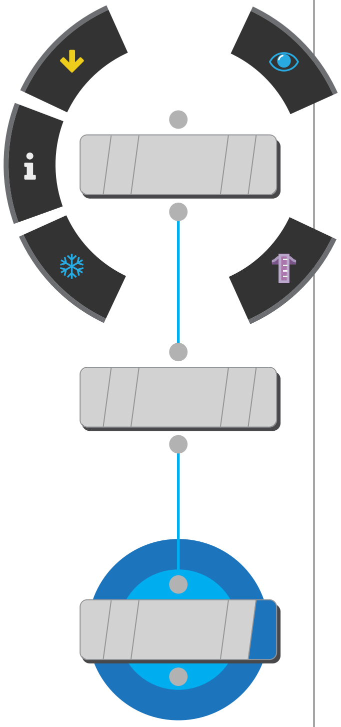
HOUDINI FOUNDATIONS
OVERVIEW



To create 3D animation and VFX for Film, TV, Video Games and VR, you need a combination of technical and creative skills. Houdini is the perfect tool for bringing these worlds together as you explore, create and refine your projects from concept to final sign off.

While Houdini has a wide variety of tools designed for generating CG content, its **node-based procedural workflow** is what sets it apart. This approach makes it easier for you to **create directable shots**, explore **multiple iterations** and **hit deadlines**. As you learn Houdini, understanding how to work with these nodes and networks will be important to your success.

WHAT YOU WILL LEARN

This overview chapter contains general information about Houdini that will help you become familiar with important concepts and ideas. While you might not understand what it all means, this chapter will be a valuable reference point as you work through the foundation tutorials and build up your knowledge.

- **If you already work with 3D software** then learning Houdini will be a transfer of existing skills. You will learn how to interactively build-up shots using the scene view and shelf tools, then how to work with the nodes and networks to take advantage of Houdini's procedural nature.

- **If you are new to 3D and Computer Graphics** then Houdini is a great package to start with. The Foundations material assumes some general knowledge, therefore you may want to read up on CG concepts that you are unfamiliar with. In the end, Houdini will help you achieve a deeper understanding of what goes on under the hood of not only Houdini but other 3D apps as well.

Once you have finished the foundation lessons, visit **SideFX.com** for more tutorials. From the main menu, go to **Learn > Learning Paths** for a comprehensive list of lessons created by SideFX and members of the Houdini community. There are lots of lessons for you to explore as you build up your Houdini skillset.

DOWNLOAD
HOUDINI FOR FREE

SideFX has a free learning edition for you to use as you work through the lessons. The **Houdini Apprentice** edition gives you **FREE** access to all of Houdini's features with a few restrictions such as limited render size and user interface and render watermarks.

You can download Houdini Apprentice from the SideFX website where you can also get the latest versions which are updated regularly:

SideFX.com/download

INDIE
ANIMATORS AND GAMERS

If you want to go beyond the free learning edition, **Houdini Indie** removes the watermarks found in Apprentice and offers higher render resolutions up to 4K x 4K and limited commercial use **[less than $100K USD]** of Houdini.

The Indie program makes Houdini a great tool for developing personal projects and indie games. To learn more you can go to:

SideFX.com/indie

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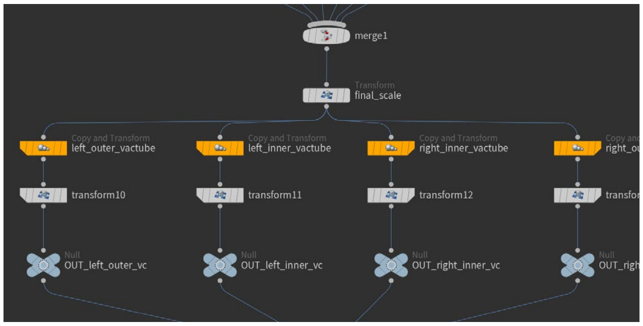
Learning Houdini

Houdini is a computer graphics, or CG, application which you can use to model, animate, render and simulate. In the process of learning Houdini, you will explore new ways of managing the creative process that involves the interactive manipulation of nodes, networks and assets.

Everything is procedural in Houdini, which means that modeling, character rigging, lighting, rendering and visual effects all benefit from a node-based workflow where artists can build up networks of nodes to manage all the steps needed to complete a creative task. Networks can then “talk” to other networks to create even more sophisticated systems.

GOING PROCEDURAL

In Houdini, every action you take is stored as a node. These nodes are then “wired” into networks which define a “recipe” that can be tweaked to define a repeatable outcome where each iteration can generate unique results. The ability for nodes to pass important information down the chain, in the form of attributes, helps give Houdini its procedural nature.



KNOWN FOR VFX

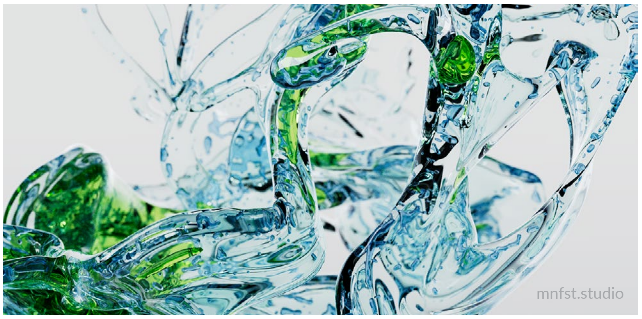
Visual effects artists have traditionally gravitated to Houdini because this procedural workflow is ideal for working with particles and dynamics. Often visual effects are designed to react to actions that are taking place in a shot and a procedural solutions “automate” these reactions. Therefore, Houdini provides studios with higher levels of productivity and more control over the creative process.

Igor Zanic

Houdini is also capable of working with large data sets which is critical as visual effects become more sophisticated with many layers such as rigid body destruction, fluids, and particles all interacting to achieve the final result.

PROCEDURAL CONSTRUCTS

For motion graphics projects, a procedural approach offers lots of visually-stunning eye candy. These special effects are often the result of animating parameters on nodes and adding noise in interesting ways that you wouldn’t expect in real life.



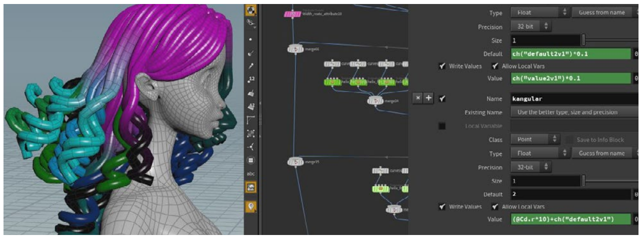
mnfst.studio

THE WIDER CG PIPELINE

Beyond VFX and motion graphics, Houdini has bread-and-butter tools for all parts of the pipeline from modeling to rendering to character work and gamedev. Its procedural workflow supports you as you create all of your CG content. Along the way, you will benefit from the ability to explore multiple iterations and make changes deep into production.

Andrey Belichenko

While the nodes are what makes Houdini unique and give it its power, there are lots of viewport and shelf tools that are used to work interactively while Houdini builds the networks.



Type Float Guess from name
Precision 32 bit
Size 1
Default ch("default2v1")*0.1
✓ Write Values ✓ Allow Local Vars
Value ch("value2v1")*0.1

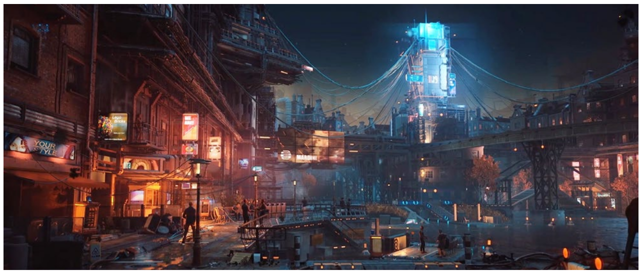
✓ Name kangular
Existing Name Use the better type, size and precision
■ Local Variable
Class Point Save to Info Block
Type Float Guess from name
Precision 32-bit
Size 1
Default 2
✓ Write Values ✓ Allow Local Vars
Value (@Cd.r*10)+ch("default2v1")

DIRECTABLE RESULTS

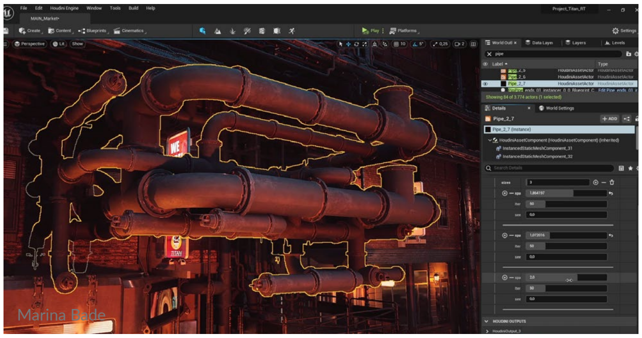
The reason you are able to make edits deep into production is because changes made to parameters on Houdini nodes will cascade right through the network to update the results. This directability is retained throughout the creative process and can be used to make last minute decisions that would be too costly in a traditional CG pipeline.

TOOL BUILDING

Another benefit of the node-based approach is that it is easy to encapsulate node networks to create custom nodes that are shared with colleagues without writing any code. Houdini's re-usable networks can be wrapped up quickly and easily into special nodes called **Houdini Digital Assets**.



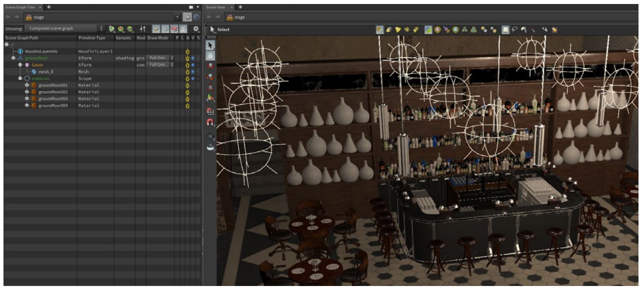
These assets open in Houdini, or in other applications such as **Autodesk Maya, 3DS Max**, **Unreal** and **Unity** using **Houdini Engine** plug-ins, with the asset's procedural nature left intact.



Marina Bade

FULL ACCESS TO ALL YOUR DATA

As objects move through a typical animation or visual effects pipeline, they accumulate information which is often stored as point or primitive attributes such as velocity, capture weights or UV texture coordinates. While other 3D applications hide this information and attempt to control it for you behind the scenes, Houdini gives you tools for working with and managing this data. This results in a much more powerful and flexible approach that makes a huge difference down in production.



A NEW WAY OF THINKING

As you become more proficient with Houdini, you will find new ways to approach a shot or a game level that will make you and your team more productive. Houdini gives you the flexibility to build tools that will support you throughout a project's life cycle and instead of simply reacting to issues and problems, you will be able to anticipate the pain points and use a procedural solution to work much more efficiently.

Andrey Bilichenko

Now that you have chosen to learn Houdini, you will find yourself exploring a versatile application that will redefine how you approach future projects. The key is to embrace this new way of working and be ready to explore CG at a level deeper than you ever imagined.

DO I NEED TO WRITE CODE TO USE HOUDINI?

DEFINITELY NOT! In fact, because of Houdini's node-based workflow, you will often be able to create results interactively that would require writing code in other 3D applications. Houdini is very much an artist's tool and while it has a technical side that uses scripts and expressions, the out-of-box tools will let you accomplish amazing things. And the nodes let you easily go back and make changes which mimics how the creative process works.

If you do want to work with code then Houdini supports a number of languages inside the Houdini interface. There are Wrangle nodes for working with VEX and Python and PyQT is supported as well. You can also use Houdini's expression language hscript or you can mix all of them together to meet your specific needs.

The Houdini Workspace

Houdini offers a user interface experience that will be familiar for artists coming from other CG applications with the biggest difference being the panes used to manage nodes and networks. The workspace is highly configurable and can be set up to support different ways of working.

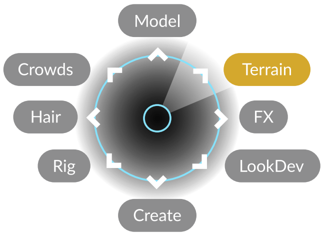
Houdini gives artists many different ways to view the bits and pieces that make up a 3D scene. From the **Scene View** where you look through a camera at your geometry to the **Network view** where you manage the procedural nodes and networks, you will find many different ways to make creative decisions while making sure each shot works at a technical level.

RADIAL MENUS

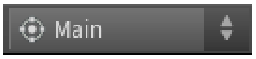
One way to access tools in the Scene View is the radial menus which you can access using the **X**, **C** and **V** hotkeys. Each of these brings up a radial menu with lots of options for you to choose from. The main focus of each menu is as follows:

Snapping	X
Main	C
Views	V

Once you learn how a radial menu works, you can access the tool with a quick sweep gesture without dwelling on the widget.

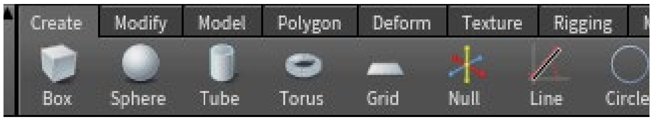


You can change the **custom** menu at the top of the menu bar which says **Main** by default. On OS X this is the **Radial** menu.



SHELF TOOLS

At the top of the workspace, you will find multiple shelves filled with tools for creating and manipulating objects, geometry, cameras, lights and effects.

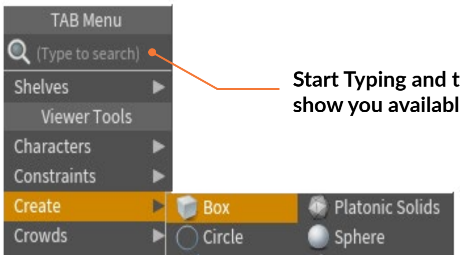


These tools work in the scene view and often involve some sort of scene view interaction. Once you have used one of these tools, one or more nodes will be created which you can then refine in the **Parameter** and **Network** panes.

The shelves provide a very important resource to new Houdini artists because the shelves reduce clicks and often put down networks of nodes that you can learn from.

TAB MENU

Another way to access tools in either the **Scene** view or the **Network** view is to press the **tab** key. This brings up a menu of available tools and nodes you can use in your work.



Start Typing and the menu will show you available tools

Tool Shelf - The shelf tools let you work with objects and geometry in the scene view.

TOOL BAR:

Selection Modes - Focus on scene, geometry, or dynamic objects.

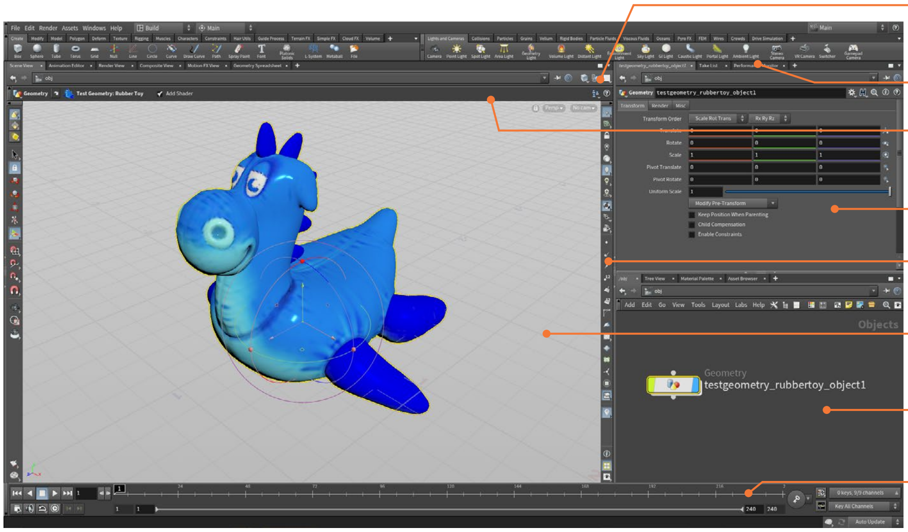
Select Tools - Select, Secure Selection

Transform Tools - Move, Rotate, Scale or Pose or the Handle tool for node-specific controls.

