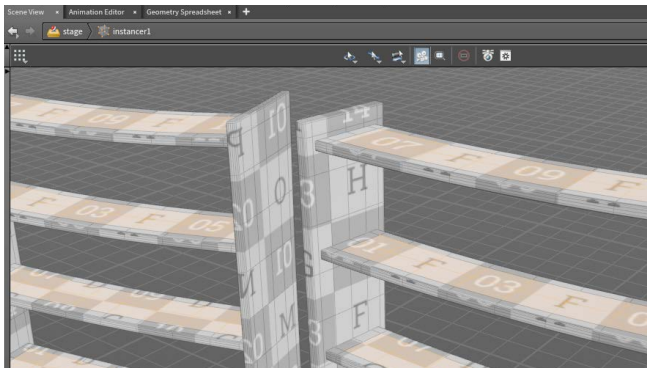
04 Add a **Group** node to the end of the chain and set its Display Flag. Press the arrow next to **Base Group** and **press 4** in the Scene view to get **Primitive** selection.

Double-click on one of the shelves. Press shift and double click on all the other shelves until you have all 12 selected then press **Enter**. The side boards should not be selected.

Turn on **Enable** under **Keep by Normals** then set the following:

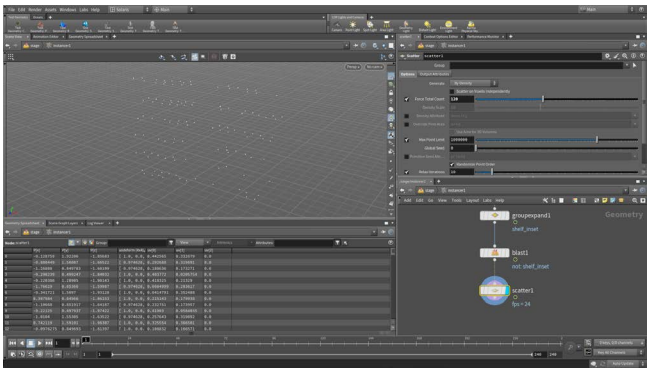
- **Direction** to **0, 1, 0**
- **Spread Angle** to **30**

Set the **Group Name to** *shelves*. The top surfaces are isolated.



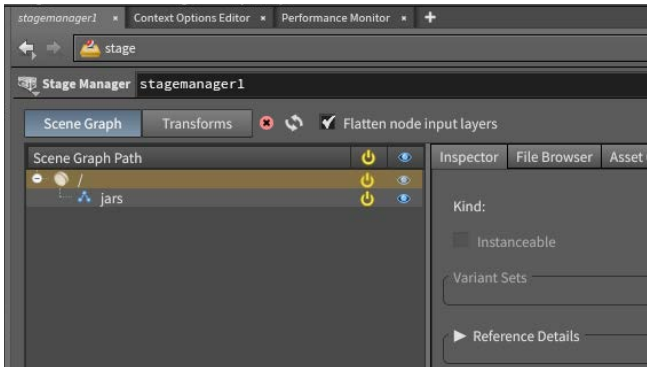
05 Add a **Group Expand** node to the end of the chain and set its Display Flag. Set the **Group Name** to *shelf_inset*. From the arrow next to **Base Group**, select *shelves*.

Set the **Steps** to **-2**. This will remove the outer ring of primitives from the group.

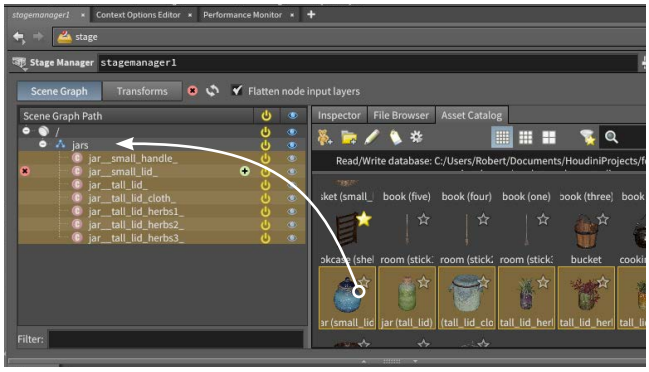


06 Add a **Blast** node to the end of the chain and set its Display Flag. From the arrow next to **Group**, select *shelf_inset*. Turn on **Delete Non Selected**.

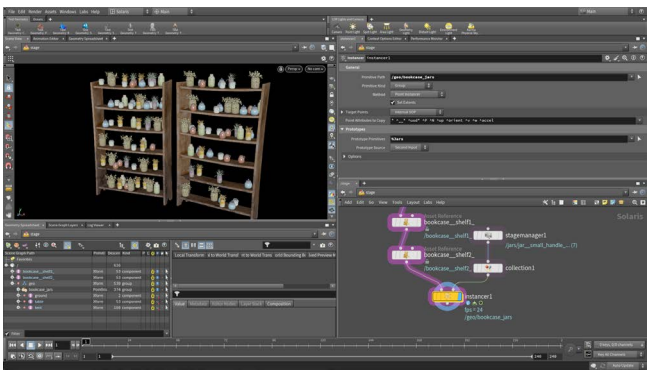
Add a **Scatter** node to the end of the chain and set its Display Flag. Set the **Force Total Count** to **120**. These will be the points used for instancing the jars. Later you can add more jars by increasing this number.



07 Go up one level to the *Stage* Level. In the Network view press **tab > Stage Manager** and place the node off to the side without wiring it into anything. In the Scene Graph Path section, hover over the / path and a + sign appears. Click on the plus sign which creates a group node. Double-click on the group and rename it *jars*.



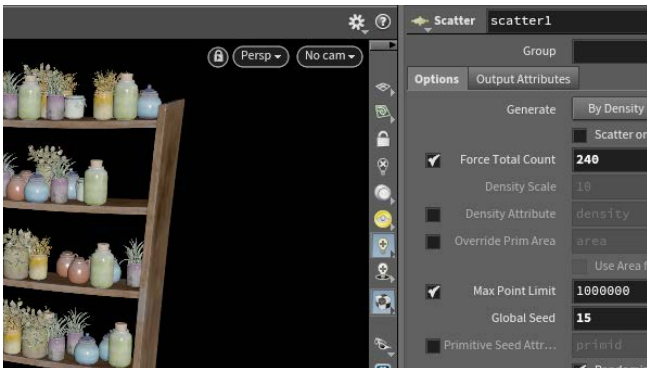
08 Now click on the **Asset Catalog** tab and the Layout Gallery is available as part of this node. Expand the Parameter pane so you can see all the assets. **Shift select** all of the jar assets and drag them onto the *jar* group. This will make them available to the instancer node.



09 Add a **Collection** node after the stagemanager node. Set the **Collection name** to *Jars* and set **Primitives** to */jars/**.

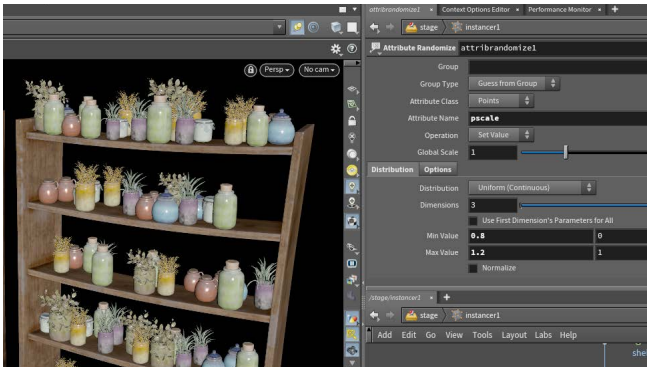
Wire the *collection* node into the second input of the *instancer* node. On the **Instancer** node, remove the text from **Prototype Primitives** then from the menu on the right choose *Collection: Jars* to set it to *%Jars*. Set the Display flag on the *instancer* node and in the Scene view you can see some jars set up on the shelves.

To focus on the shelves, click on the **eye** icon next to *ground*, *table* and *tent* in the Scene Graph. You can bring them back later. You can also set the **Visibility** to **Final Render** to see the full geometry.



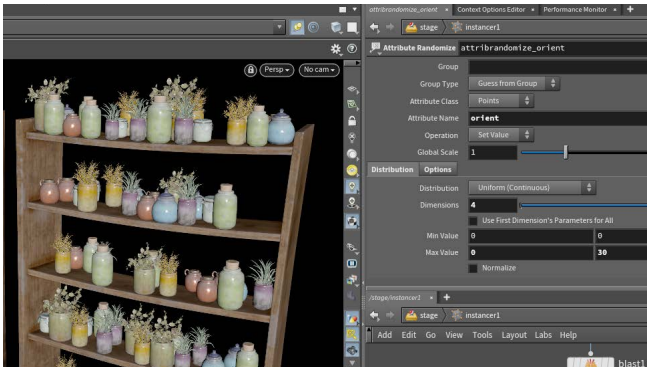
10 In the top bar of the Scene view, click on the **Pin** icon. Double click on the *instancer* node. Now you can tinker with the geometry network while seeing the result at the *stage* level.

Select the *scatter* node and change **Force Count Total** to **240**. Now the shelves have more jars on them. Drag on the **Global Seed** slider to explore different options for setting up the points.