Snapping Tools - Turn on Grid, Primitive, Point or Multi-snapping.

Viewing - Use the View tool to Tumble, Pan and Dolly or Render Region to render in the Scene View. Click and hold to change to 2D Pan and Zoom.

Output Tools - You can render or flipbook your scene with these tools.



3D VIEW TOOLS

Here are some of the hotkey combinations available while viewing. You can skip **spacebar/alt** if you are actually in the **View** tool:

Tumble	Spacebar or Alt[Opt] - Left Mouse Button [LMB]
Pan	Spacebar or Alt[Opt] - Middle Mouse Button [MMB]
Dolly	Spacebar or Alt[Opt] - Right Mouse Button [RMB]

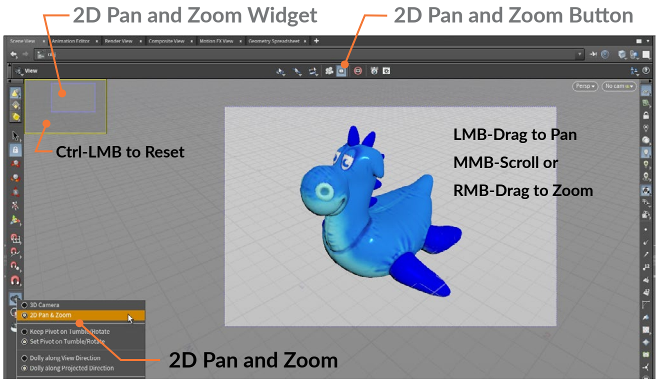
You can find the **View** tool in the toolbar. When you use the **spacebar** or **alt** keys, you temporarily evoke the view tool. This can be quite useful when you are selecting or manipulating in a view and need to quickly change your point of view.

If you want to focus on viewing then you can press **Escape** to go to the **View** tool. Here are some other hotkeys, you can use to get your bearings:

Home Construction Plane	Spacebar + H
Frame All	Spacebar + A
Home Selected	Spacebar + G

2D PAN AND ZOOM

You can click on the **2D Pan and Zoom** tool in the **Operation Control** bar to change your view in 2D without altering your 3D camera position. The widget at the top left lets you click to pan and zoom or to reset the view with **Ctrl - LMB** click. This is a great tool for working with locked off cameras.



Viewport Display Menus - These tabs let you create and organize multiple panes at the same time.

Pane Tabs - These tabs let you create and organize multiple panes at the same time.

Operation Controls - Use the Handle tool with this bar to access parameters from your selected node.

Parameter Pane - This pane lets you set values, add expressions and keyframe selected nodes.

Display Options Bar - These toggles let you control scene display options such as normals, point numbers or lighting.

Scene View - Visualize your work and use handles to manipulate objects interactively in your scene.

Network Pane - View and manage networks of nodes to work with the underlying structure of your scene.

Playbar - Set the current time and edit keyframes on selected nodes. You can also use the Playbar to copy and paste keyframes.

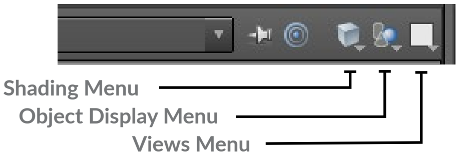
FIRST PERSON CAMERA

While in the **View** tool, you can turn on a first person fly through mode similar to those used in videos games.

Toggle First person On/Off	M
Dolly In/Out	W/S
Pan Right/Left	A/D
Look Around	LMB

VIEWPORT DISPLAY MENUS

Change how objects appear and views are organized using the menus in the top right of the Scene view or the **V** radial menu.



Shading Menu - Choose from options such as wireframe, flat shaded, smooth shaded or smooth wire shaded.

Object Display Menu - As you dive into networks, this menu sets whether you hide, view or see geometry ghosted.

Views Menu - This menu lets you split your scene view into various views such as perspective or orthographic views.

DISPLAY OPTIONS BAR

At the right side of the scene view, the display bar gives you access to options for viewport display. Here are a few examples.

Reference Plane/Ortho Grid - Turn on and off a grid that can be used for reference and for grid snapping.

Construction Plane - Turn on and off a construction plane which is used to define where you place objects or points.

Lock Camera- Lock the current camera to the view so that view changes modify the camera transform values.

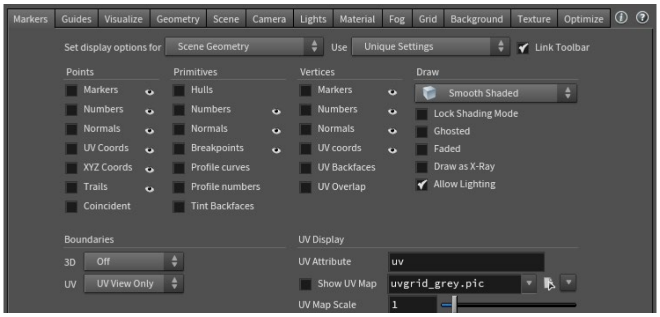
High Quality Lighting with Shadows- Set the best quality of viewport rendering.

Display Primitive Normals - Show the normals belonging to all primitives in the scene to determine their direction.

DISPLAY OPTIONS

The Scene and Network views each have Display option panels that you can access by clicking on the icon at the bottom of the Display options bar or using the following hotkey:

Display Options	D



Set display options for: Scene Geometry   Use: Unique Settings   ☑ Link Toolbar

Points: □ Markers □ Numbers □ Normals □ UV Coords □ XYZ Coords □ Trails □ Coincident

Primitives: □ Hulls □ Numbers □ Normals □ Breakpoints □ Profile curves □ Profile numbers □ Tint Backfaces

Vertices: □ Markers □ Numbers □ Normals □ UV coords □ UV Backfaces □ UV Overlap

Draw: Smooth Shaded □ Lock Shading Mode □ Ghosted □ Faded □ Draw as X-Ray ☑ Allow Lighting

Boundaries: 3D: Off   UV: UV View Only

UV Display: UV Attribute: uv   □ Show UV Map: uvgrid_grey.pic   UV Map Scale: 1

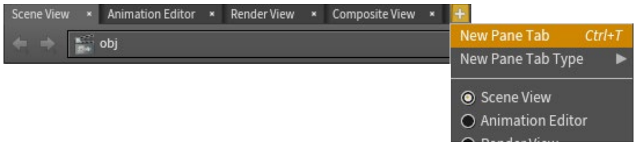
Panes & Desktops

The Houdini workspace is broken up into Panes which offer unique ways of organizing your scene data. You can work interactively in a 3D view or analyze attribute values in a spreadsheet. It is important to learn how these different UI elements can be used to get your work done.

PANES AND PANE TABS

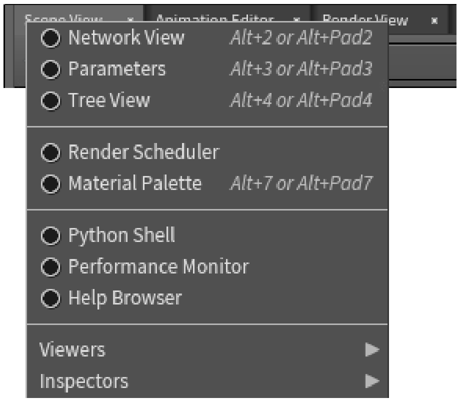
The Houdini workspace is divided into panes so that you can set up and explore your scene. Pane tabs let you overlap several panes within the same zone to keep them handy but not visible by default

You can access a pane tab by clicking on it in the workspace. You can close it by clicking on the x. The **+ menu** can be used to change the pane you are looking at or to add new panes.



PANE TYPES

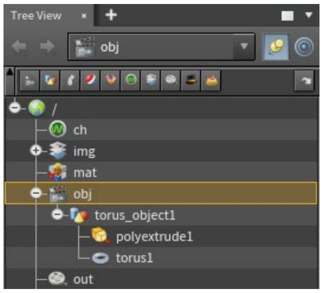
RMB-click on the pane tab to change its type. There are many pane types to choose from. Here are some of them which have hotkeys. Some of the other ones are listed here. Refer to the documentation to find learn more about all of the others.


Network View Alt+2 or Alt+Pad2
Parameters Alt+3 or Alt+Pad3
Tree View Alt+4 or Alt+Pad4
Render Scheduler
Material Palette Alt+7 or Alt+Pad7
Python Shell
Performance Monitor
Help Browser
Viewers
Inspectors

Network View [Alt-2] - This view lets you see the nodes and networks and connect, rewire, and reorganize them to suit your needs.

Parameters [Alt-3] - Set values on parameters, add expressions and control the properties of your nodes.

Tree View [Alt-4] - This is a hierarchical view of the nodes. This can be a great way to understand how scene hierarchies work.



Viewers > Scene View [Alt-1] - Work interactively in 3D space. This type of view can be set up with one or more viewports. You can have more than one scene view panels open at the same time to look at your scene from different points of view.

Composite View [Alt-0] - View images and composites created using Compositing [COP] nodes.

Viewers > Motion FX View [Alt-^] - This lets you view motion created using Houdini's channel operator [CHOP] nodes.

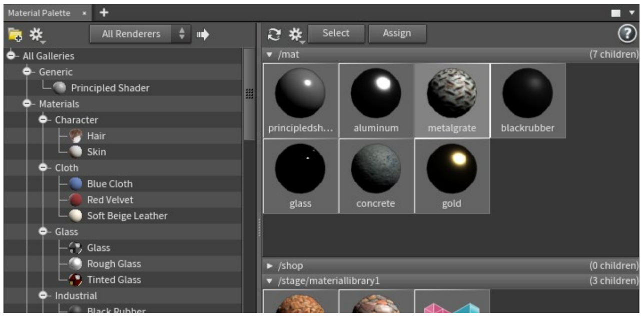
Solaris > Scene Graph- This pane shows you the USD scene graph when working with Solaris [LOP] nodes.

Solaris > Render Gallery - This pane lets you save test renders then revert back to the settings of each image after reviewing them all.

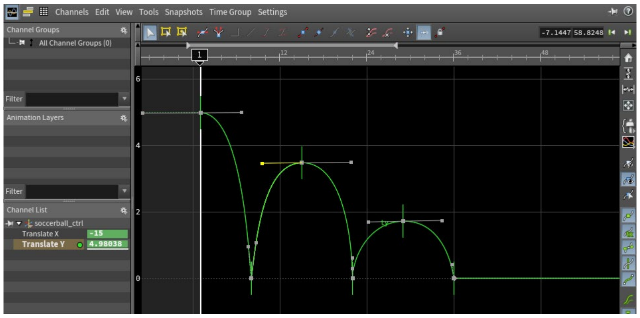
Solaris > Light Linker - Connect lights and objects.

Render Scheduler - This panel shows you Renderings that are completed and in progress. You can pause and kill renderings here.

Material Palette [Alt-7] - This palette lets you see all the materials in your scene and select and assign them to objects and geometry.



Animation > Animation Editor [Alt-6]- Manage keyframes and animation curves. The editor also has **Table** and **Dope** sheet views.



Animation > Channel List - Create channel groups and manage the scoped channels as you animate in Houdini.

Animation > Autorigs- This pane gives you access to tools for building your own rig out of modules for biped, quadruped and facial rigs.

Animation > Character Picker - You can use this pane to make it easier to select parts of a character rig.

Inspectors > Geometry Spreadsheet [Alt-8]- A view of the attribute values you have on your geometry. This could include UVs, normals, or custom values you have set yourself.

Inspectors > Data Tree- This view gives you access to a light bank, Material Stylesheet and Object appearance list.

Mantra Rendering > Render View [Alt-9] - Start interactive Mantra renderings, that will update when you change something in your scene.

Mantra Rendering > Take List- This list lets you explore different "takes" by making changes to specific parameters. You can then manage the takes to focus on your preferred creative choices.

TOPS > Task Graph Table - The Task Graph Table shows the metadata of all work items in the graph, or all work items in a particular node.

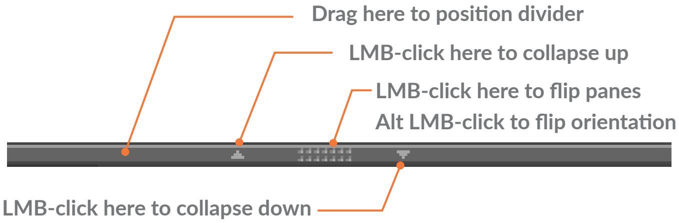
Misc > Orbolt Asset Browser - This browser lets you access assets from Orbolt.com. To use this pane you need to log in with an orbolt.com account.

Misc > Textport - You can use this pane to type commands.

Misc > Python Shell -You can type Python commands using this pane.

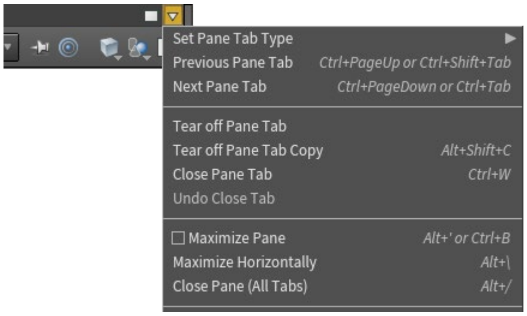
ORGANIZING AND COLLAPSING PANES

Both panes and tool bars can be collapsed and expanded by clicking on the arrows found in their UI. Whole panes can be collapsed to the left or right and you can flip the contents using the center grip. These options let you focus on certain panes by hiding others using a single click of the mouse.


Drag here to position divider
LMB-click here to collapse up
LMB-click here to flip panes
Alt LMB-click to flip orientation
LMB-click here to collapse down

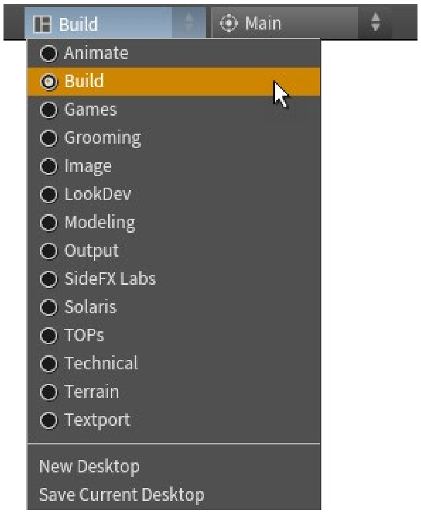
PANE MENU

At the top left of each pane is a button for maximizing and minimizing the pane and an arrow which gives you access to the Pane menu. This menu lets you tear off the pane or a copy of the pane, close, or split your pane. You also have options for determining the UI of each pane.


Set Pane Tab Type
Previous Pane Tab Ctrl+PageUp or Ctrl+Shift+Tab
Next Pane Tab Ctrl+PageDown or Ctrl+Tab
Tear off Pane Tab
Tear off Pane Tab Copy Alt+Shift+C
Close Pane Tab Ctrl+W
Undo Close Tab
□ Maximize Pane Alt+' or Ctrl+B
Maximize Horizontally Alt+\
Close Pane (All Tabs) Alt+/

DESKTOPS

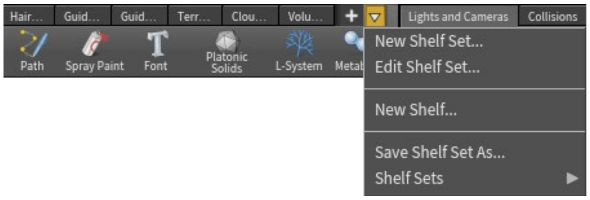
As you open up tabs, add dividers and organize your pane tabs, you start to set up your own workspace. To save any layout, go to the **Desktop** menu (**Windows > Desktop** on OSX) where you can access saved desktops, save your own and manage them as you work. When you save a desktop, it will save the Pane layout, Radial menus and visible Shelf sets.



When you save your scene, it remembers which **Desktop** you are looking at but not any changes to the pane layout while working. These changes will go away unless you explicitly save them to the desktop or create a new desktop.

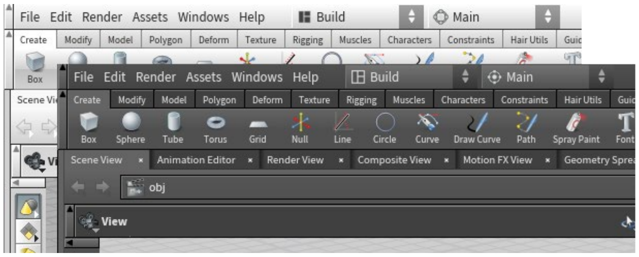
SHELVES AND SHELF SETS

To manage the shelves at the top of the workspace, access the menu found under the arrow icon. You can use this to work with Shelf sets. You can also bring up shelf sets that might be hidden in your desktop.



COLOR SETTINGS

You can customize the look of the Houdini UI by choosing a color scheme for your workspace. Select **Edit > Color Settings** to bring up the option window then you can choose from the default **Houdini Dark** or **Houdini Light.** Click on the **Download** button to choose from a list of color schemes created by the Houdini community.


File Edit Render Assets Windows Help
Build
Main
Create Modify Model Polygon Deform Texture Rigging Muscles Characters Constraints Hair Utils
Box Sphere Tube Torus Grid Null Line Circle Curve Draw Curve Path Spray Paint Font
Scene View
Animation Editor
Render View
Composite View
Motion FX View
Geometry Sprea
obj
View

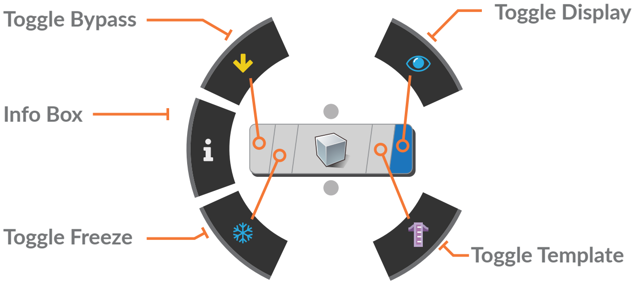
Nodes & Networks

With Houdini's node-based workflow at the heart of its procedural architecture, the ability to work directly with these nodes and networks becomes very important to using it effectively. While the idea of nodes might sound technical, they are actually quite artist friendly and easy to work with.

As you use tools in Houdini, nodes are created and wired with other nodes. The resulting networks offer a history of your actions while providing a simple way to make changes and refine your work. Learning how to work effectively with the node networks is an important part of working with Houdini.

NODE FLAGS

Each of the nodes have various flags which determine if it is displayed, locked or bypassed. You can evoke these by either clicking on the flag itself or using the radial node menu.



Display Flag [R] - This flag lets you choose the display output node for the network and is highlighted with a hollow ring. The **Render flag** [T] sets which node will be output for rendering and is highlighted with a solid circle. You can set this separately from the Display flag by **Ctrl-clicking** on the Display flag.

Template Flag [E] - This flag displays the node in grey and can be used for reference or snapping.

Freeze Flag - This caches at the locked node and all nodes earlier in the chain are ignored when the network is cooked.

Bypass Flag [B] - This flag lets you ignore the node when the network is cooked.

CONNECTING AND DISCONNECTING NODES

When you work in the Viewport, nodes are often placed and wired together automatically. When you want to reconfigure how a network is set up, you will need to connect and disconnect nodes by hand.

Here are some ways to interact with nodes and connections in the Network pane:

Connect Node	LMB-drag from output to input
Connect Nodes	J drag across the nodes
Insert New Node	RMB on an output or connector
Insert Node	LMB drag and drop onto connector wire
Disconnect from Wires	LMB select then Jiggle node(s)
Cut Wire	Y drag across connector wire
Move node	LMB-drag
Copy selected nodes	Alt + LMB-drag
Reference Copy	Alt + Shift + Ctrl + LMB-drag

Dot nodes can be used to organize your networks:

Add Dot	Alt + LMB wire
Pin/Unpin Dot	Alt + LMB dot

NODE GALLERIES

The galleries offer quick access to nodes that you want to add to your network directly. The galleries contain those nodes used the most in day-to-day work while the **tab** key gives you access to all the available nodes.

You can create your own galleries using the **Windows > Gallery Manager** and you can add items to your galleries by **RMB-clicking** on a node then choosing **Save to Gallery...**

Nodes saved in the **Mat** network will also be available in the **Material Palette** as long as they are given the proper keywords such as *Mantra* for Mantra materials.

NETWORK VIEW

Network Path - The path leading to the current network level. You can also use this bar to navigate to other networks.

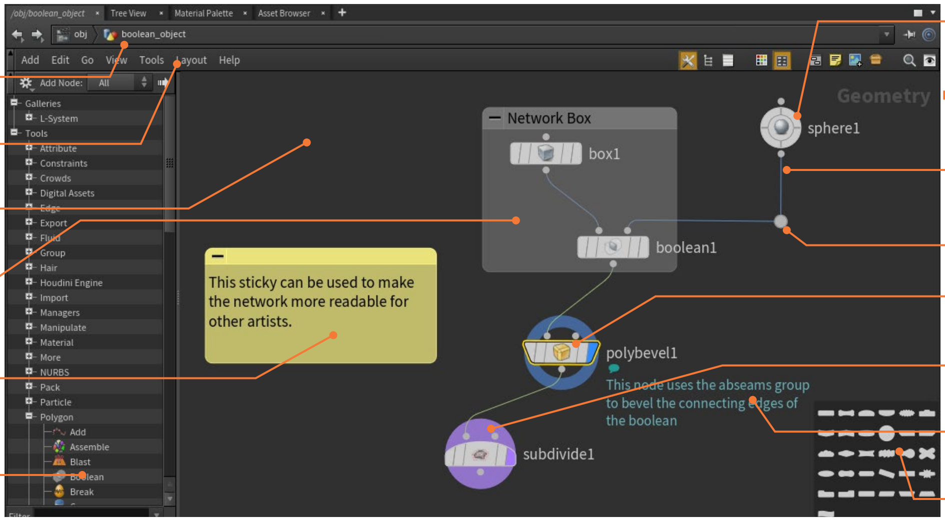
Pane menu - These menus and icons are for organizing your network.

Network Background - Use the Pane menu to add an image or set up a grid to help you organize your nodes.

Network Box - Group related nodes then quickly collapse and expand them.

Sticky - Add notes to help other artists read your network or to offer ideas for their networks.

Node Gallery - Drag nodes from here to your network. Use the filter at the bottom to find the node you need.



This sticky can be used to make the network more readable for other artists.

This node uses the abseams group to bevel the connecting edges of the boolean

NETWORK TYPES

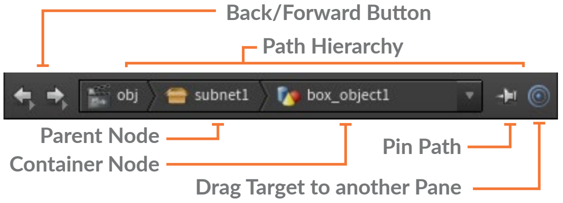
Houdini includes different kinds of nodes which each work in their own context. The network type is labelled in the top right corner of the network view. Nodes from each type can connect to other networks. While the different types of nodes are similar in how they are wired together, they each have unique capabilities:

Scene	Objects	OBJ
Geometry	Surface Operators	SOP
Solaris	Lighting/Layout Operators	LOP
Materials	VEX Builder	MAT
Motion FX	Channel Operators	CHOP
VEX	VEX Builder	VOP
Outputs	Render Operators	ROP
Tasks	Task Operators	TOP
Dynamics	Dynamic Operators	DOP
Compositing	Compositing Operators	COP/IMG

As you work with Houdini, you will begin to learn how to use this “secret” language to talk about the node types and how they apply to working procedurally.

NETWORK PATHS

Nodes are organized hierarchically with some nodes nested in other nodes known as network managers or subnetworks. To help you manage these hierarchies, a browser-like path is available at the top of most panes.



Use this path to navigate up and down the hierarchy or to other networks. By default, the path changes as you make selections in the scene view although you can **Pin** down a path to keep it focused. You can also drag the **Target** icon to a pinned pane to sync up their paths.

Node - This represents an operation that contributes to the final output of the network.

Network Type - Shows which network type you are working in.

Connector - The connecting lines show how your nodes are linked together and how the data is moving through the network.

Dot - You can add dot connectors to make it easier to organize your nodes.

Display Ring - This small circle shows which node is displayed in the Scene view.

Render Ring - This large circle indicates a render node even if another node is displayed.

Comments - Node comments can be displayed to help other artists understand your thinking.

Palettes - Buttons on the menu display Palettes that let you set the color and shape of nodes.

NAVIGATING NETWORKS

To jump between network types there are a number of different approaches you can take. Some of these happen naturally as you work with objects in the scene view and others offer shortcuts which allow you to work more quickly.

Selection Modes - As you select in the scene view, the network editor jumps to the location of the selection. Different selection modes will in turn take you to different network types as you make a selection.

Network path - You can **LMB-click** on a parent node to navigate back up the path or **LMB-click** on the container node to access parallel nodes or dive into the contents of other container nodes.

Radial menu - **Press n** to get a radial menu that lets you navigate up, down and to different network types.

Hotkeys - These help you navigate up and down as you work with a selected object.

Dive in	I
Jump up	U
Toggle Objects/Geometry	F8
Previous or Next Network	Alt + ← or Alt + →

Quick Marks- These let you quickly set and return to network locations. You can use them as-needed and then override them or forget about them. They are not saved with the scene file.

Set a Quickmark	Ctrl + 1, 2, 3, 4 or 5
Return to a Quickmark	1, 2, 3, 4 or 5
Go Back to Previous View	`

SELECT AND VIEW HOTKEYS

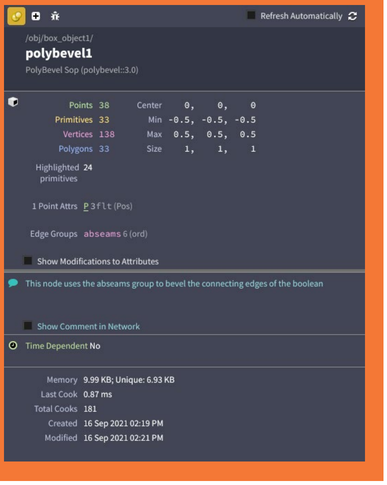
In the network pane, you will need to pan and zoom around to work with the complete network. Here are the key combinations for these actions.

Pan	MMB
Zoom	RMB
Select Nodes	LMB
Add to Selection	Shift + LMB
Remove from Selection	Ctrl + LMB

LEARN ABOUT YOUR NODE

Bring up the **Info Box** using either the **Radial Menu** or **MMB-press** on the node. This panel gives you info about the node’s contents, groups, attributes and other important facts. This panel also highlights any errors that are interfering with your workflow.

This panel will close automatically but you can click on the **Pin** icon to keep it visible as you work. You can add comments and display them in the Network view using this panel.



■ Refresh Automatically

/obj/box_object1/
polybevel1
PolyBevel Sop (polybevel::3.0)

```
     Points  38      Center     0,    0,    0
 Primitives  33         Min  -0.5, -0.5, -0.5
   Vertices  138        Max   0.5,  0.5,  0.5
   Polygons  33        Size     1,    1,    1

Highlighted  24
 primitives

1 Point Attrs  P 3flt (Pos)

Edge Groups  abseams 6 (ord)
```

■ Show Modifications to Attributes

This node uses the abseams group to bevel the connecting edges of the boolean

■ Show Comment in Network

Time Dependent No

```
     Memory  9.99 KB; Unique: 6.93 KB
  Last Cook  0.87 ms
Total Cooks  181
    Created  16 Sep 2021 02:19 PM
   Modified  16 Sep 2021 02:21 PM
```

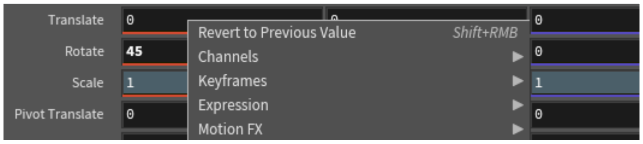
Parameters, Channels & Attributes

All of the nodes in Houdini are driven by parameters, channels and attributes to help you achieve the results that you want. The terminology used in Houdini may differ from other 3D applications therefore it is a good idea to take a moment to understand them in a Houdini context.

PARAMETERS

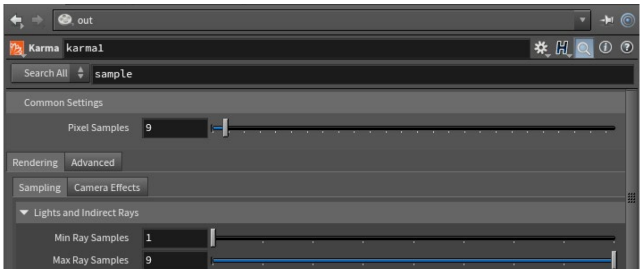
Parameters refer to the values, sliders, buttons and checkboxes found on Houdini nodes. These are sometimes referred to as attributes in other applications but Houdini uses attributes in a different way.

You can change parameter values in the Parameter pane or using handles in the viewport. There is a RMB menu on each parameter that gives you a number of important options such as copying and pasting and reverting to defaults.



SEARCHING PARAMETERS

A node might have a large number of parameters and sorting through them all can take time. If you click on the magnifying glass in the top right, you get a search bar that lets you filter the parameters based on name and content. You can find parameters using expressions, overrides and even a raw value.

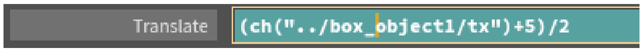


CHANNELS | KEYFRAMES

You can set a keyframe on a parameter by pressing the **Alt** key and **LMB-clicking** on the name or value field. Once you have set a keyframe, the parameter's field changes color and you have created an animated channel. There will now be keyframes associated with the parameter which you can access in the Animation editor.

CHANNELS | EXPRESSIONS

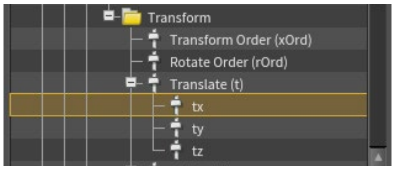
Instead of a raw value, you can add expressions into the parameter using either *hScript* or *Python*. There is a menu in the top right of the Parameter pane for choosing which language you want to use. You can press **Ctrl-E** to bring up an expression editor with a number of scripting tools to make it easier to work.



```
(ch("../box_object1/tx")+5)/2
```

REFERENCE SCENE DATA

You can also **RMB-click** on a parameter and choose **Reference > Scene Data** to bring up a window for choosing specifically what you want to link to. Once you have made a choice from any node in your scene, to create a channel reference. This method lets you create references without worrying about the exact syntax needed to write the proper expression.



PARAMETER PANE

Navigation Bar- This bar lets you see where the node is located in the scene hierarchy.

Node Type and Name - Here you can see the node type and set its name. Clicking on the icon gives you a menu for working with the node.