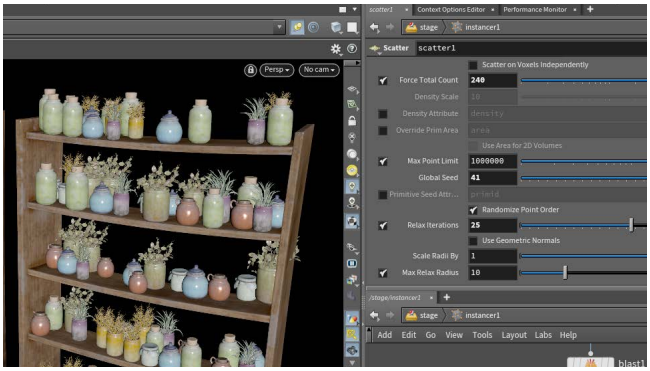
11 Create an **Attribute Randomize** node and place it between the *blast* node and the *scatter* node. Set the Attribute Name to *pscale*. Now you can see all of the jars are randomly scaled.

Set the first **Min Value** to **0.8** and the first **Max Value** to **1.2**. This create a more appropriate range.

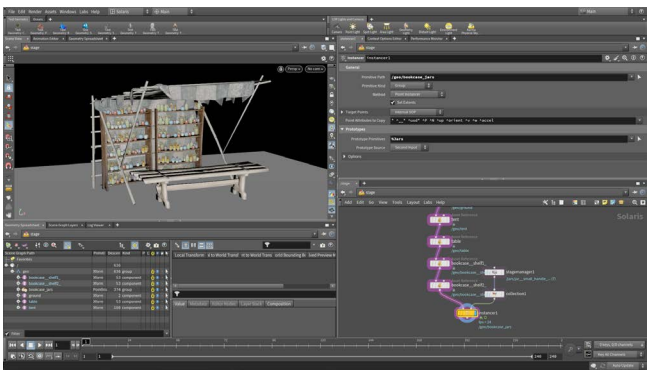


12 **Alt-drag** the **Attribute Randomize** node and place it between the first *attributerandomize* node and the *scatter* node. Set the **Attribute Name** to *orient* then set **Dimensions** to **4**. The jars are now oriented in all directions

Set all the **Min Value** to **0, 0, 0, 0** and the first **Max Value** to **0, 60, 0, 1**. This will randomly rotate around the Y axis to add some more variety to the jars.



13 Select the *scatter* node and drag **Relax Iterations** down to **0**. You will see more jars overlapping with this setting. Now drag **Relax Iterations** up to around **25**. This will change the relationship between the jars and allow them to fit better on the shelves. You can again use the **Global Seed** slider to get the look you want based on these new settings.

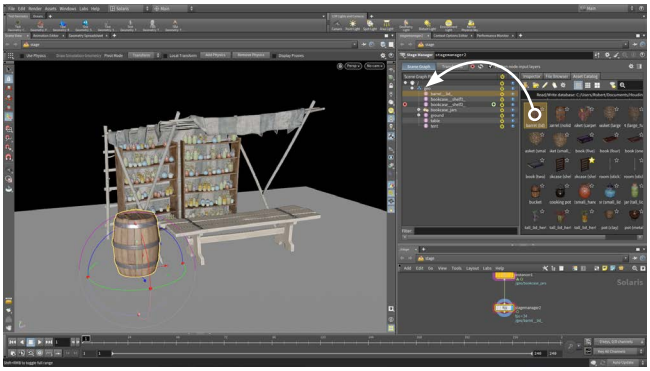


14 Go back up to the *stage* level. To see the whole scene, click on the **eye** icon next to *ground*, *table* and *tent* in the Scene Graph to bring them back.

Set Visibility back to **Preview with Guides** to display the proxies before moving on to the next step. You can click on the eye icon next to *bookcase_jars* to turn off the jars if you want to optimize the scene while you add more props. Or you can leave them if you are getting good performance with the proxy geometry.

PART FIVE:
Add Props using the Stage Manager

So far you have dragged items from the Gallery to the stage which has resulted in reference nodes in the network. You are now going to use the Stage Manager node to work with several assets at the same time. This node gives you access to the gallery and lets you place, duplicate and set variants on your assets.

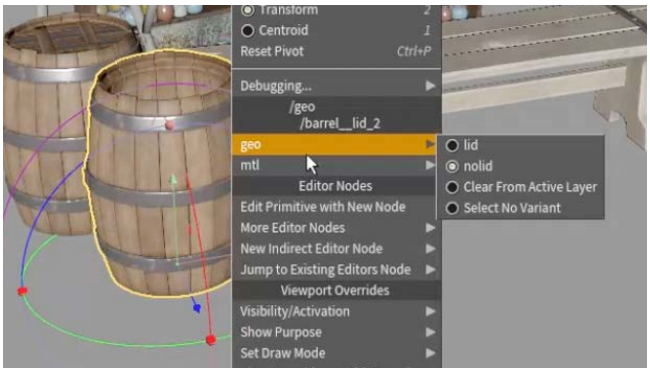


01 Add a **Stage Manager** node under the *instance* node and set the Display flag on the *stagemanager* node. In the Parameter pane, click on the **Asset Catalog** tab. Click on the down arrow on the bottom of the Scene View to expand it from top to bottom. This will give you more space to work.

Drag a *barrel (lid)* from the catalog to the Scene Graph and be sure to drop it on the *geo* group so that it is under it. In the Scene view **press t** to get the **Translate** handle and move in x and z to place the barrel next to the table.

02 With the barrel still selected, press **Ctrl-D** to duplicate it. Move it beside the first one. Be sure to only translate in x and z. **Duplicate** again and move the third barrel to the other side of the table.

Press and hold **S** to turn on **Select** mode and select one of the original barrels. Now you can move that one to tweak its position.



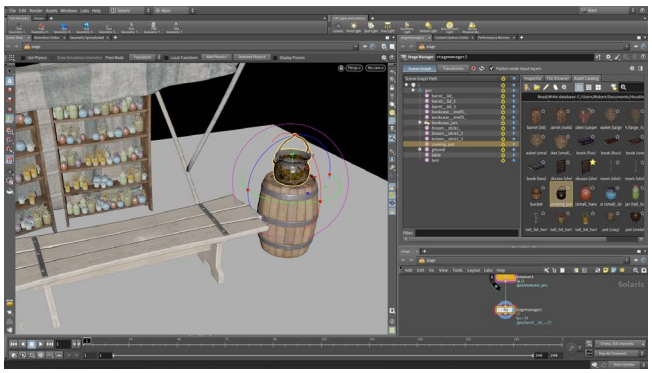
03 **RMB-click** on one of the *barrels* and select **geo > nolid** to change it to the *nolid* variant. The Stage Manager gives you access to the variant feature of the assets you built using the component builder.

04 Drag the *Broom* asset from the catalog to the Scene Graph list and place it in *geo*. In the scene, use the **translate** and **rotate** handles to move it into the barrel so that it is leaning on the edge of the barrel. Duplicate to create a second and move it around inside the barrel.

Add another one outside the barrel but leaning on the side. **RMB-click** on one of the *broom* and select **geo > stick3** to change it to this variant

THE STAGE MANAGER

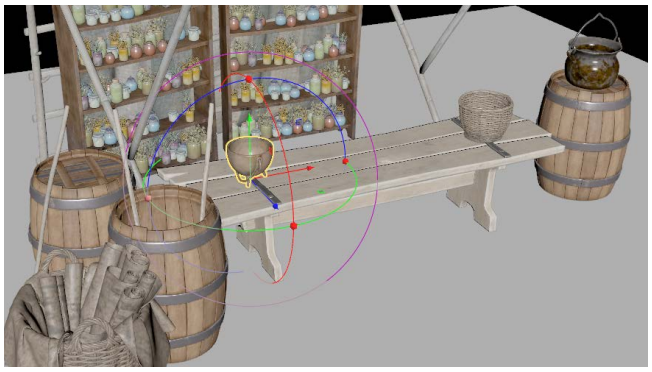
The **Stage Manager** node references in prims from disk and attaches them to prims in the scene graph tree. This serves the same function as the **Reference** LOP, however this node provides a custom interface to make it easy to reference in many files and interactively place them in the tree. Referencing in many files at a time is often part of a layout workflow, where you start to build a scene by importing available assets and organizing them into a meaningful hierarchy. There are some limitations when working with complex USD setups therefore you should read the documentation to understand this node.



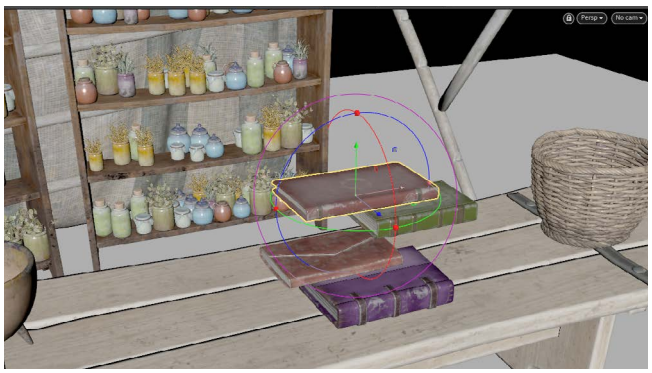
05 Drag the **Cooking Pot** asset from the catalog to the scene. Before clicking to place it, press **Ctrl J**. This turns on snapping. You can now move the pot onto surfaces such as the table or the barrels. Click to place the pot on top of the table.

After placing the pot, click on the center of the translate handle to move it some more. The snapping will still work. Move the pot on top of one of the barrels.

In the Scene Graph area of the **Stage Manager** you can see that the pot was not put into the *geo* group. Drag it down to make it a child of *geo*. This keeps your scene graph organized.

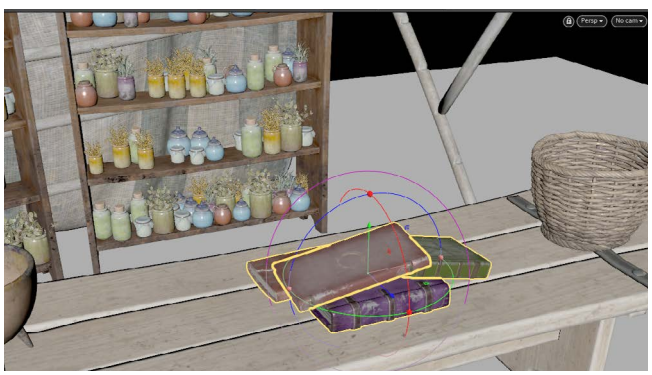


06 Add the **Basket with Carpets** to the shot along with a **small basket** and **pot** to the top of the table. Make sure they are all organized under the *geo* group. You can use the snapping to help with placing all of the props.



07 Add a book and using snapping to place it on top of the table. Press **Ctrl-J** to turn off snapping. Select the book and press **Ctrl-D** to duplicate it. Move it up and a bit to the side. **Duplicate** two more times and lift the it up and off to the side again.

RMB-click on the last three books and choose different variants using the *geo* submenu.



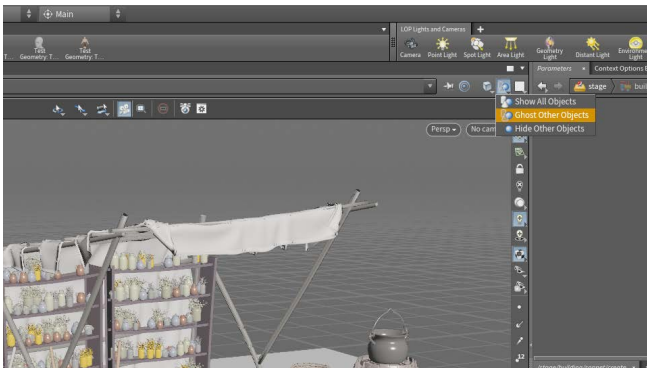
08 **Press s** and **shift** select the books and the table. In the Operation Control bar at the top, click on the **Add Physics** button. Now select only the books and turn on the **Use Physics** check box.

Now with the move tool drag the books down along Y. They will collide with each other and the table. This gives you a more realistic grouping of books.

You can add more books and add them to the pile. Just be sure to **Add physics** before moving them. Turn off **Use Physics** at the end.

PART SIX:
Create Background Elements

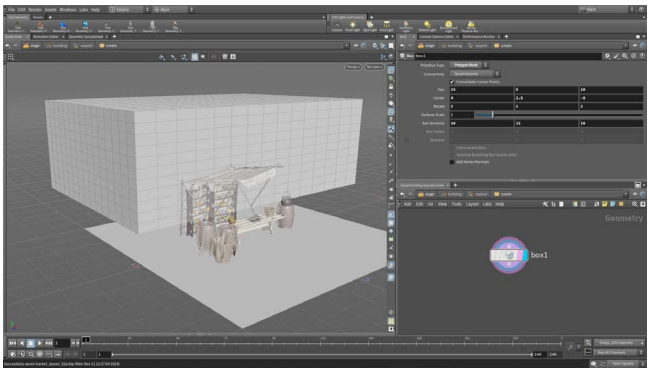
This scene would look better with some context. You are going to build a small building behind the market stall to flesh out the scene. This involves going to the geometry level where you can still see the Stage level to make creative decisions. You will also add detail to the ground surface using textures created in Copernicus to make it look like sand dunes.



01

This set could use a background element such as a small building. You can add that to the scene by adding a **SOP Create** node to the end of the chain. Set its Display Flag and rename it ***building***.

Double-click to dive into this network. Click on the **Visibility** pull down in the top right of the Scene View and choose **Ghost Other Objects**. This will show the props from the LOP level to help you position the building.

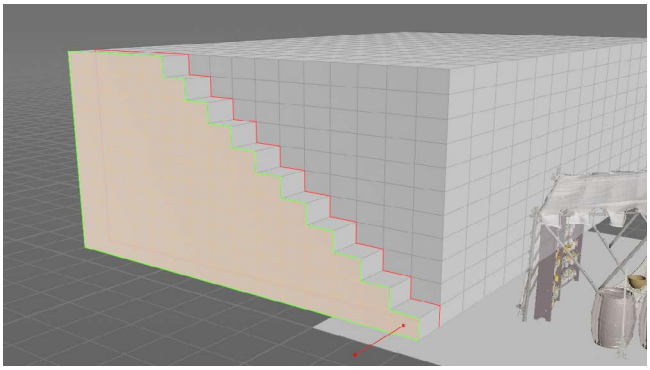


02

Add a **Box** node to use as the starting point of the building. Set the Following:

- **Size** to **15, 4, 10**
- **Center** to **4, 2, -8**
- **Axis Divisions** to **16, 12, 16**

This puts the tent at the corner of the building. You can now add details to make it look better for the shot.



03

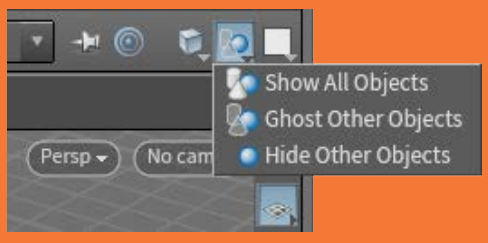
Tumble to the left side (from your point of view) of the building. **Press s** and then **4** to get primitive selection. Select the primitive at the bottom back corner then press **Shift - a** and select the whole bottom row. Press **Shift** and select the second polygon at the back of the building. Press **Shift-a** to select the whole row minus two polygons. Continue doing this until you have a staircase shape.

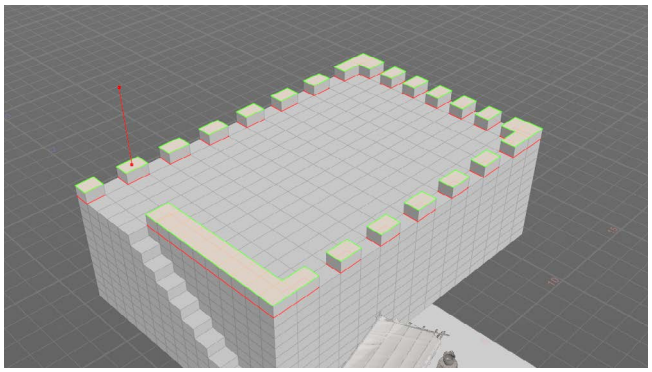
Press **tab > PolyExtrude**. Pull the shape out to a **Distance** of around **0.8** to create a skinny staircase going up the side. These are big steps to suit the type of building we are creating.

VISIBILITY MENU

When working at the geometry level of a node such as **SOP Create** or the **Instancer**, you may or may not want to see through to the Solaris level. The visibility menu at the top right of the Scene View lets you hide the Solaris level, ghost it or fully display it.

You will find yourself toggling between these options as you model at the geometry level. It makes it easier to make creative decisions when you can visually reference the larger context.

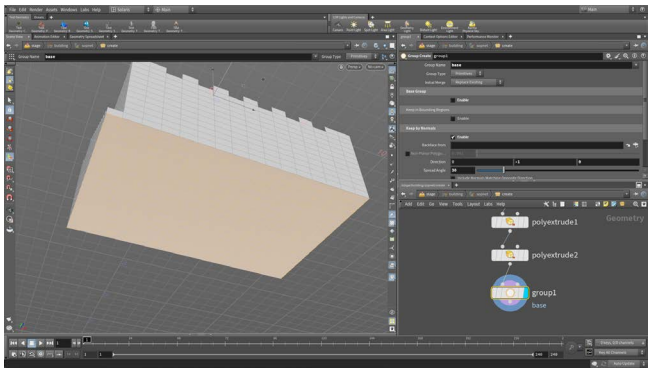




04 Tumble around to see the top of the building. Select the primitive at the back of the building behind the stairs. Press **Shift-a** and click on the four corners and then back along the side of the stairs.

Now press the **Ctrl** key and click to remove the polygons shown here. Every second one but leave two near the corners.

Press **tab > PolyExtrude**. Pull the shape out to a **Distance** of around **0.5** to turn the top of the building into a battlement.



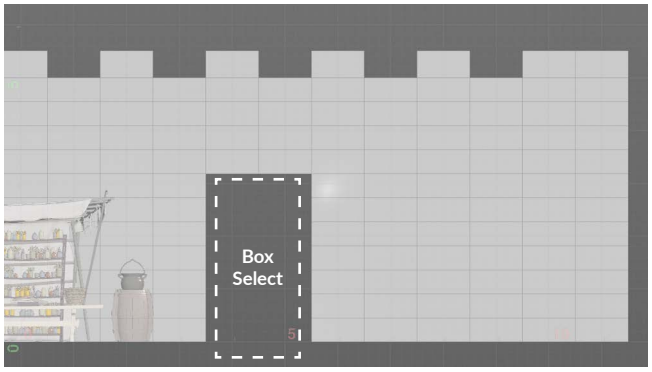
05 Set the **Visibility** to **Hide Other Objects**. This will make it easier to work with the bottom polygons.