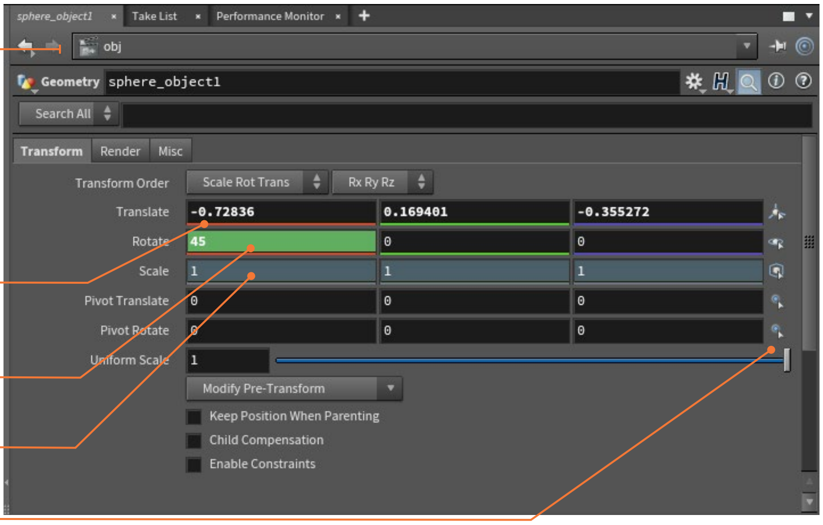
Search Bar - Click on the magnifying glass icon to search parameters by name or by content.

Changed Parameter - When a parameter has been changed from its defaults then its value is bolded. The folder tab name is also bolded.

Animated Parameter - When you have keyframed a parameter it is highlighted in green.

Locked Parameter - You can RMB-click on a parameter to lock and unlock it. It will be highlighted in grey

Select to Match - These icons let you match these parameter values to other objects.

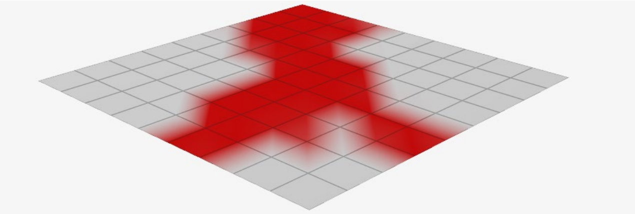


CUSTOM PARAMETERS

If you click on the Gear icon in the top right of the Parameter pane, you can choose **Edit Parameter Interface**. Here you can add custom parameters which can then be linked to other parts of your node network.

ATTRIBUTES

Attributes let you attach data to your geometry that can be used by nodes down the chain to complete an operation. A fuel attribute can drive a Pyro FX simulation or a UV attribute sets up texturing. Some attributes are created by Houdini nodes or you can create custom attributes.

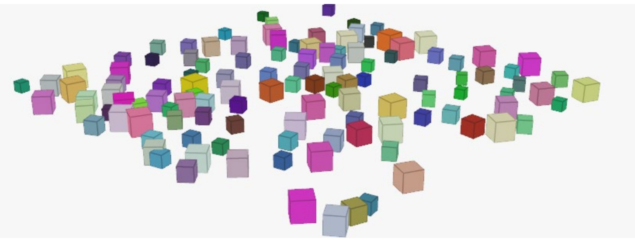


Class - Attributes can belong to Points, Primitives, Details and Vertices. This will affect how they get used down the chain.

Type - You can set up float, integer or string attribute types amongst others.

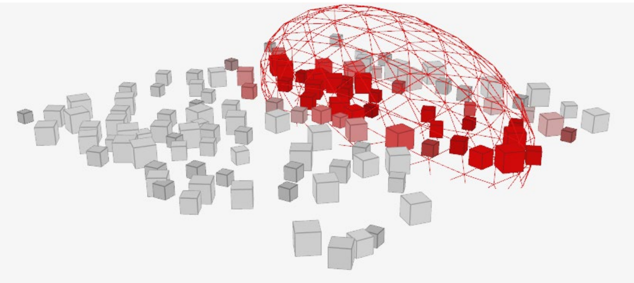
ATTRIBUTE RANDOMIZE

Attribute Randomize lets you create an attribute and immediately randomize its values. For instance here you can see the Color, rotation and Scale of these boxes being randomized.



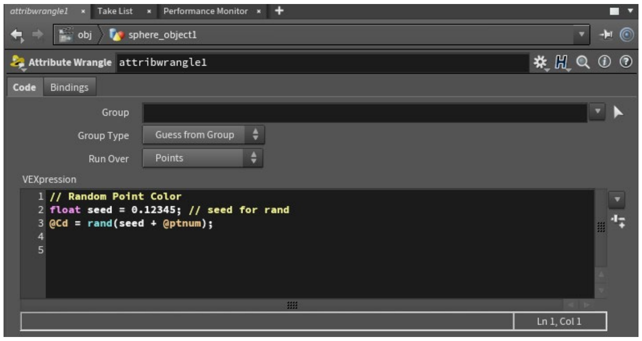
ATTRIBUTE TRANSFER

Within a node chain, attributes are attached to geometry then used by other nodes. You can also pass attributes to other pieces of geometry using **Attribute transfer**. Here the sphere is passing color attributes to the boxes based on a defined threshold value.



ATTRIBUTE WRANGLE

Houdini has a wide variety of nodes that let you create and work with attributes. You can also use the **Attribute Wrangle** node to use a script-based approach to this work. For a lot of Technical Directors this may be the most comfortable way to work.



Attribute Wrangle: attribwrangle1

Group:

Group Type: Guess from Group

Run Over: Points

VEXpression

```
// Random Point Color
float seed = 0.12345; // seed for rand
@Cd = rand(seed + @ptnum);
```

For artists, working with nodes will make it easier to deal with this kind of information. A lot of Houdini's power is found in the proper use of Attributes and you will eventually need to learn about them.

GEOMETRY SPREADSHEET

You can view all attribute values, even invisible ones using the geometry spreadsheet.

Navigation Bar- This bar lets you see where the node is located in the scene hierarchy.

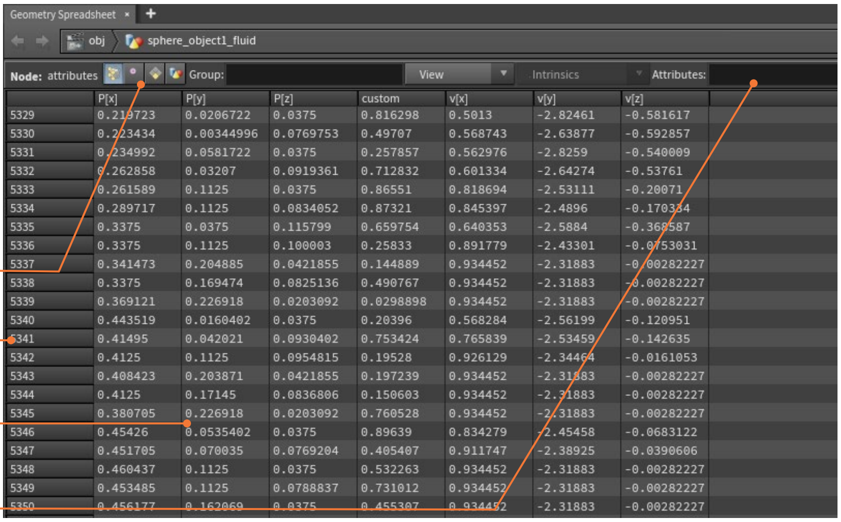
Node Name - This shows you which node is currently selected and which node is generating these attribute values.

Attribute Class Buttons - Use these buttons to filter which kind of attribute you are looking at.

Point Number - Here are the geometry point numbers to help you determine where the attribute is on your model.

Attribute Values - These are the values at this point in the node network chain.

Filter - You can type parameter names here to filter the list when you are working with lots of parameters.



Node: attributes

Group:

Attributes:

	P[x]	P[y]	P[z]	custom	v[x]	v[y]	v[z]
5329	0.219723	0.0206722	0.0375	0.816298	0.5013	-2.82461	-0.581617
5330	0.223434	0.00344996	0.0769753	0.49707	0.568743	-2.63877	-0.592857
5331	0.234992	0.0581722	0.0375	0.257857	0.562976	-2.8259	-0.540009
5332	0.262858	0.03207	0.0919361	0.712832	0.601334	-2.64274	-0.53761
5333	0.261589	0.1125	0.0375	0.86551	0.818694	-2.53111	-0.20071
5334	0.289717	0.1125	0.0834052	0.87321	0.845397	-2.4896	-0.170334
5335	0.3375	0.0375	0.115799	0.659754	0.640353	-2.5884	-0.368587
5336	0.3375	0.1125	0.100003	0.25833	0.891779	-2.43301	-0.0753031
5337	0.341473	0.204885	0.0421855	0.144889	0.934452	-2.31883	-0.00282227
5338	0.3375	0.169474	0.0825136	0.490767	0.934452	-2.31883	-0.00282227
5339	0.369121	0.226918	0.0203092	0.0298898	0.934452	-2.31883	-0.00282227
5340	0.443519	0.0160402	0.0375	0.20396	0.568284	-2.56199	-0.120951
5341	0.41495	0.042021	0.0930402	0.753424	0.765839	-2.53459	-0.142635
5342	0.4125	0.1125	0.0954815	0.19528	0.926129	-2.34464	-0.0161053
5343	0.408423	0.203871	0.0421855	0.197239	0.934452	-2.31883	-0.00282227
5344	0.4125	0.17145	0.0836806	0.150603	0.934452	-2.31883	-0.00282227
5345	0.380705	0.226918	0.0203092	0.760528	0.934452	-2.31883	-0.00282227
5346	0.45426	0.0535402	0.0375	0.89639	0.834279	-2.45458	-0.0683122
5347	0.451705	0.070035	0.0769204	0.405407	0.911747	-2.38925	-0.0390606
5348	0.460437	0.1125	0.0375	0.532263	0.934452	-2.31883	-0.00282227
5349	0.453485	0.1125	0.0788837	0.731012	0.934452	-2.31883	-0.00282227
5350	0.456177	0.162069	0.0375	0.455307	0.934452	-2.31883	-0.00282227

Selecting Geometry

Working in Houdini involves the selection and manipulation of many different elements. There are a number of tools and options available to help you work efficiently with objects and geometry components such as points, edges and primitives.

SELECT TOOL

The **Select** tool lets you focus on making selections therefore it doesn't have any manipulation handles.

Select Tool	Tap S

When working with tools such as **Move** or **Rotate** and **Secure Selection** is on, you need to invoke the **Select** tool to make a selection. Toggle **Secure Selection** to **Off** to select freely.

Evoke the Select tool while in other Tool	Press and Hold S
Toggle Secure Selection	~

SELECTION TYPES

There are different shortkeys for adding, subtracting or toggling your selection as well as for selecting all or none. These techniques play an important part in this workflow.

Select	LMB
Add to Selection	Shift + LMB
Remove from Selection	Ctrl [Cmd] + LMB
Toggle Selection	Ctrl [Cmd] + Shift + LMB
Select All	A [Object Level] / N [Geometry Level]
Select None	N [Object Level] / Shift + N [Geometry Level]

SELECTION TECHNIQUES

In the viewport, you can choose from four different selection types that offer different ways of accessing geometry.

Box Select	F2
Lasso Select	F3
Brush Select	F4
Laser Select	F5

There are also some selection filters that let you focus on visible geometry or select groups. You have a wide range of selection options to help make this easier as you work.

Select Visible Geometry Only	Shift + V
Select Fully Contained Geometry Only	Shift + C
Select Groups or Connected Geometry	9
Select Whole Geometry	Choose in Operation Control bar
Select by Normals	Choose in Operation Control bar

SELECTION MODES

Selection modes, give you access to objects and components. They also let you easily jump from object level to geometry level using a the buttons in the toolbar or the hotkey.

Objects - The object network level is where you work with an object's transforms. In any tool other than the **View** tool, the following hotkey will bring you back to the Object level:

Objects	1

Geometry - You can use any of the following hotkeys, when not in the **View** tool, to jump into the geometry level with the chosen components available for selection.

Points	2
Edges	3
Primitives [Faces]	4
Vertices	5

TWEAK MODE

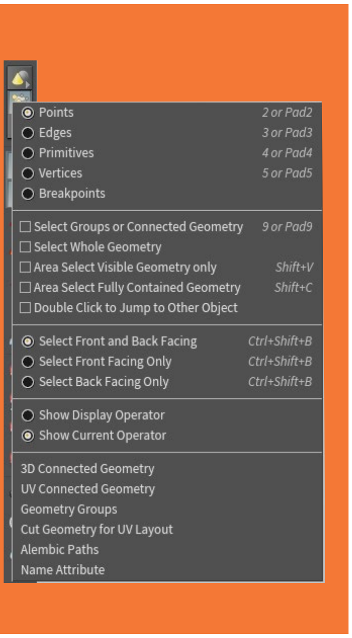
Only one geometry selection modes can be active at a time. If you are working with an **Edit** node then **Tweak Mode** lets you choose any combination of points, edges and primitives.

SELECT MODE MENUS

Each of the selection modes comes with options which let you alter how you interact with your scene. You can access these options by either **LMB** or **RMB-clicking** on each mode's icon.

While working with components, this menu lets you choose to show **Display** or **Current** Operators. These same options are available at the top of the Scene view when working with the **Edit** node.

This menu is different at the object level where it includes some filters for different kind of objects as well as options for more easily selecting materials, constraints and Digital Assets.



◉ Points 2 or Pad2
○ Edges 3 or Pad3
○ Primitives 4 or Pad4
○ Vertices 5 or Pad5
○ Breakpoints

☐ Select Groups or Connected Geometry 9 or Pad9
☐ Select Whole Geometry
☐ Area Select Visible Geometry only Shift+V
☐ Area Select Fully Contained Geometry Shift+C
☐ Double Click to Jump to Other Object

◉ Select Front and Back Facing Ctrl+Shift+B
○ Select Front Facing Only Ctrl+Shift+B
○ Select Back Facing Only Ctrl+Shift+B

○ Show Display Operator
◉ Show Current Operator

3D Connected Geometry
UV Connected Geometry
Geometry Groups
Cut Geometry for UV Layout
Alembic Paths
Name Attribute

SELECTION OPTIONS

Edit | Components You can choose which components you want to work with from this collection of buttons. Here edge selection has been chosen.

Select Tool - The **Select** tool lets you make the selection. To access it press the **S** hotkey.

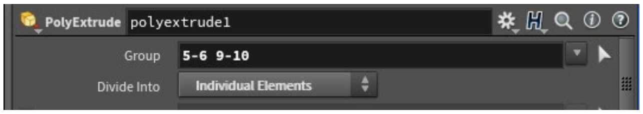
Secure Selection - This locks your selection when using other tools. To invoke the **Select** tool with it on, press and hold on the **S** hotkey.

Selection Types - You can use this top bar to change your type of selection. You can choose from Box, Lasso, Brush or Laser. There are also some filter options.

Edge Loop - To select an edge loop you can **double-click** while selecting edges. To select partial loops, select one edge then press **A** and then an end edge. This works with points and primitives. You can also select point loops or primitive loops using the same technique.

HOW SELECTIONS ARE USED BY TOOLS

When you make a selection in the viewport then use a tool, a node is created and the selected points, primitives or edges are listed in the node's **Group** parameter.