Add a **Group** node and set the **Group Name** to *base*. Turn off **Base Group > Enable** and turn on **Keep by Normals > Enable.** Set the following:

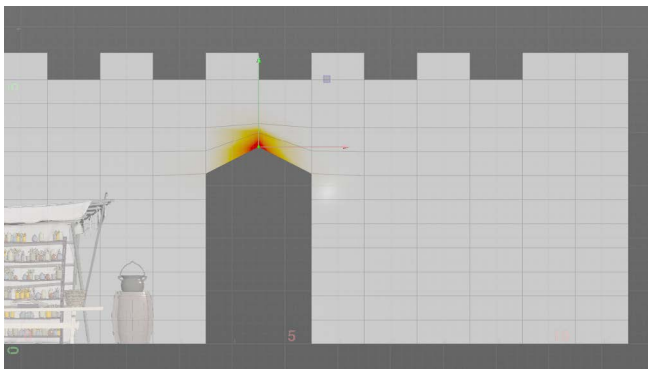
- **Direction** to **0, -1, 0**
- **Spread Angle** to **30**

Get the **Handle** tool to see the primitives that belong in the group.

Add a **Blast** node and set its **Group** to *base*. This will delete the primitives on the bottom of the building.

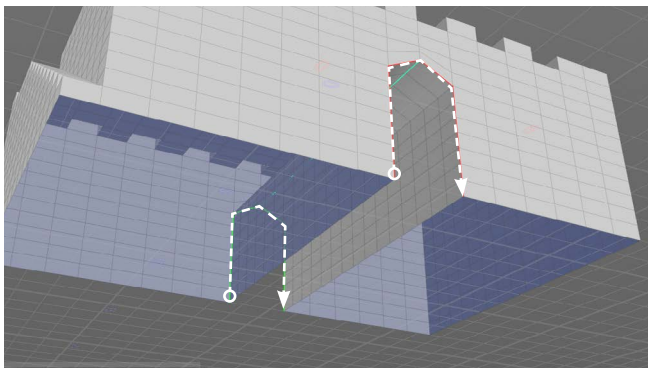


06 Set the **Visibility** back to **Ghost Other Objects**. Press **Spacebar-b** to go to a four view layout then hover over the front view and press **Spacebar-b** again. Add another **Blast** node to the network and set its Display Flag. Press the **arrow** next to **Group** and box select the polygons shown here to the right of the tent. Press **Enter** to select. This will create an opening on both sides of the wall.



07 **Press 2** to get point selection and select the points at the top of the opening. **Press t** to get the **Move** tool and move the points up to arch the opening.

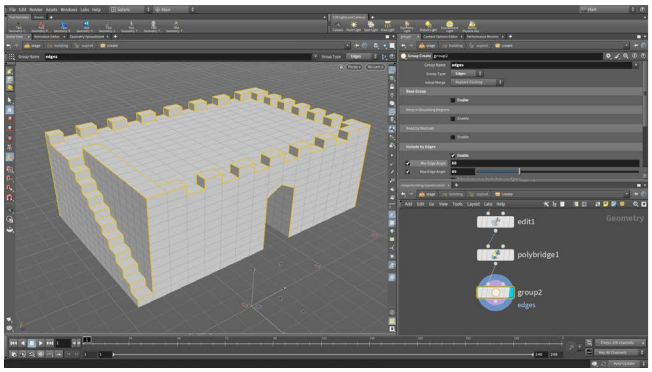
On the *Edit* node, set the **Soft Radius** to around **1.2** to make sure the other points move with it.



08 Set the **Visibility** back to **Hide Other Objects**. Press **Spacebar-b** to go to a four view layout then hover over the perspective view and press **Spacebar-b** again. Tumble around to see the bottom of the building.

Press 3 to get edge selection and select the bottom edge of the back opening. Press **Shift-A** and click on the other side to get the whole profile. Press **tab > PolyBridge**. Now select the front openings profile and press **Enter**.

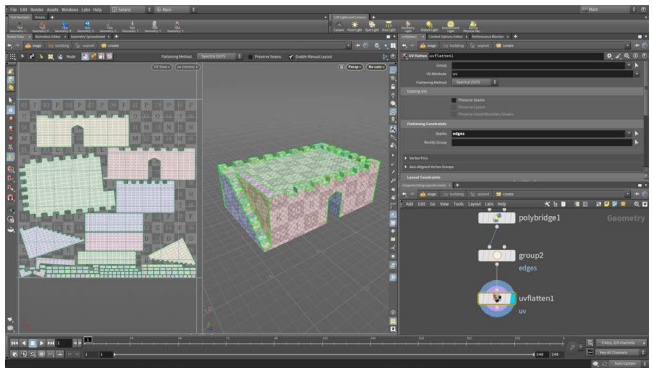
Set **Divisions** to **15** to match the sides of the building.



09 Add a **Group** node and set the **Group Name** to *edges* and **Group Type** to **Edges**. Turn off **Base Group > Enable** and turn on **Include by edges > Enable.** Set the following:

- **Min Edge Angle** to **60**
- **Max Edge Angle** to **95**

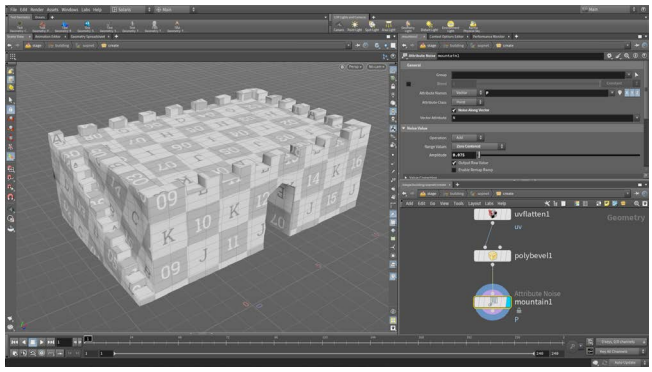
Get the **Handle** tool to see that only the right angle edges have been added to the group.



10 Add a **UV Flatten** node to the end of the chain. Set its Display Flag. Set the following:

- **Seams** to *edges*

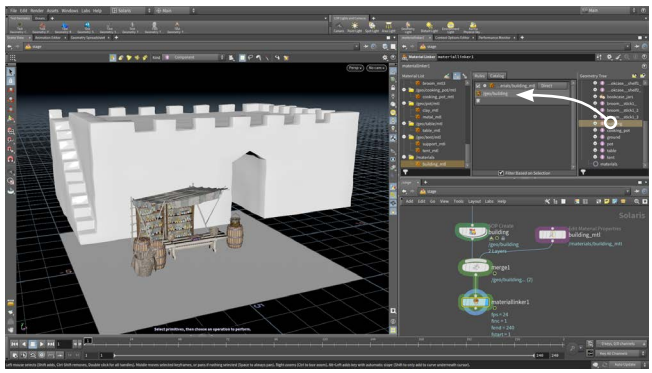
Click on the **Repack** button in the Operation Controls bar. You will see in the UV View how the geometry is laid out. This will work fine because later you will be adding a noise texture to add more detail to the look of the building.



11 Add a **PolyBevel** node to the end of the chain. Set its Display Flag. Set the following:

- **Group** to *edges*
- **Distance** to **0.05**
- **Fillet > Divisions** to **2**

The building needs a bit of noise. Add a **Mountain** node and set **Amplitude** to **0.075**. Add a **Null** node and name it *BUILDING_OUT*.



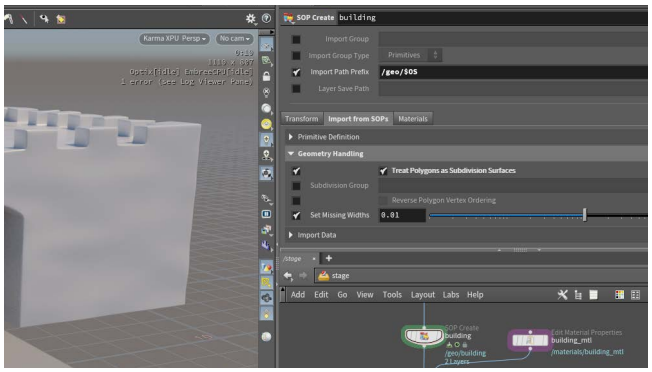
12 Go back to the stage level and create a **Quick Surface Material** and place it to the side. Rename it *building_mtl*. Add a **Merge** node after the *building* node and merge the *building_mtl* node into it.

Add a **Material Linker** node to the end of the chain. Open the */materials* section of the **Material List** and drag the *building_mat* over to the **Rules** section. Find the *building* in the **Geometry Tree** and drag it to the Material section of the rule.

MODELING IN SOLARIS

This lesson began with you converting existing bgeo files into USD. By modeling directly in the **SOP Create** node, you are automatically generating USD that is part of your scene but won't be saved to disk until you export out the completed scene assembly. Modeling in context allows you to make key creative decisions.

Once this model is fleshed out, you could send the geometry network to the modelling team who could put more time into refining the asset then use the Component Builder to export it to USD. It can then be layered back into the scene.

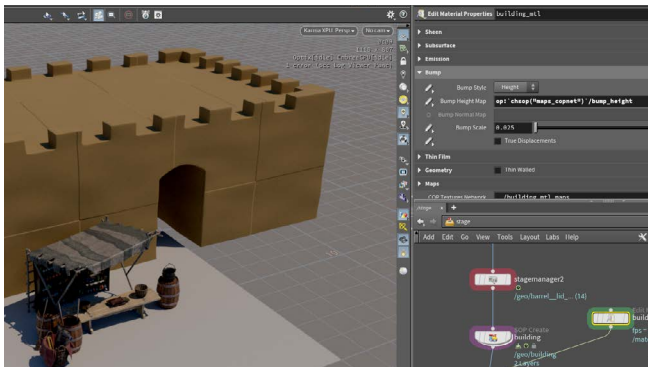


13 Add a Karma Physical Sky node to the end of the chain and set the following:

- **Solar Altitude** to **60**
- **Solar Azimuth** to **120**

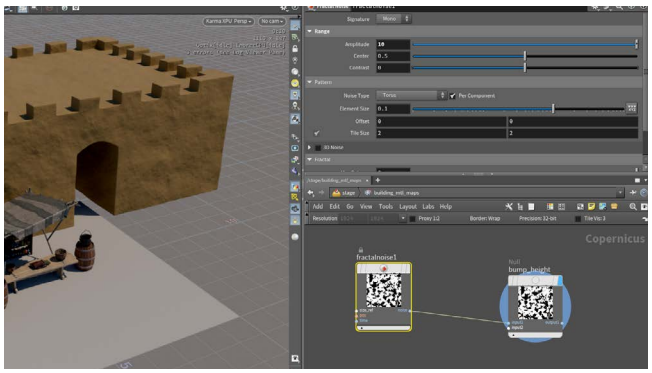
Set the Scene View display to **Karma XPU**. This will help you evaluate the material choices for the building.

Select the *building* node and then click on the **Import from SOPS** tab and under **Geometry Handling** turn on **Treat Polygons as Subdivision Surfaces**. This will ensure micropolygon subdivisons at render time.



14 Select the *building_mtl* node and set the **Base > Color** to **0.25, 0.15, 0.05**. Set **Specular > Roughness** to **0.8**.

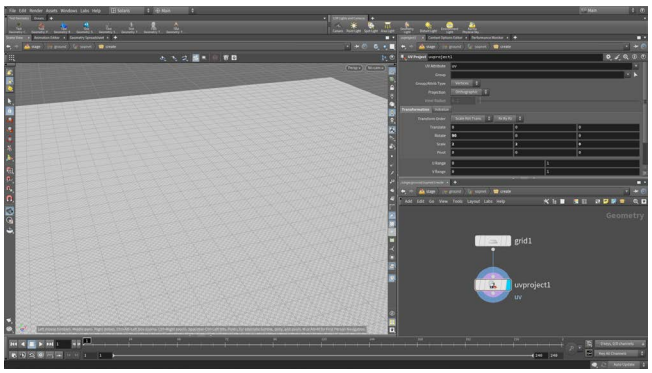
Scroll down to the **Bump** section and set **Bump Style** to **Height**. Click on the button on the left of **Bump Height Map** and choose **Set or Create** then click on the **Create COP Texture** button. This adds to a COP Network off to the side.



15 **Pin** the Scene View to the stage level. **Double-click** on the COP Network node to dive into it.

Here you will find a *bump_height* node being fed by a checker node. **Delete** the checker node and press **tab > Fractal Noise**. Place this node down and connect the *noise* output to *input1* on the *bump_height* node.

Check out the Scene View to see the effect of the texture. It needs some more intensity. On the *fractalnoise* node, set **Amplitude** to **10**. This adds a bumpy look to the surface of the building.

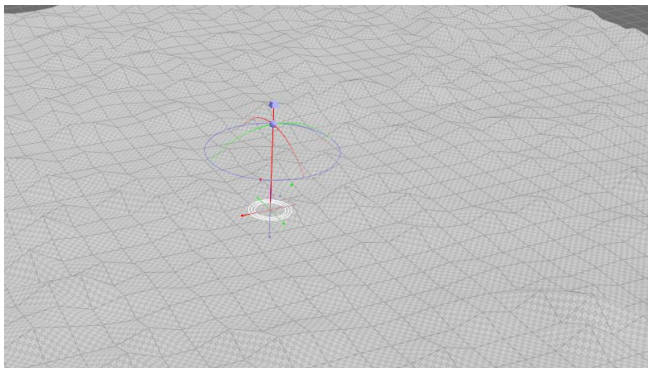


16 Now the ground surface looks a little plain Go back to the *stage* level and double-click on the *ground* node to dive into it. On the *ground* node set the following:

- **Size** to **50, 50**
- **Rows** to **50**
- **Columns** to **50**

Add a **UV Project** node and set the following:

- **Rotate** to **90, 0, 0**
- **Scale** to **2, 2. 0**



17 Add a **Mountain** node and set the **Amplitude** to **1**. This will create a bumpier surface for the ground. But we don't want any points to go below 0.

Add a **Group** node and set **Group Name** to *belowground*. Turn off the **Base Group > Enable** and turn on the **Keep in Bounding Regions > Enable**. Set the following under Bounding Box:

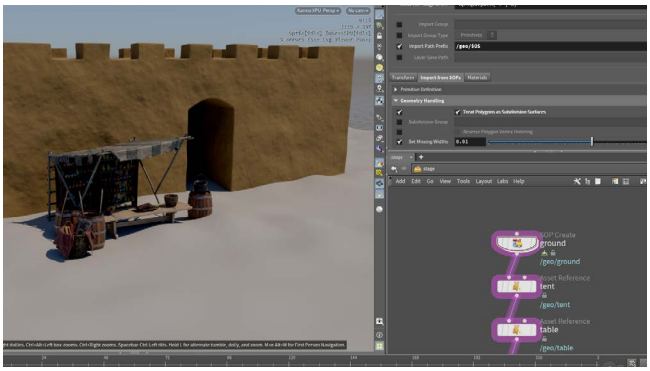
- **Size** to **100, 1, 100**
- **Center** to **0, -0.5, 0**

Add a **Flatten** node and set **Group** to *belowground*. Now any points that were below 0 are lifted up to 0.

PROCEDURAL TEXTURES WITH COPERNICUS

The new Copernicus context is a 2D and 3D GPU image processing framework that provides real-time image manipulation and is ideal for tasks such as building texture maps and setting up Slap Comps. When working with the Quick Surface Material, you can quickly set up a COP Network for building up textures that plug right into the material.

This context is currently a **beta feature** in Houdini and should be used with caution in production. It is good for you to learn about it now so you can explore what is possible.

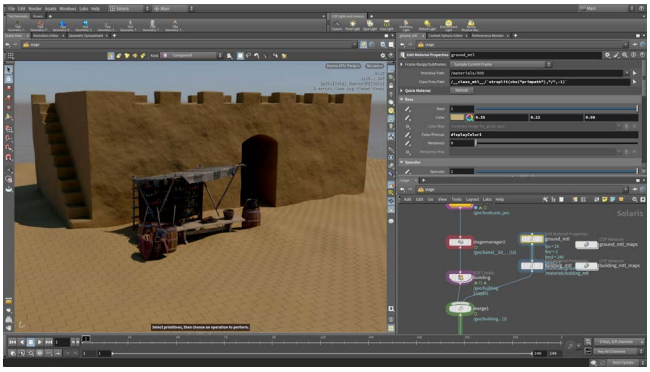


18

Add a **Subdivide** node to smooth it out a little then add a **Null** node and name it *GROUND_OUT*.

Go up to the stage level. Select the *ground* node and then click on the **Import from SOPS** tab and under **Geometry Handling** turn on **Treat Polygons as Subdivision Surfaces**. In the Scene view you can see the ground looks more organic.

There is some overlap between the ground and some of the tent props. It looks like the sand has blown over the stall a bit.

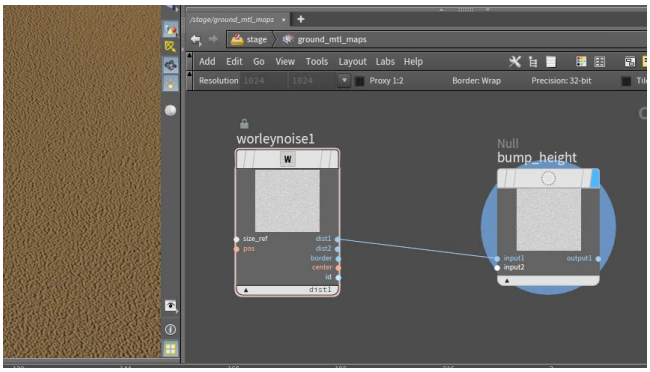


19

Create another **Quick Surface Material** and feed it into the *building_mtl* node. Rename it *ground_mtl*.

Select the **Material Linker** node and from the */materials* section drag the *ground_mat* over to the **Rules** section. Find the *ground* in the **Geometry Tree** and drag it to the Material section of the rule.

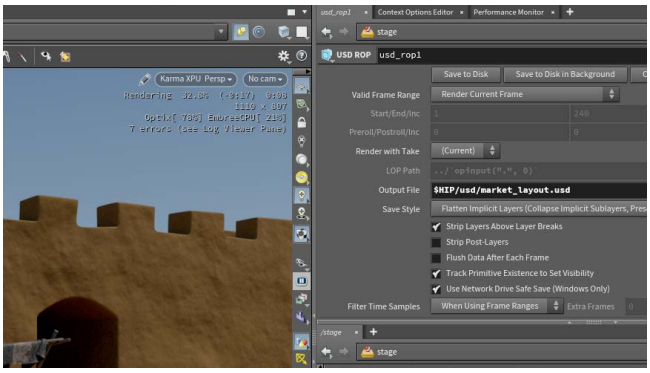
Select the *ground_mtl* node and set the **Base > Color** to **0.35, 0.22, 0.08**. Set **Specular > Roughness** to **0.8**. Scroll down to the **Bump** section and set **Bump Style** to **Height**. Click on the button on the left of **Bump Height Map** and choose **Set or Create** then click on the **Create COP Texture** button.



20

Pin the Scene View to the stage level. **Double-click** on the *ground_mtl_maps* COP Network node to dive into it. **Delete** the *checker* node and press **tab > Worley Noise**. Place this node down and connect the *dist1* output to *input1* on the *bump_height* node.