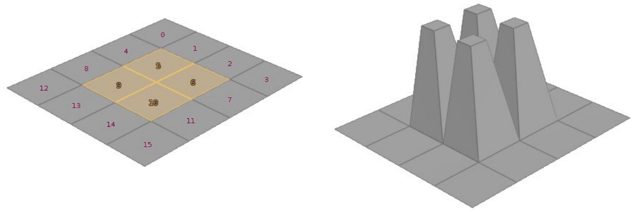


PolyExtrude polyextrude1

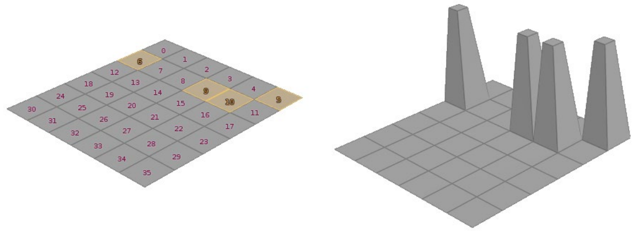
Group 5-6 9-10

Divide Into Individual Elements

For example here we see primitives **5, 6, 9 and 10** are being used by a *polyextrude* node. You can see them listed in the Group node and then used to extrude the faces.



If you were to change the topology of the incoming geometry node then there might be more or less faces and the extrusions will have moved to a different location. This may not be what you want and you may need to reselect faces.



To do this, you can select *polyextrude*, press **Enter** to go to the **Handle** tool and press ` to go into re-select mode. Select new primitives then press **Enter** and your new selection will be used in the **Group** parameter.

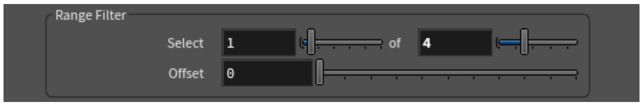
SELECT ALL AND THE GROUP FIELD

To select all of the primitives on incoming geometry, leave the **Group** parameter blank. If the topology of the incoming geometry changes, everything will be operated on by the node.

Using **Select All [N]** in the viewport will usually ensure that this field remains blank when a tool is used. With some tools, the Group field will show all the selected parts and you would have to clear the field manually to make it blank.

THE GROUP NODES

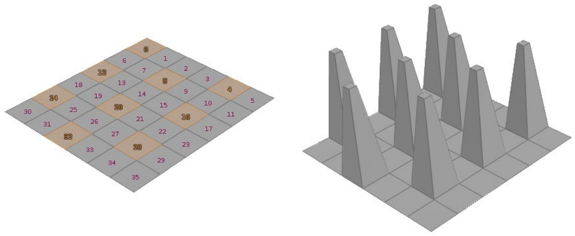
Group nodes let you refer to a defined selection of points, vertices, polygons, or edges by **name**. You can define a group interactively, by selecting components in the viewer, or mathematically, using ranges or an expression. The group name can then be assigned to the **Group** parameter instead of using point or primitive numbers.



Range Filter

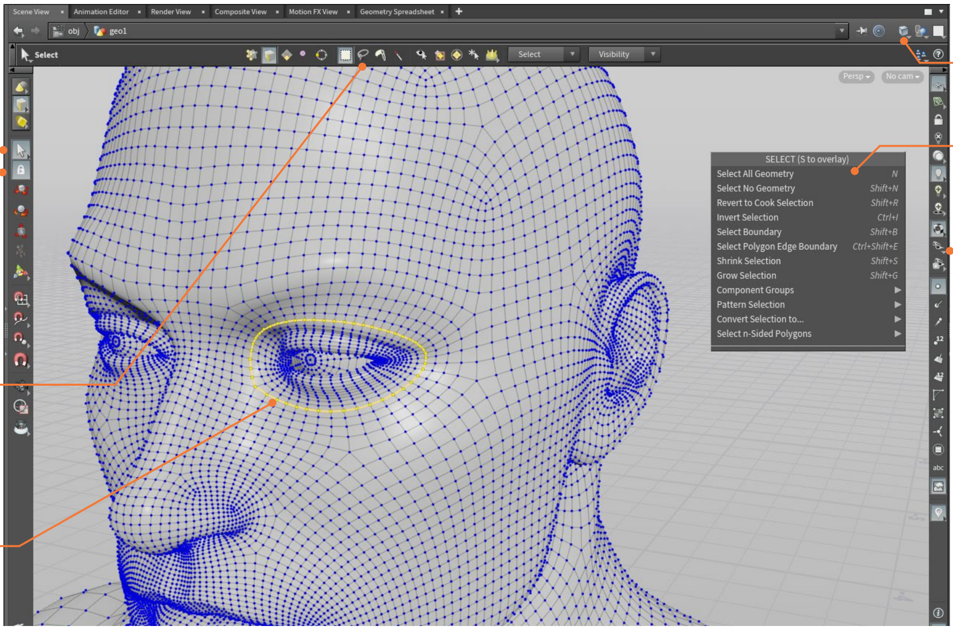
Select 1 of 4

Offset 0



Here are some **Group** nodes for you to choose from:

- **Group Create** - Use interactive selection, a bounding box, face normal direction or edge angles to populate the group.
- **Group by Range** - This lets you choose a range and a simple pattern to populate the group.
- **Group Expression** - With this node you can use a vex expression to define the membership of the group.
- **Group Paint** - This node lets you use an interactive paint interface to choose the geometry for the group.



SELECT (S to overlay)

Select All Geometry N
Select No Geometry Shift+N
Revert to Cook Selection Shift+R
Invert Selection Ctrl+I
Select Boundary Shift+B
Select Polygon Edge Boundary Ctrl+Shift+E
Shrink Selection Shift+S
Grow Selection Shift+G
Component Groups ▶
Pattern Selection ▶
Convert Selection to... ▶
Select n-Sided Polygons ▶

Shading Options - The shading options determine what you see in the Scene view. In this case, we are using Smooth Wired Shading.

RMB Menu - While in the Select tool, this menu gives you access to selection options such as inverted selections, boundaries or growing and shrinking your selection.

Display Filter - This filter lets you turn off things you don't need such as bones, null objects, lights or cameras to let you focus on the work at hand.

Display Options - While selection modes will show you edges or points to help you select, they will not be visible when using other tools. Use these options to keep them visible even when not using a specific modeling tool.

Transform & Edit

From basic transformation tools for objects, to the pose tool for animation rigs and the edit node for reshaping geometry, there are a number of different tools that let you use interactive handles in the viewport. In Houdini, these handles are tied closely to the node you are working with.

TRANSFORM TOOLS

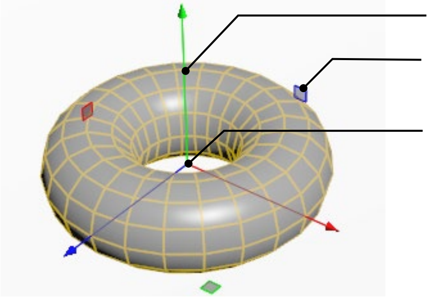
The transform tools give you handles that you can use to manipulate objects or reshape geometry. When you transform objects, the parameters at the object level are updated to reflect your changes.

Move	T
Rotate	R
Scale	E
Pose	Ctrl-R
Handle	Enter

The **Handle** tool gives you access to handles that are specific to your selected node. While using these tools, you can re-select by **pressing and holding S**, making a new selection then **releasing S** and continuing to transform.

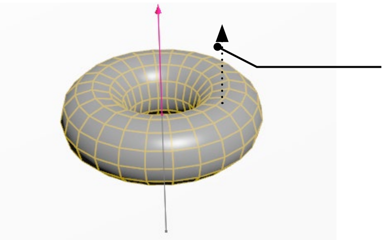
TRANSFORM HANDLES

When you are working with a **Move** handle you can work with a single axis, two axes or move along the camera plane using the center. **Rotate** and **Scale** handles offer similar controls.



MMB TRANSLATION

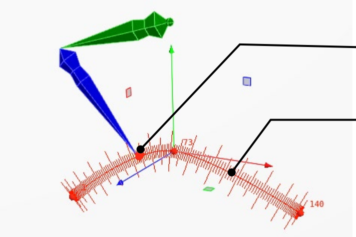
If you don't want to click directly on handles, you can use the **Middle Mouse Button** in open space combined with a drag to move it along the construction plane. To change this to translate along nearest axes go to **Edit > Preferences > Handles** and set Translate Handle to **Map Drag to Axis.**



Moves along Y axis if the preference is set to Map Drag to Axis

POSE TOOL

When you are animating, you can use the **Pose** tool to work with bones and to display motion path handles that reveal the motion of an object. You can then use tangent handles and keyframe points to modify the motion in the viewport.



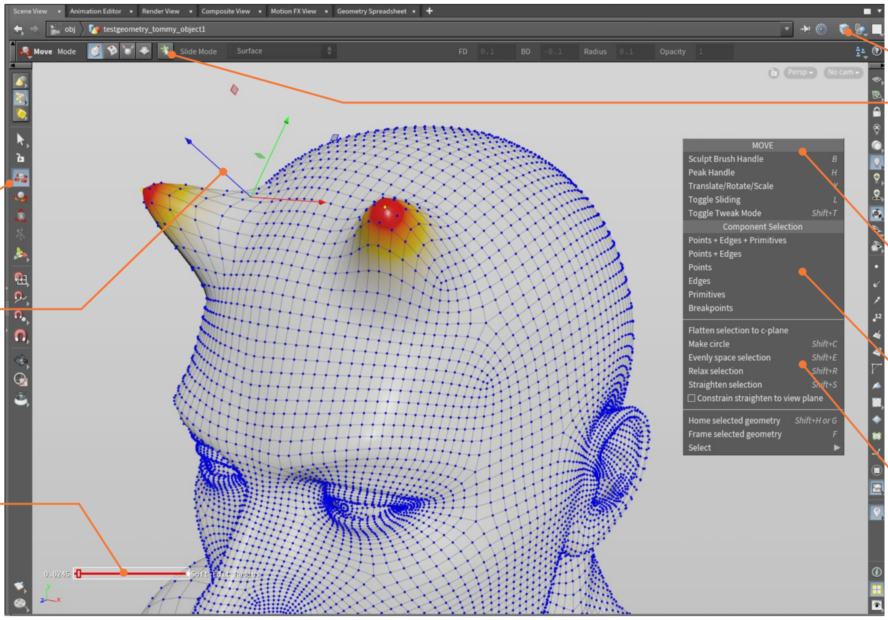
EDITING GEOMETRY

Edit | Components You can choose the components you want to edit using these buttons. The **Points** option has been chosen here.

Move Tool - The **Move** tool lets you translate the selection using the Scene View handle.

Move Handle - This handle lets you move along one axis using the lines or two axes using the square dots. **RMB-click** on the handle to access the handle options.

Soft Edit Radius - When moving points on a surface, you can use this radius value to create a soft falloff as you move the points. The Soft Edit Radius doesn't work with primitives or edges.



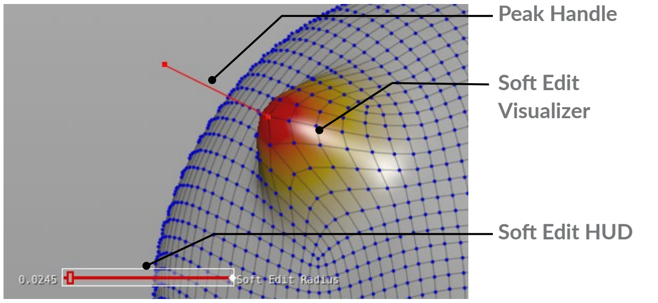
EDIT NODE

If you try to move geometry components then an **Edit node** is placed down to accept your transformations. In addition to transforming the geometry, you can slide on surface, work perpendicular to the normals or sculpt the surface.

Edit	T/R/E
Slide on Surface	L
Peak	H
Sculpt	B

SOFT FALLOFF

When you are transforming points, you can use the **Soft Edit Radius** to create a falloff. There is a visualizer that is evoked to show you where the falloff is occurring on the surface.



EDIT OPTIONS

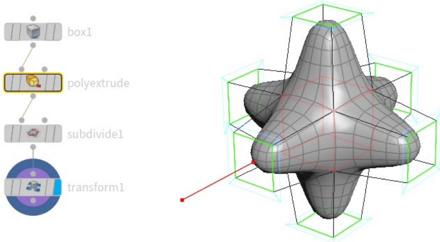
If you **RMB-click** while in the Edit node, you can access options for transforming your selection. You can make a circle or straighten the selection. These options work with points and edges but not always with primitives.

Make Circle	Shift-C
Evenly Space Selection	Shift-E
Relax Selection	Shift-R
Straighten Selection	Shift-S

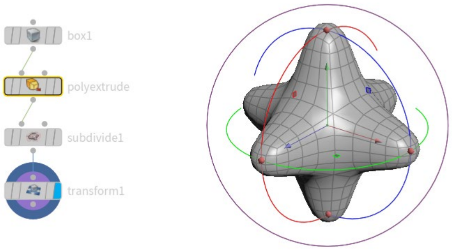
HANDLE TOOL

After using a shelf tool, you often find yourself in the **Handle** tool. Or you can select a node in the network and press the **Enter** key in the Scene view to go into the **Handle** tool. This brings up a handle which focuses on the specific parameters for the selected node such as the **distance** parameter on a *polyextrude* node.

Show Current Operator - By default when you select a node other than the display node, it becomes the current node and you get a wireframe display of the geometry. You can then use the handle to manipulate this intermediate node while evaluating the results on the shaded surface.



Show Display Operator - Another option is to always show the Display Operator. In this case, selecting a node in the chain does not show the wireframe and the handles stay focused on the display node.



You can change parameters in the parameter pane for the current node but the handles will continue to work with the parameters on the display node.

Shading Options - The shading options determine what you see in the Scene view. In this case, we are using Smooth Wired Shading.

Sloppy Selection - Three of the component buttons can be selected at the same time if the Edit node is using Sloppy selection which makes all of them available for a more fluid selection process.

RMB Menu - This menu gives you access to Edit tool options such as which type of edit you want to focus on. This information is also available on the top bar of the Scene view.

Component Selection - You can also select the component type using this menu. This offers you the same options you would find on the main toolbar.

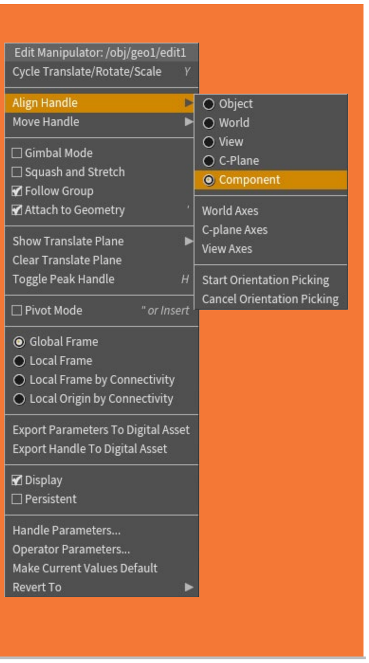
Edit Options - You can use this menu to edit the components using operations such as **Make circles** and **Straighten** the selection.

HANDLE OPTIONS

All handles have a menu that can be accessed by **RMB-clicking** on any part of the handle.

This menu gives you options for aligning the handle, detaching it from the parameters of the node, pivot mode and more. You can use these options to customize how the handle works.

You can also keyframe parameters on a handle and promote all parts of the handle to a Digital Asset. By promoting the parameter the handle will be accessible at the asset level.



Modeling Tools

Houdini has a lot of tools for creating, shaping and deforming geometry to achieve a desired look. Here are just a few of the many tools you will use on a regular basis when building models in the geometry, or SOP, context of Houdini.

CREATION

To start creating geometry, you can start with some basic shapes or draw a curve. In each case you get an object with a geometry/SOP node inside with the tool's name. You can access these on the **Create** shelf or in a radial menu.

Primitives - Houdini includes Box, Sphere, Tube and Torus primitive shapes along with a variety of Platonic solids.

Grid - The grid tool offers a great starting point for a wide range of models. You can set its shape and size at the geometry level.