The texture needs some more fine detail. On the *worleynoise* node, set **Element Size** to **0.01** and **Jitter** to **1.0**. This adds a bumpy look to the surface of the building. Go up to the *stage* level and on the *ground_mtl* node set **Bump Scale** to **0.01**.



21

Create a **USD ROP** and place it to the side. Rename it *ground_mtl* then connect it with the *materiallinker* node.

IMPORTANT: Make sure the *karmaphysicalsky* node is not part of this chain. You want to give the lighters a clean slate.

Set **Output File** to *$HIP/usd/market_scene.usd*. Click **Save to Disk**.

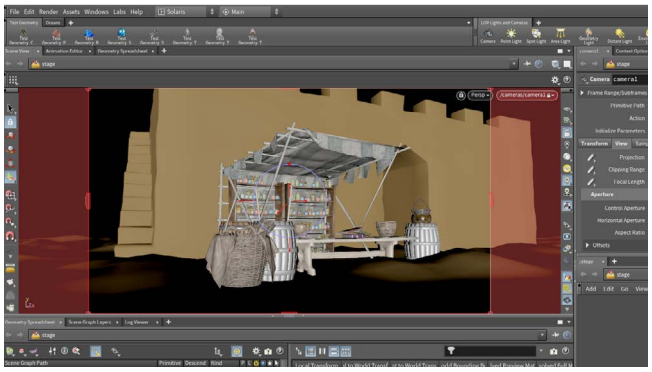
Save your scene file.

PART SEVEN:
Shot Layout and Lighting

You are now going to start a new scene where you will layout two shots as a Shot Layout/Lighting artist. You will learn how to tweak the elements of the scene to suit each shot and how to use insertion nodes to make it easier to add nodes to the right place in a network. Each shot will have a unique look using the same base assets you set up in scene assembly.

01 Select **File > New**. Select **File > Set Project.** Find the *market_lesson* directory and press **Accept**. Change your desktop to **Solaris**. Select **File > Save As**. Click on *$JOB* to get the project directory and set **File** to *market_shot_layout.hip* and then press **Accept**. You are going to work as a layout and lighting artist.

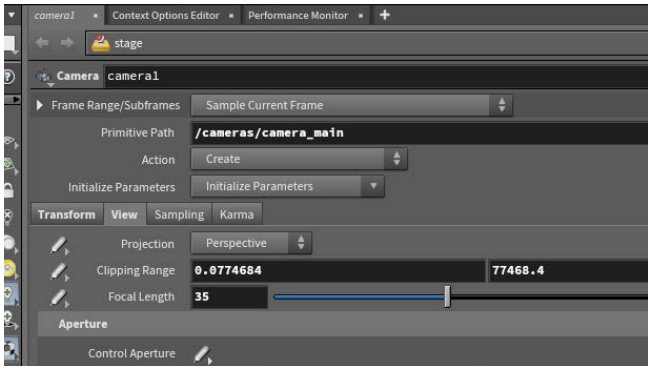
In the Network view, press **tab > Sublayer**. Click on the file chooser next to **File** and get the */usd/market_scene.usd* file. You will now see the whole market scene. In the **Scene Graph**, you will see that the structure of the scene hasn't changed. This will allow artists to work with the scene without altering the contents of the *market_scene.usd* file.



02 In the Scene view, use the view tools to get the right angle then from the **No Cam** menu in the top right corner, choose **New Camera**.

You can use the *camera* handles in the center of the view to adjust the view. Or you can go to the right side of the Scene View, click on the **Lock camera to view** button. Now use the **View tools [Spacebar-LMB/MMB/RMB]** to tweak the position the camera.

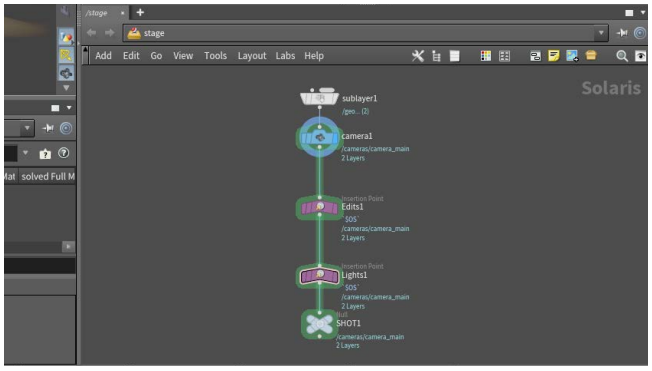
Click on the View tab and set the **Focal Length** to **35**. Now use the view tools to reframe the camera to see more of the scene.



03 Change the **Primitive Path** on the camera to */cameras/camera_main*. This will ensure that the camera name is not tied to the node name.

The name change will make you lose the camera. Select *camera_main* from the **Camera menu** in the top right of the Scene view.

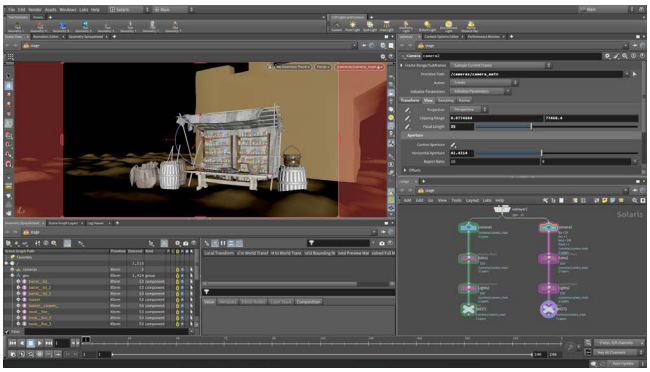
When you finish, toggle off the **Lock Camera** button in order to avoid losing your chosen camera view. You may want to tumble around later to make adjustments to the layout and you don't want the camera to come with you.



04 Add a **Null** node and name it *SHOT1*. Now press **tab > Insertion Point** and add this node between the camera and the null nodes. Rename the node *Edits1* and on the node change the **Name** to `$OS` which uses the node name as the name of the insertion point.

Alt-drag and place the node between the first *insertion* point and the *null* node. Rename this node to *Lights1*.

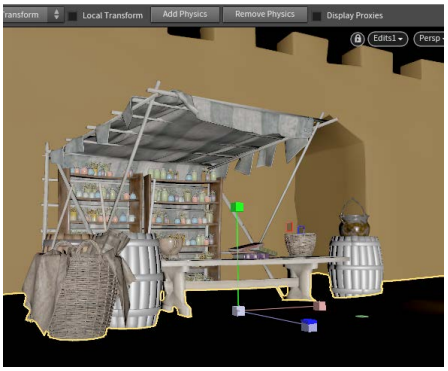
These nodes will be helpful when you start making edits to the shot. They will allow you to work in the Scene View while nodes get placed where you need them in the network.

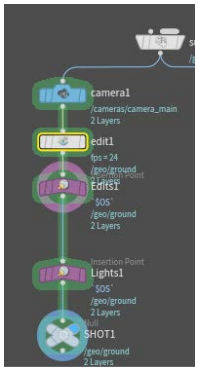


05 Select the *camera1*, *Edits1*, *Lights1* and *SHOT1* nodes and **Alt drag** them to the right. This creates a *camera2* that still has a prim name of *camera_main*, a duplicate of the others nodes.

Set the Display Flag on *SHOT2* and select the *camera2* node. Click on the **Lock camera to view** button. Now use the **View tools [Spacebar-LMB/MMB/RMB]** to tweak the position the camera to look at the shot from the other side.

When you finish, toggle off the **Lock Camera** button in order to avoid losing your chosen camera view.

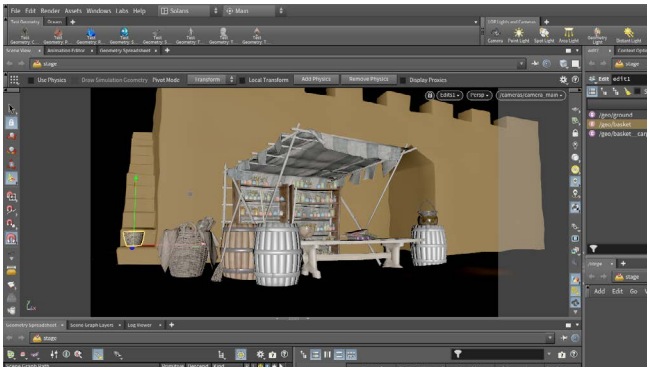




06 Set the Display Flag on *SHOT1*. Because both cameras are named *camera_main* the Scene view will update when you choose the first node chain.

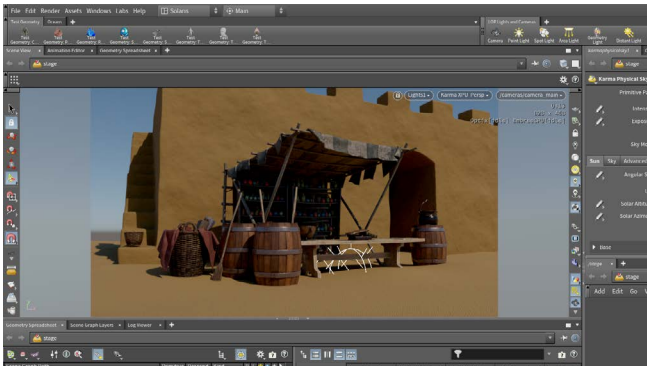
In the Scene View, Click on the **Insertion Point** menu and choose *Edits1*. Get the **Select** tool and click on the *ground* surface. Press **tab > Edit**. This node is now placed just above the Insertion point rather than at the end of the chain.