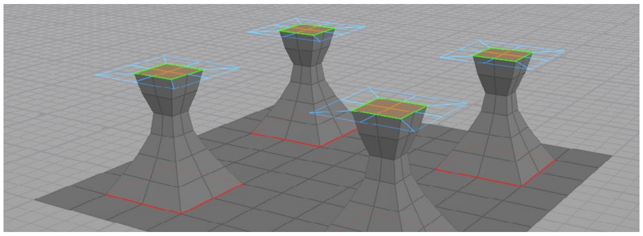
Curve - Draw a curve by laying down control points then create a Bezier, NURBS or poly curve.

POLYGON MODELING

Polygons are one of the most popular geometry types especially in video game projects where they are mandatory. Houdini has a comprehensive set of poly modeling tools which you can use to develop your models.

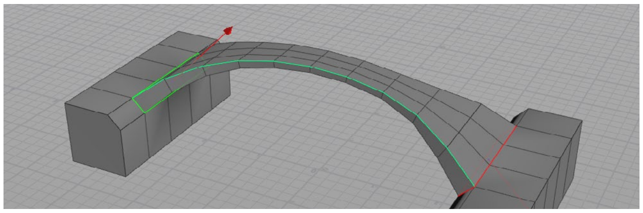
PolyDraw - This tool lets you interactively draw a polygonal mesh on the construction plane or by snapping to existing geometry.

PolyExtrude - Push or pull on one or more polygons to reshape the geometry. Control the extrusion profile to get a wide variety of shapes.



PolyBevel - Bevel selected edges to create chamfered or rounded bevels. You can often use the output group from a previous node such as Polyextrude or Boolean to automatically find the right edges.

PolyBridge - Connect two sets of polygons with control over the shape of the bridge.



PolySplit/Edge Loop/Knife - These tools let you split polygons to add more detail to your model.

PolyExpand 2D - Take curves and edges that sit on a 2D plane and creates geometry based on a desired offset value.

PolyReduce - Create different levels of detail by reducing the number of polygons while preserving quads and UVs.

PointWeld- Interactively snaps groups of points to another target point, and merges them.

UTILITY NODES

Because of Houdini's procedural nature, modeling actions like copy, clip and mirror create nodes in your network. This can makes it easier to go back and make changes later on.

Clip - Cut your model based on a clipping plane. You can set the direction of the clip and whether you keep one half, the other or both.

Mirror - This tool flips the geometry based on a clipping plane. There is an option to fusing the points after mirroring.

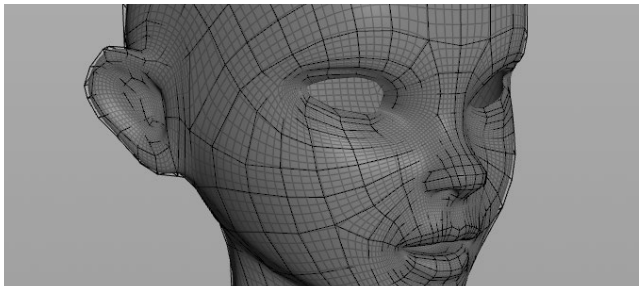
Copy and Transform- This node will let you create multiple copies based on transformation values.

Blast - This node lets you delete polygons from your model. You can choose to remove or keep the selected polygons. If you press the **Delete** key when points or a polygons are selected they will be blasted.

Dissolve - This tool lets you remove edges without breaking up the surrounding geometry. Pressing the **Delete** key when an edge is selected will dissolve it.

SUBDIVISION SURFACE MODELING

In Houdini, you can model with polygons then **display** and **render** them as subdivision surfaces using options found on the **Render** tab on the object's parameter pane. You can also create a **Subdivide** node at the geometry level to add polygons to give you a more detailed topology to work with.



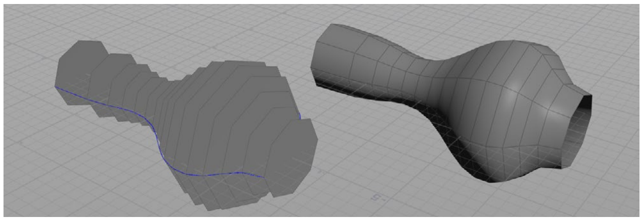
SURFACING TOOLS

There are tools in Houdini that will take profile curves and build surfaces. Those input curves can be either bezier, polygonal or NURBS or a mixture of them.

Revolve- Create geometry by revolving a profile curve around an axis. There is a handle available for tweaking the results.

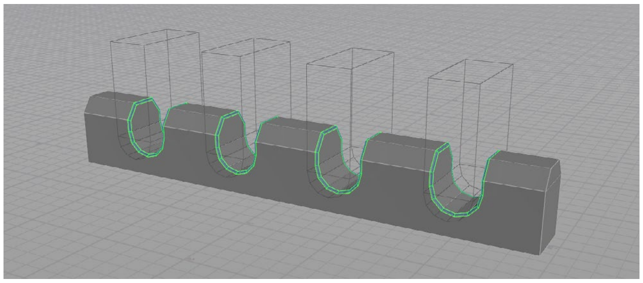
Skin - Take a series of profile curves and turn them into a surface.

Rails - Copy one or more profile curves along two or more rail curves, then Skin the results to get a surface.



BOOLEANS

Subtract, **Union** or **Intersect** geometry using the Boolean tool. This node can handle very complex topologies and can be used to break up a surface for destruction using rigid body dynamics. This often creates more realistic results compared to the Voronoi-based **Shatter** node.

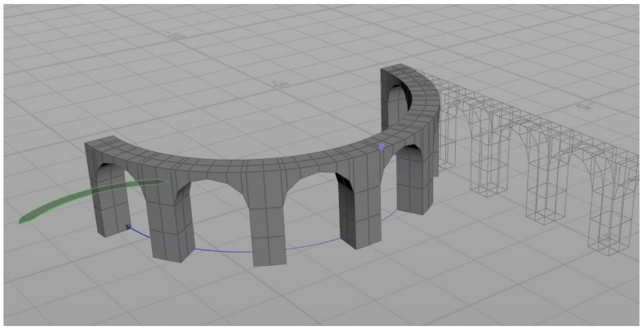


The Boolean tool can create output groups that you can use to feed other nodes such as the **Polybevel** node. This way any updates you make to the boolean will update properly when it feeds into the second node.

DEFORM TOOLS

While you can shape your geometry by editing points directly, there are times that you need a more generalized approach. The following nodes provide options for shaping your geometry procedurally.

Bend - This node lets you set a capture range and direction then bend, twist, taper and squish the encompassed geometry.



Lattice - This builds a lattice around your geometry then lets you edit points on the cage to reshape it. You can also use a custom cage.

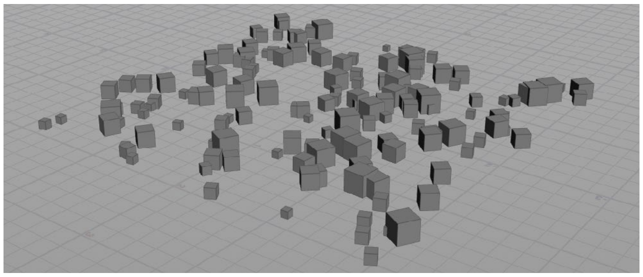
Mountain - Apply a noise function to deform the surface to create a random result. The points are actually being moved with this node.

Ripple - This node creates a ripple shape in your geometry.

Waves - This node adds noise functions to create a wave-like pattern that animates over time. Perfect for creating realistic oceans.

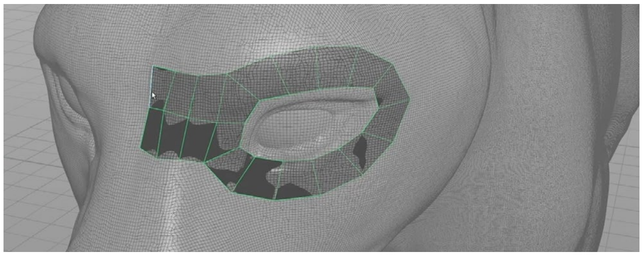
COPY TO POINTS + SCATTER & ALIGN

A typical Houdini workflow is to **Scatter & Align** points on a surface then **Copy to Points**. Attributes for scaling and rotating the objects can then be applied to create a more organic result. This is often used to create landscapes with trees and rocks.



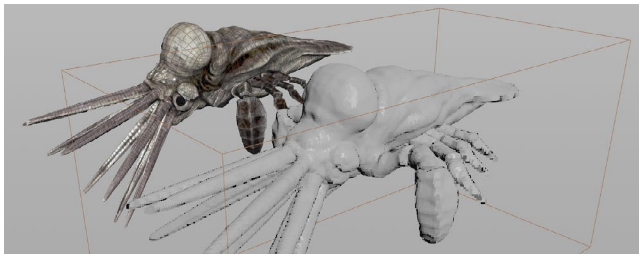
TOPOBUILD

Houdini has a **Topobuild** node that lets you draw polygons directly onto high-resolution geometry that you either scanned or created in an application such as Pixologic's Z-Brush. You can create a cleaner topology for animation then bake the details from the original model into a normal map.



VOLUMES

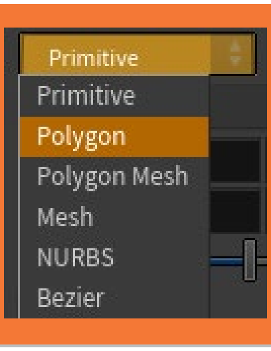
Volumes allow you to store values for voxel, or three dimensional pixels, in a space. These are often used to support collisions when using dynamic tools or to create clouds. They can also be used for modeling to combine multiple shapes into a single volume which you then convert back to a surface.



GEOMETRY TYPES

Houdini supports a number of different geometry types including **Primitives**, **Polygons**, **NURBS** and **Beziers**. You can **Convert** back and forth between them and you can have more than one geometry type merged together in a single object.

Polygons models can be set up to display and render as **Subdivision Surfaces** using **PIXAR's OpenSubdiv** standard. Both Subdivisions and NURBS will render in Karma and Mantra as perfectly smooth without relying on any tessellation settings.

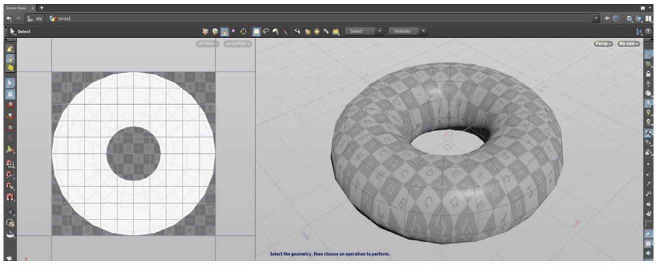


UVs & Textures

To make 2D maps fit properly onto 3D objects, UV coordinates are needed to define a flattened view of your geometry. When you first create geometry in Houdini it will not have any UVs. Even primitive objects do not have any built-in UVs. This means that you will need to add them at the geometry level using one or more SOP nodes.

UV TEXTURE DISPLAY

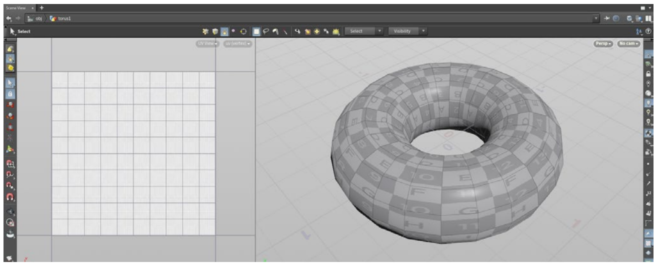
Since geometry in Houdini does not have UV texture attributes set up by default, you need to add them using UV tools. Once you have UVs set up, you will see a texture grid on your geometry because **Show UV Texture** is on in the **Display Options** bar. You can toggle it off if you don't want to see the UV texture or change it to a color texture.



Select the geometry, then choose an operation to perform.

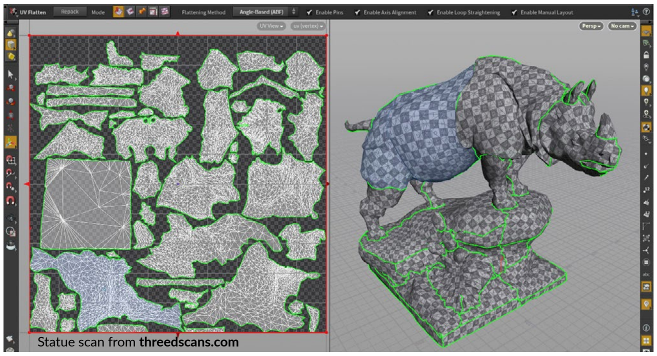
UV PROJECT

This node let you assign UVs using one of several projection techniques. Once you choose your projection type you can **initialize** the projection to match your object. This may invert the UVs and you will need to set a **rotate x** value of **-90** instead of 90. Above you can see an **Orthographic** projection and below you can see a **Toroidal** projection.



UV FLATTEN

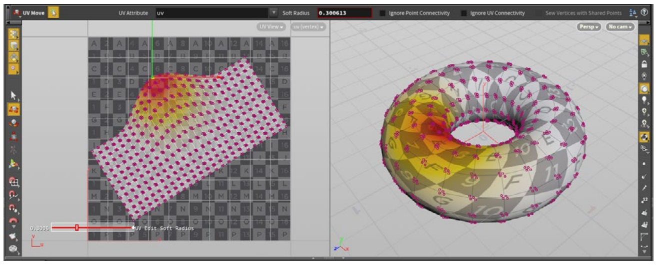
UV Flatten unwraps your geometry based on predefined boundaries created using selected edges or edge groups. The results can then be tweaked by pinning points in the **UV view** and adjusting the islands to get the look you want.



Statue scan from **threeddscans.com**

UV EDIT & DISTORTION

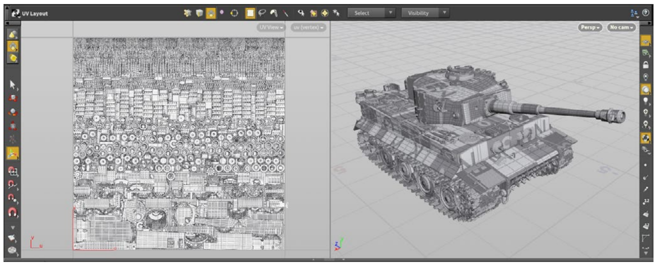
To edit individual vertices or groups of vertices you will use either the **UVedit** or **UVtransform** nodes. The UVedit node lets you perform many edits using a single node while UVtransform allows one edit per node which can provide a more procedural result. You can use **Display > UV Distortion** from the **UV Viewport menu** to see whether you are editing too much.



UV Attribute uv
Soft Radius 0.300613
Ignore Point Connectivity
Ignore UV Connectivity
Sew Vertices with Shared Points

UV LAYOUT

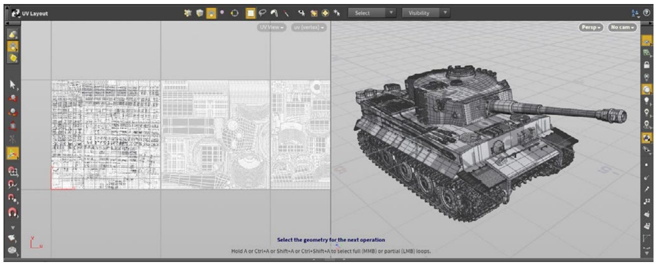
UV layout will let you create UV islands and pack them into UV space as efficiently as possible. This lets you maximize how much of a texture is being used on your geometry which is important when optimizing for both rendering and gameplay.



You can use the region handle to put a the UV layout into a particular part of your UV space. Subsequent layouts can then work around this layout using the **Pack Islands in Cavities** option.