Press e to get the **Scale** handle and scale along the **Y axis** to make the surface bump less pronounced.



07 **Press s** and click on the *basket with carpets*. **Press t** to get the **Move** handle and move the basket back along the Z axis so you can see the barrels better.

Press s and click on the *small basket* on the table. Press **Ctrl-j** and use the **Move** handle to move the basket to one of the steps on the background building.



08 In the Scene View, Click on the **Insertion Point** menu and choose *Lights1*.

Press **tab > Karma Physical Sky**. This node is now placed just above the Insertion point rather than at the end of the chain.

From the **Persp** menu in the Scene View, choose **Karma XPU**. You can now preview this shot in Karma.

To create a daylight scene, set the following:

- **Solar Altitude** to **45**
- **Solar Azimuth** to around **160**

INSERTION POINTS

You can have multiple insertion points in a network and switch between them using the menu in the viewer. When you create new LOP nodes in a view, Houdini inserts them above the active insertion point instead of at the end of the network.

This is ideal for multi-shot editing workflows, where artists working on a shared file in the Scene view can choose the a specific insertion point for their department to make sure the nodes are created in the right part of the network. For example, you could have insertion points for Lighting, Camera, and Layout.

PRUNING

When working with USD you cannot delete items in the active layer. Instead you can use a Prune node to either hide or deactivate them. Deactivated prims and their children will not be traversed or processed by USD functions or LOP nodes. Children of deactivated primitives don't appear in the Scene Graph Tree. Hidden prims and their descendants are still processed by USD functions and LOP nodes, but are not shown in the viewport or rendered.

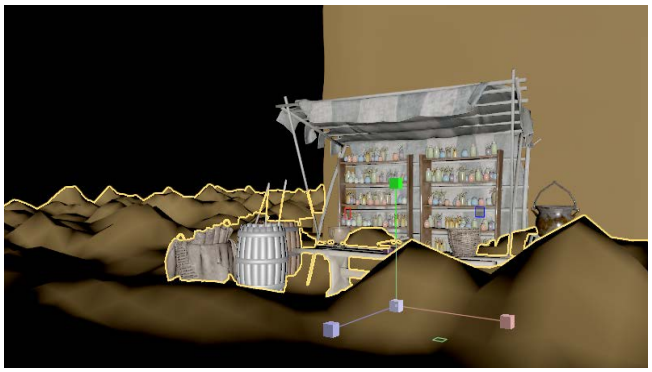
You are going to hide some elements from the Scene Assembly to create a more barren second shot. You haven't changed the incoming USD file, you have just pruned some items,

09 In the Scene View, press **tab > Light**. This adds a light node just before the insertion point.

Press **Enter** to place it at the origin then use the handle to move it into the tent above the ground. This will illuminate the shelves and the inner part of the tent. Leave the intensity set to 1. You can adjust this later.

On the **Display Options** bar, you can click on the **Display Light Guides** button to turn it off.

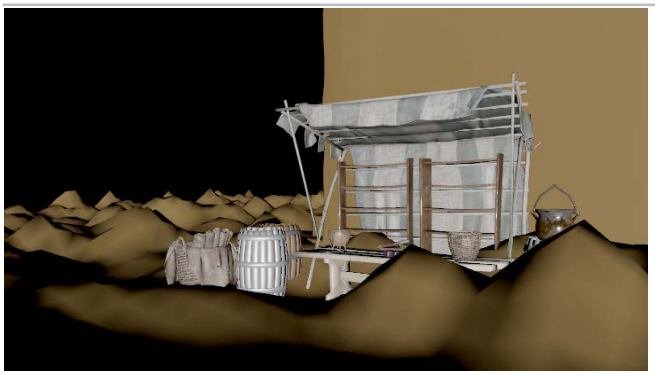
You have now made specific edits to the first shot and set up lights. Now let's take a look at the second shot.



10 Set the Display Flag on *SHOT2*. In the Scene View, Click on the **Insertion Point** menu and choose *Edits2*. Go back to Houdini VK for the viewport Display.

Get the Select tool and click on the *ground* surface. Press **tab > Edit**. This node is now placed just above the Insertion point rather than at the end of the chain.

Press e to get the **Scale** handle and scale along the **Y axis** to make the surface bump more pronounced until it looks like the scene is buried in sand.

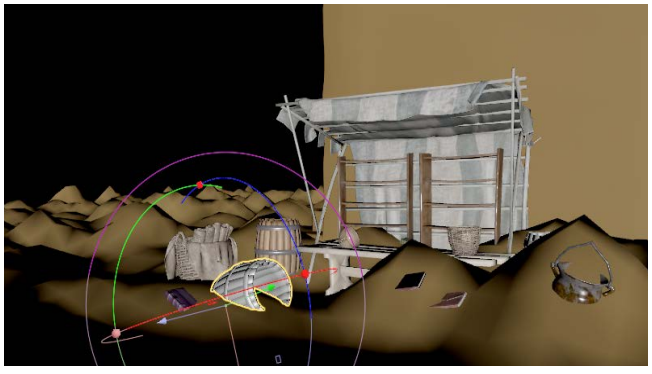


11 In the Scene View, click in the sky to deselect the ground and then press **Tab > Prune**. Press **Enter** with nothing selected. This will add a *prune* node into the network above the Insertion point.

In the Parameter pane, set the **Primitive Pattern** to:

/geo/broom /geo/bookcase_jars*

These items will now be removed from the scene. You are not deleting them but rather you are making them invisible. Imagine that they were lost in the storm.



12 **Press s** and click on the *barrel with nolid*. **Press t** to get the **Move** handle and move the basket in front of the table then **press r** to get the **Rotate** handle and rotate it to look buried in the sand. Make sure you can see into the barrel.

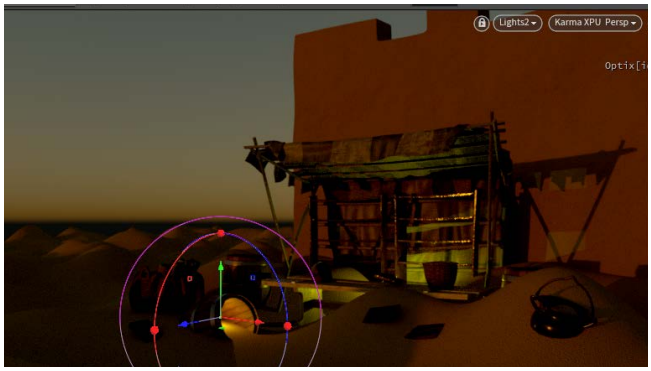
Select and move the books and pots to put them into the sand or toppled over on the table. You might want to use **Ctrl-j** to help place them on the sand. Make a mess of things.

13 In the Scene View, Click on the **Insertion Point** menu and choose *Lights2*.

Press **tab > Karma Physical Sky**. Set the following:

- **Intensity** to **1.5**,
- **Solar Altitude** to **2**
- **Solar Azimuth** to around **200**.

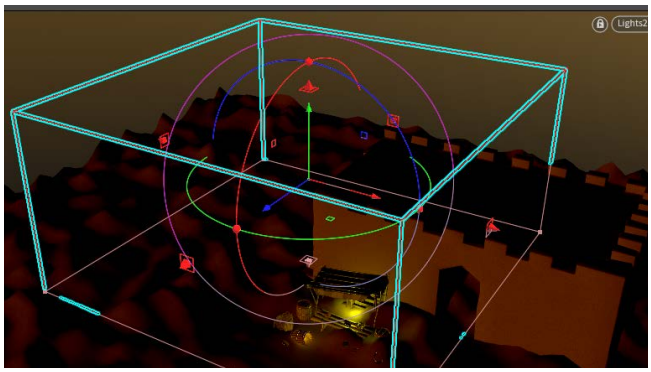
Go back to **Karma XPU** display. This creates more of a late evening look.



14 In the Scene View, press **tab > Light**. This adds a light node just before the insertion point.

Press **Enter** to place it at the origin then use the handle to move it into the tent above the ground. This will illuminate the shelves and the inner part of the tent. Set the **Color** to a yellow color.

Press **tab > Light**. This adds another light node. Move this one inside the barrel on its side. Set its **Intensity** to **0.5** and change its **Color** to **orange**. Something is going on in there that needs to be illuminated.



15 In the Scene View, press **tab > Karma Fog Box**. In the Parameter pane, set the following:

- **Translate** to **-5, 5, -5**
- **Scale** to **20, 10, 20**

You can also go to **Houdini VK** display and zoom out to view the handles on the fog box. You can use these if you want to tweak it further.

16 Go back to the *camera_main* and turn **Karma XPU** back on. You can now see the effect of the fog on the shot. The light inside the tent is creating a nice effect as i illuminates the volume.

Save your work. Next you will dig deeper into rendering the two shots.

KARMA XPU VS CPU

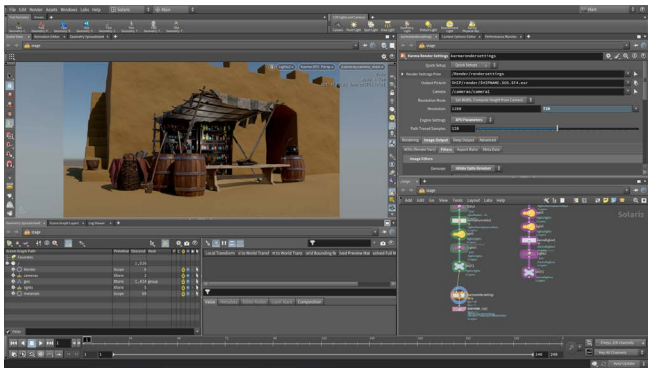
Karma has two render engines designed to produce the same high quality results:

Karma XPU takes advantage of both the GPU and CPU simultaneously to ensure full use of all computers resources. This renderer works exclusively with MaterialX shaders. Karma XPU is the faster renderer and is production-ready for a wide range of uses.