UDIMS

In addition to working with a Single UV tile, you can use UDIMs to spread your UVs over many tiles. This technique lets you create more detailed texture maps because your UV islands are not packed in too tight. Properly numbered texture maps will then be assigned to the appropriate tile.



Select the geometry for the next operation

Hold A or Ctrl+A or Shift+A or Ctrl+Shift+A to select full (MMB) or partial (LMB) loops.

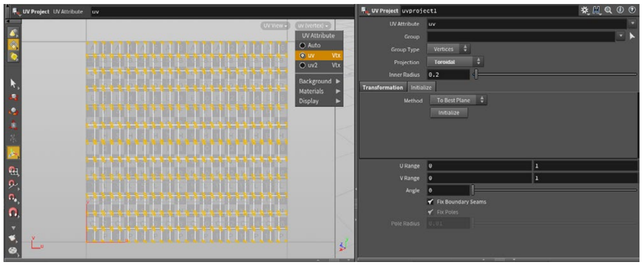
UV ATTRIBUTES

Earlier, you learned how attributes can be assigned to geometry that carry important information down the line. UVs are vertex attributes that let you wrap texture maps around your model and are also carried down your network.

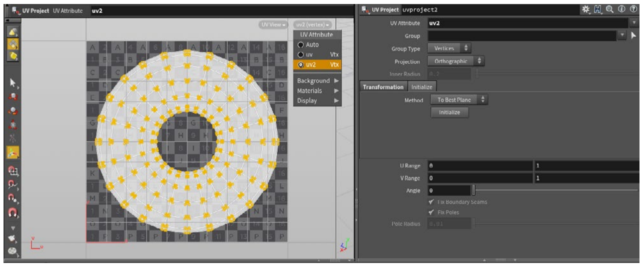
These attributes are visualized in the UV viewport and analyzed in the geometry spreadsheet. These attributes work with various SOP nodes including the attribute wrangle node which lets advanced TDs manage their UVs using scripting.

UV SETS

You can create more than one UV set on the same geometry. When you use the UV nodes, you can set the UV attribute. By default this is *uv* but you could create a *uv2* to create a second set. These different UV sets are used when you assign textures in VOPs so that different texture maps use different UV attributes.



UV Attribute: uv
Group Type: Vertices
Projection: Toroidal
Inner Radius: 0.2
Transformation | Initialize
Method: To Best Plane
U Range: 0 1
V Range: 0 1
Angle: 0
☑ Fix Boundary Seams
☑ Fix Poles
Pole Radius: 0.01

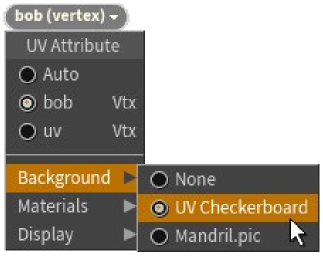


UV Attribute: uv2
Group Type: Vertices
Projection: Orthographic
Transformation | Initialize
Method: To Best Plane
U Range: 0 1
V Range: 0 1
Angle: 0
☑ Fix Boundary Seams
☑ Fix Poles
Pole Radius: 0.01

In the two images shown here, the first uses a toroidal projection and is assigned to a *uv* **UV attribute** while the second uses a planar projection and is assigned to a *uv2* **UV attribute**. These UV attributes can have any name, for instance, it could be *bob* instead of *uv2*.

UV VIEWPORT MENU

The UV viewport menu lets you display UVs based on the UV attribute. You can also use this menu to figure out the background image which can either be the default UV grid or a texture map pulled from an assigned material.

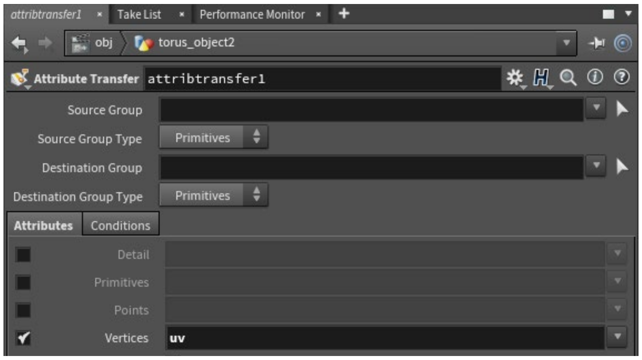


This menu also has display options for displaying **UV Overlap**, **UV Backfaces** and **UV Distortion**. These can be helpful when evaluating your UVs to decide if more tweaking is required.

ATTRIBUTE TRANSFER

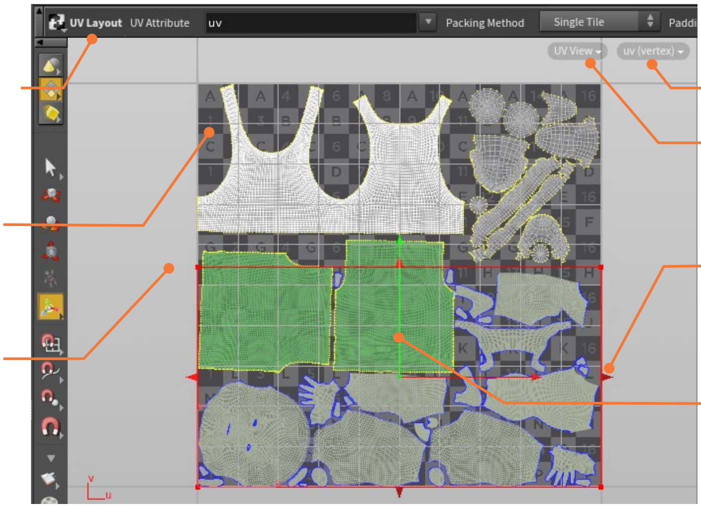
One of the SOP nodes that can be used to manage attributes is **Attribute Transfer** which lets you take the UV attributes from one piece of geometry and transfer them based on proximity to another.

This can be useful when the topology of a model has changed but you want to preserve some of the work you did creating UVs for the original model.



Attribute Transfer attribtransfer1
Source Group:
Source Group Type: Primitives
Destination Group:
Destination Group Type: Primitives
Attributes | Conditions
□ Detail
□ Primitives
□ Points
☑ Vertices uv

SCENE VIEW | UVS



Current Tool - At the top of the Scene View, you will find the selected node when the Handle tool is active.

Background - The background of the main tile can be set using options found in the UV menu.

Outside Main Tile - Polygons positioned in the area outside the main tile would overlap the same area on the main tile because the texture repeats unless you are using UDIMS which cover more than one tile.

UV menu - When you are in the UV view, this menu gives you a number of different options for working with UVs.

View menu - Use this menu to choose the UV view for this viewport.

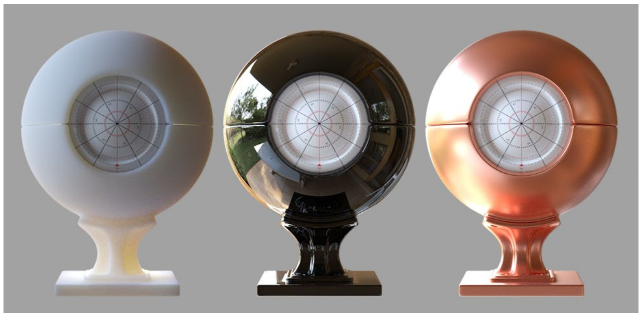
Layout Handle - This handle is part of the UV Layout node and lets you focus the UVs to a certain part of the tile.

Pack Around - The UV layout will pack your UVs around any existing geometry that has already had its UVs set.

LookDev: Shaders & Materials

To render objects in your scene, you must assign materials, also known as shaders, to your geometry. In Houdini, these materials and shaders are created in the mat/vex builder networks. The ability to build up materials using nodes is a powerful tool when defining the look of a shot.

Houdini organizes different types of nodes into network types and for materials you will use the `/mat` network type. This is where you can set up **VEX operators** for Karma and Mantra or **Material X** for Karma. Material X is an open standard, that originated at Lucasfilm,® which is used or the transfer of look-development content between applications and renderers.



THE MATERIAL PALETTE

You can add VEX-based materials using the **Material Palette** then assign them to objects by clicking and dragging. This pane has a workspace for managing the materials in your scene which is organized into tabs that represent different subnetworks such as **Material Library LOPS**. Use the **tab key** to add Material X shaders to material networks. Once they are in place they will show up in the Material Palette.

ASSIGNING MATERIALS IN LOPS

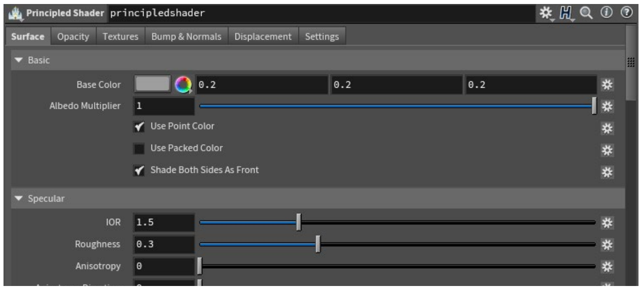
To assign a material in the Solaris LOP context, first create a **Material Library LOP** which contains a */mat* network. You can assign the material using this node or use an **Assign Material LOP** later in the chain. The **Material Palette** will let you drag from the gallery to the library or in LOPS you can use the **arrow button** to access a list of materials in your scene graph.

PRINCIPLED SHADER

In the Material Palette, you will find the principled shader, a material based on the Disney "principled" BRDF by Brent Burley. This shader is "principled" rather than physical in order to make it easier for artists to work with.

The **Principled Shader** has been pre-built to include the ability to assign textures directly to parameters such as base color, bumps, normals, displacements and more. The texture maps you assign will be displayed in the viewport and you can achieve a wide variety of looks right out of the box.

You can extend this material by feeding it with other VOPs but that isn't necessary in all cases. Many of the materials found in the gallery are variations on this shader.



Principled Shader principledshader

Surface | Opacity | Textures | Bump & Normals | Displacement | Settings

Basic

Base Color 0.2 0.2 0.2

Albedo Multiplier 1

☑ Use Point Color

☐ Use Packed Color

☑ Shade Both Sides As Front

Specular

IOR 1.5

Roughness 0.3

Anisotropy 0

PRINCIPLED SHADER CORE

The **Principled Shader Core** node sits inside the **Principled Shader** and contains the main features of the shading model but doesn't have all of the texturing features built-in.

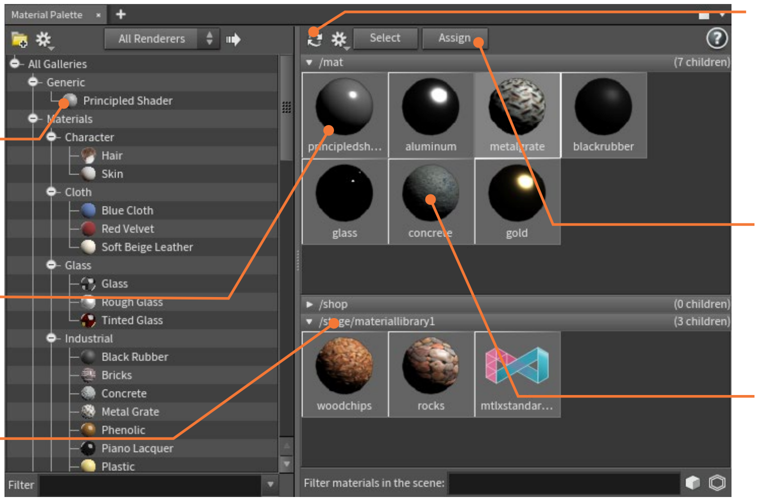
To build a robust shader from scratch using this node, you would need to add VOP nodes using Houdini's shader building tools. You can accomplish this by either wiring nodes together in the Node view or adding them using the Shader FX menus.

MATERIAL PALETTE

Materials in Gallery - The Materials listed here are saved to disk in a gallery file. You can drag these into the scene area found on the right or onto objects in the viewport.

Material in Scene - This is where you find materials that are part of your scene file. They can be assigned to objects by dragging from here into the viewport.

Material Library LOP - Materials set up in the LOP context can be placed into Material Libraries - you can drag materials into here from the gallery.



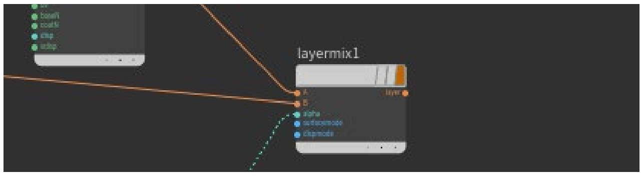
Update Material Icon - To update all material icons you can click on this button or RMB-click on material to do it one at a time.

Assign Material - If you select an object in the scene and the material in the palette then you can use this button to assign the material.

Double Click to Edit - If you double-click on any of these materials, you will jump to a Node View where you can make edits at the /mat level.

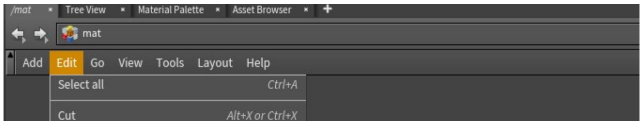
LAYERING MATERIALS

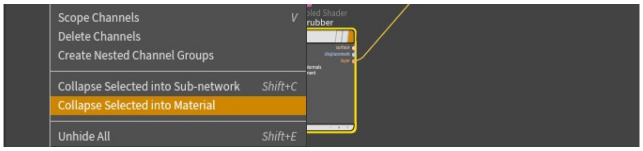
You can layer materials to create a unique look for your object. Using a **Layer Mix** node, you can combine two different materials into a single look. For instance, a shiny metal material and a matte rust material can be layered using this technique. You can then texture an alpha channel and you can choose to mix the surface, the displacement or both.



MATERIAL BUILDER

If you want to turn your layered nodes into a new material then you can select them and choose **Edit > Collapse Selected into Material**. This puts the nodes inside a **material builder** where you can continue to tweak it. At this level, there are *output* and *collect* nodes to make the network work efficiently.



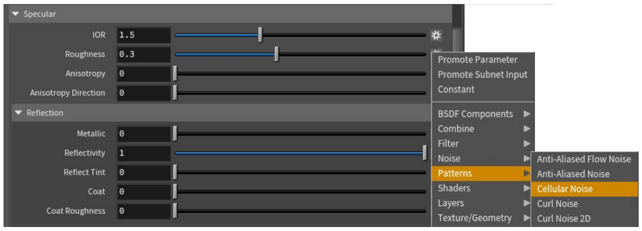

Scope Channels V
Delete Channels
Create Nested Channel Groups
Collapse Selected into Sub-network Shift+C
Collapse Selected into Material
Unhide All Shift+E
rubber

MATERIALS AS DIGITAL ASSETS

You can make materials even more efficient by saving them out as **Houdini Digital Assets**. In the **Asset Properties** pane, you can go to the **Save** tab and choose **Save Cached Code** so that the material is pre-compiled when you render with Mantra. You can also load texture maps into the digital asset then reference them from inside the asset file. Turning materials into HDA's can make it easier to share with your team.

SHADER FX MENU

While working with material VOPs, you can add nodes in the Network view and wire them together or you can use the **Shader FX Menu** by clicking on the icon at the far right of each parameter. This menu lets you focus on the parameter that you want to work with and create the node in context.