Karma CPU runs entirely in software on the CPU and is able to render both MaterialX shaders and legacy shaders built using VEX. Karma CPU can access a few features not in XPU.

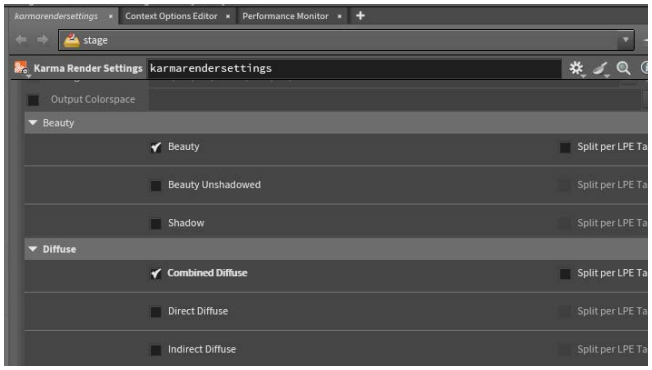
PART EIGHT:
Render Shots with Karma XPU

Now that the two shots are ready, you can refine the rendering. Using Karma XPU, you will use render settings and set up AOVs - render layers for the shot. You will then Snapshot different lighting setups and compare the results. Once the shots are ready, you will render them to disk.



01 Up until now you were using viewport settings to render. You can access them with the **d** key in the scene view. Now you will add a *karmarendersettings* node which will add settings to your node chain.

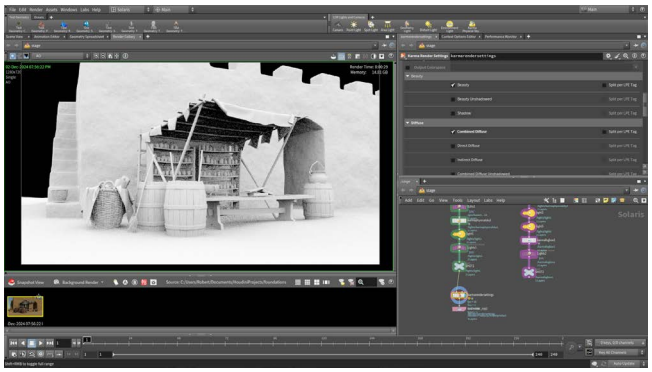
In the **Network View**, press **tab > Karma** to add a **Karma Render Settings** and **USD Render ROP** node. Wire them into the end of the SHOT 1 chain. Set the Display Flag on the *karmarendersettings* node and set **Camera** to */cameras/camera_main/* and **Engine Settings** to **XPU parameters**. On the **Image Output > Filters** tab set **Denoiser** to **nvidia Optix Denoiser** to turn the denoiser back on.



02 On the **Image Output > AOVs** tab, scroll down and turn on the following render layers:

- **Diffuse > Combined Diffuse**
- **Reflections > Combined Glossy Refection**
- **Ambient Occlusion > Ambient Occlusion**
- **Utility > Depth (Camera Space)**

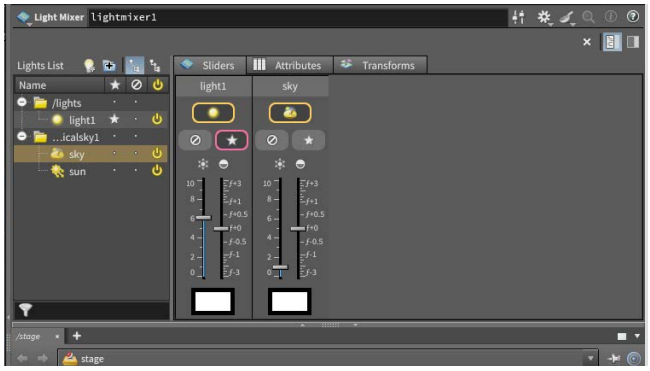
These will be generated at render time and be available for compositing purposes.



03 Click on the **Show Snapshot Strip** button on the bottom of the toolbar to turn it on. Make sure you are looking through the *camera_main* and click on the **Snapshot** button.

In the Scene view tab section, click on the **+ sign** and choose **Solaris > Render Gallery.** You can now click on the snapshot icon and inspect the image.

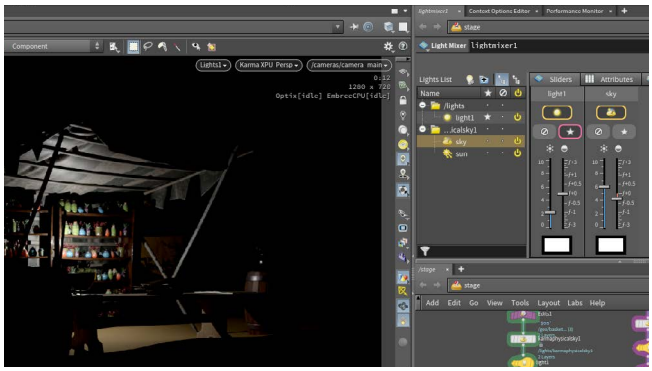
In the top bar you can click on the **C** menu and choose from the different AOVs. Here is the Ambient Occlusion pass.



04 In the Scene View, Click on the **Insertion Point** menu and choose *Lights1*.

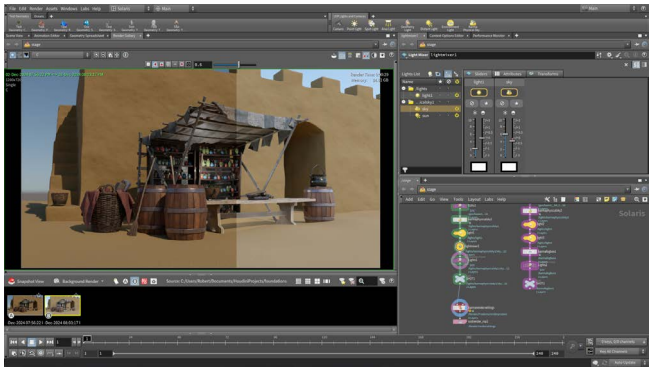
Press **tab > Light Mixer** then press **Enter** to place the node just before the insertion point. This will create a special panel in the Parameter pane which has a list of lights on the left side.

Click on the **Sliders** tab then **Drag** the existing lights from the list to the area on the right. This node lets you layer edits to the existing lights without making changes to original settings. This way if you don't like your edits it is easy to go back to what you had or branch off and try a different setup with a different **Light Mixer** node.



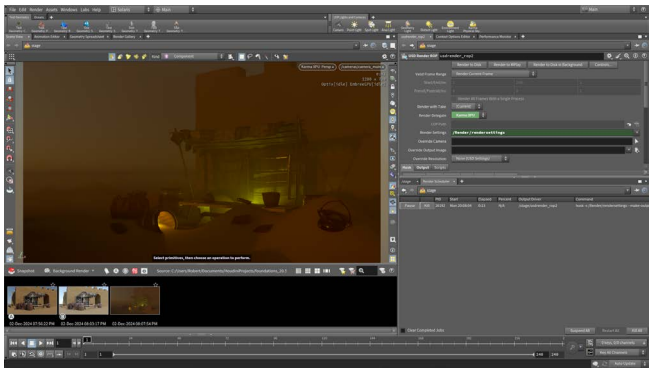
05 Click on the **Star** icon to **Solo** each light to determine each of their contribution then tweak **Exposure** to adjust the lighting. You can click on the icon above the intensity bar and from the pop-up set a **Max value** that works for your shot.

When you are finished be sure to **turn off** the **Solo** button to see all the lights. Once the rendering is complete, press the **Snapshot** button.



06 Go back to the **Render Gallery**. Select the first snapshot and press the **A button** then click on the second one and press the **B button**. In the top bar, drag on the slider to explore the difference between the images.

Go back to the Scene view. **RMB-click** on the older snapshot and choose **Revert Network to this Snapshot**. Now you can see the original rendering. **RMB-click** on the newer snapshot and **revert** it back. The **Light Mixer** node is gone. You can explore different looks for your shot and use snapshots to capture and retrieve them.



07 Select the *karmarendersettings* and *usdrender_rop1* nodes and **Alt drag** them to make copies. Feed the *SHOT2* node into these new nodes. Use the **Snapshots** and the **Render Gallery** to tweak the second shot.

When you are ready to render out the two shots, go to the *karmarendersettings* node and set up the **Output Picture** name then set the **Resolution**. Then go to the *usdrender_rop* node and click **Render to Disk**.

To watch the progress of your rendering, click on the **+ sign** and choose **Render Scheduler.**

CONCLUSION

In this lesson, you learned how to use the Solaris Lookdev, Layout and Lighting tools to create a market scene using existing assets. The Solaris/LOPS context lets you work with USD natively using procedural nodes to manage key USD concepts. You learned how one artist can publish USD layers or files that can be picked up by the next artist. Changes can be added non-destructively to set up a scene or refine a shot.

Along the way you worked with the Component builder to create first-class USD assets, the Stage Manager to bring in and manage the assets and instancing for efficiently setting up multiple assets such as the jars on the bookcase.

Solaris is the context for look development in Houdini and this lesson was designed to give you a good overview of some of its key strengths.