Specular
IOR 1.5
Roughness 0.3
Anisotropy 0
Anisotropy Direction 0
Reflection
Metallic 0
Reflectivity 1
Reflect Tint 0
Coat 0
Coat Roughness 0

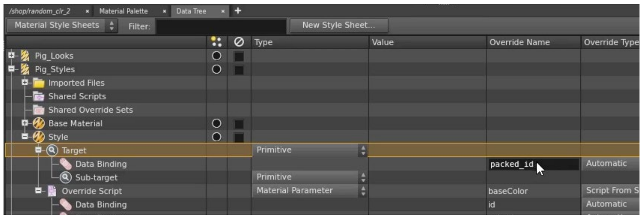
In the Parameter Pane, you can see what type of connection each parameter has by looking at the icon on the far right:

- No Connection ⚙
- Parameter Node ◉
- Connected with other Nodes ⚙
- Hidden Connection ⁘

PROCEDURAL MATERIAL ASSIGNMENT

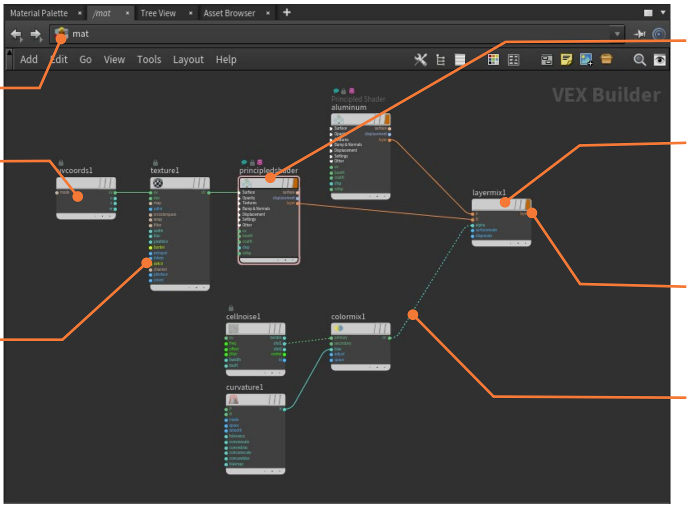
When working in production with lots of data, it is often necessary to take a procedural approach to assigning materials. With **Solaris** and **Karma**, you can accomplish this using nodes such as the **Assign Material LOP** or **Material Variation LOP.**

If you are working with **Mantra**, materials can be assigned to the object using the **Data Tree** panel which gives you access to **Material stylesheets.** Stylesheets let you use rules to assign materials and textures to large groups of objects.



		⊘	Type	Value	Override Name	Override Type
Pig_Looks	○	■				
Pig_Styles	○	■				
Imported Files						
Shared Scripts						
Shared Override Sets						
Base Material	○	■				
Style	○	■				
Target			Primitive			
Data Binding					packed_id	Automatic
Sub-target			Primitive			
Override Script			Material Parameter		baseColor	Script From S
Data Binding					id	Automatic

SHADER BUILDING



Node Path - This will confirm your current path and help you navigate into and out of the material network.

VOP Nodes - In the material context, you can start with material nodes then wire in VOP nodes to customize the texturing of the material. Once you are finished you can choose to collapse all of this back into a material builder node.

Node Connectors - You can add nodes to this area using the Shader FX menu which can be accessed by **MMB-clicking** on the dot. **RMB-clicking** on the dot gives you a full node menu.

Principled Material - This is a typical material which can be assigned on its own or fed into the Layer mix.

Layer Mix - The Layer output on the materials can be fed into this mix node. You can assign this to your geometry.

Material Flag- If you want the layer mix to show up in the material palette then check this flag.

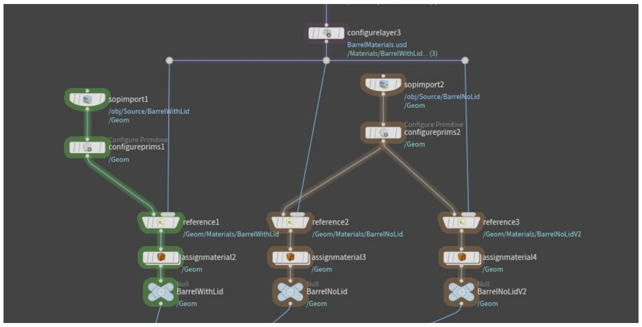
Alpha - Here the layer mix node's alpha is being fed by VOP nodes to create the alpha mask for the two layered materials.

Solaris: Layout

Solaris is the context in Houdini dedicated to Lookdev, Layout and Lighting that has USD at its core. Objects and geometry brought into this context become USD and you can use specialized nodes for positioning objects, instancing geometry and managing shot layout.

SOLARIS: LOPS

The Solaris environment can be found in the /stage network or by creating a LOP network. Here you will place nodes for bringing in geometry, assigning materials and adding lights and cameras. These nodes let you create sequences and shots using shared assets and procedural edit nodes to customize settings for each shot.



At its core, 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 USD concepts such as references, payloads, layers, collections, variants and level of detail.

LOP networks can then be rendered using either Karma or other Hydra-compatible renderers. Hydra is the technology that lets you render your USD to the viewport for interactive exploration or to disk for final renderings.

SCENE IMPORT: OBJECTS TO LOPS

For artists used to working at Houdini's Object level for layout and lighting, the **Scene Import LOP** node makes it easy to bring your geometry, lights and cameras into LOPS to render. If your goal is to create a controlled USD scene graph then you may want to take another approach but for quick access to Karma and other renderers the Scene Import node works fine.

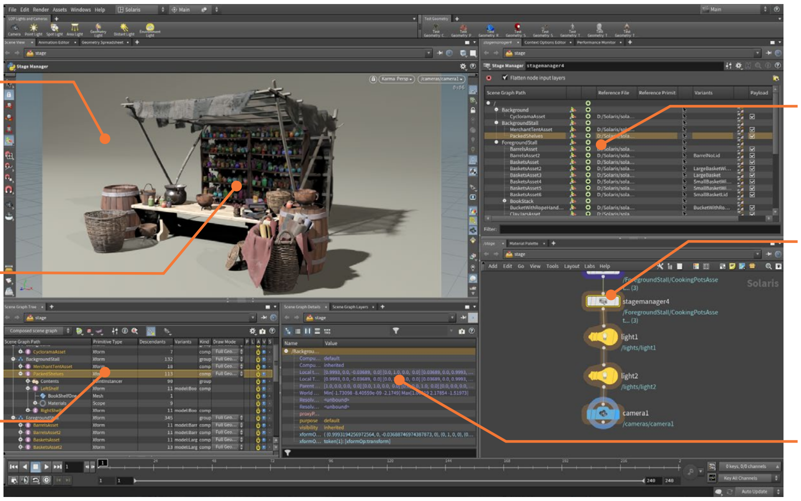
PREPARING ASSETS FOR USD

Another approach is for you to configure props using either a **Component Builder LOP** network or the **USD Export SOP**. This would be geometry and materials set up on a prop-by-prop basis then exported as USD for use in the layout stage.

For some of the props, you will use **variants** to create different variations that can be chosen during layout. There are LOP nodes that let you set up this USD concept.

Once you have the props set up as USD, the files can then be brought into a larger layout scene file using **Sublayer** or **Reference LOPS** then **Edit LOPs** can be used to position the props. If the assets are prepped properly then they will come in with geometry, materials and variants set up and ready.

SOLARIS DESKTOP



Stage - The Stage view provides a place for viewing your layout and lighting and to interact with primitives, lights and cameras to set them up properly.

Viewport Render - On the stage, you can render using Houdini GL or Storm the USD GL solution. You can also render interactively to Karma and Hydra compliant 3rd party renderers.

Scene Graph - The USD structure offers a renderable scene graph that can be inspected using this panel.

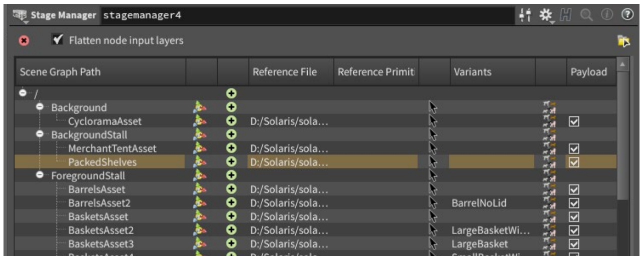
Stage Manager - This node lets you load USD files to be positioned on the stage.

LOP Nodes - All your actions in LOPS are accomplished using procedural nodes that make it easy to step back and make changes.

Scene Graph Details - As you select items in the Scene Graph you can check for details that inform you of its status in the pipeline.

STAGE MANAGER

The Stage Manager is designed to be a one-stop node for referencing USD assets from disk, transforming them in 3d space, and adjusting your scene hierarchy. This does involve a flattening of the inputting layers which will block up-stream changes from coming through. This lack of flexibility is balanced by the rapid setup possibilities of this node.



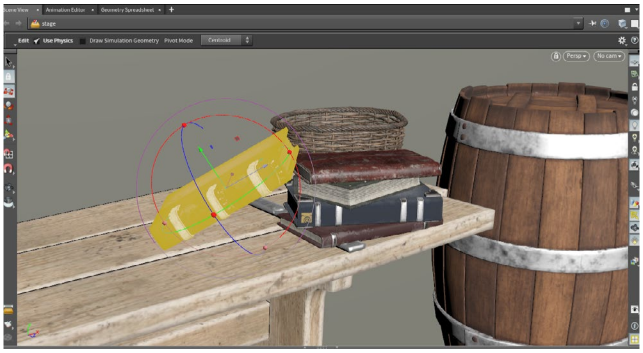
Stage Manager stagemanager4

☑ Flatten node input layers

Scene Graph Path	Reference File	Reference Primit	Variants	Payload
/				
Background				
CycloramaAsset	D:/Solaris/sola...			☑
BackgroundStall				
MerchantTentAsset	D:/Solaris/sola...			☑
PackedShelves	D:/Solaris/sola...			☑
ForegroundStall				
BarrelsAsset	D:/Solaris/sola...			☑
BarrelsAsset2	D:/Solaris/sola...		BarrelNoLid	☑
BasketsAsset	D:/Solaris/sola...			☑
BasketsAsset2	D:/Solaris/sola...		LargeBasketWi...	☑
BasketsAsset3	D:/Solaris/sola...		LargeBasket	☑

PHYSICALLY-BASED EDITS

Once you have all of the props loaded onto the Stage, you can use the **Edit LOP** to begin moving them around. The edits become a separate non-destructive layer which keeps the referenced assets intact in case you need to step back.

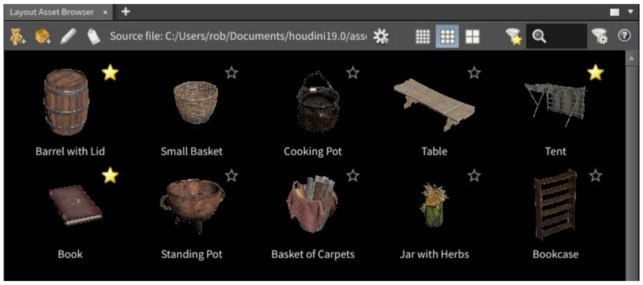


In the **Edit LOP**, there is a **Use Physics** option that lets you leverage the rigid body capabilities of Houdini to detect collisions and make it easier to position objects in a realistic manner. This lets the artist achieve a natural organic look while working interactively in the 3D view.

INSTANCING

There is an instancing solution in USD that can be utilized in LOPS. The Instance LOP lets you input one or more objects that will be distributed to points set up inside the LOP. These points can be created by importing geometry from your scene then scattering points on surfaces extracted from the model.

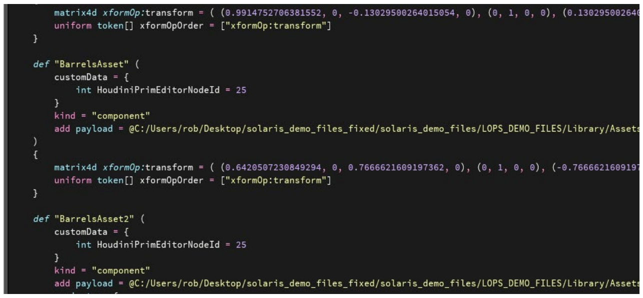
Materials can be assigned to the instances using a variety of methods including the **Material Variation LOP** which also offers per-geometry render properties.



You can also use the **Layout Asset Browser** and the **Layout LOP** to use a brush workflow to place, edit and transform instance points that reference the assets you choose in the browser.

EXPORTING USD

At various points in your LOP graph, you can inspect the USD code by RMB-clicking on the node and selecting **LOP Actions > Inspect Active Layer**. You can also inspect the **Flattened Stage**. When you export to USD, you can break out all the layers or save it as a single flattened graph.



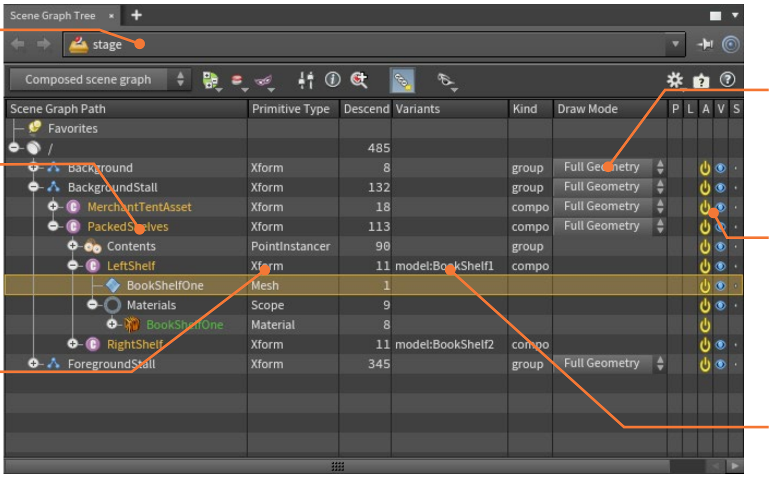
```
        matrix4d xformOp:transform = ( (0.9914752706381552, 0, -0.13029500264015054, 0), (0, 1, 0, 0), (0.130295002640
        uniform token[] xformOpOrder = ["xformOp:transform"]
    }

    def "BarrelsAsset" (
        customData = {
            int HoudiniPrimEditorNodeId = 25
        }
        kind = "component"
        add payload = @C:/Users/rob/Desktop/solaris_demo_files_fixed/solaris_demo_files/LOPS_DEMO_FILES/Library/Assets
    )
    {
        matrix4d xformOp:transform = ( (0.6420507230849294, 0, 0.7666621609197362, 0), (0, 1, 0, 0), (-0.766662160919
        uniform token[] xformOpOrder = ["xformOp:transform"]
    }

    def "BarrelsAsset2" (
        customData = {
            int HoudiniPrimEditorNodeId = 25
        }
        kind = "component"
        add payload = @C:/Users/rob/Desktop/solaris_demo_files_fixed/solaris_demo_files/LOPS_DEMO_FILES/Library/Assets
```

SCENE GRAPH

Stage - This is the top level network context for creating LOPS. You can also do all of this work in LOP Networks.

Scene Graph Path - These represent the USD layers and sublayers that define the look of the stage. These are most likely different USD files on disk being referenced into a shot.

Primitive Type - Each primitive comes with a type or schema that defines how it works. This can help you determine the contribution each layer is making to the stage.



Scene Graph Path	Primitive Type	Descend	Variants	Kind	Draw Mode
Favorites					
/		485			
Background	Xform	8		group	Full Geometry
BackgroundStall	Xform	132		group	Full Geometry
MerchantTentAsset	Xform	18		compo	Full Geometry
PackedShelves	Xform	113		compo	Full Geometry
Contents	PointInstancer	90		group	
LeftShelf	Xform	11	model:BookShelf1	compo	
BookShelfOne	Mesh	1			
Materials	Scope	9			
BookShelfOne	Material	8			
RightShelf	Xform	11	model:BookShelf2	compo	
ForegroundStall	Xform	345		group	Full Geometry

Draw Mode - Here you can change the display of any element in the path to either Full Geometry, Bounding Box or Textured Cards.

Display Options- Here you can set the visibility or activation of each layer. It is not possible to delete anything from the scene graph therefore hiding or deactivating is necessary.

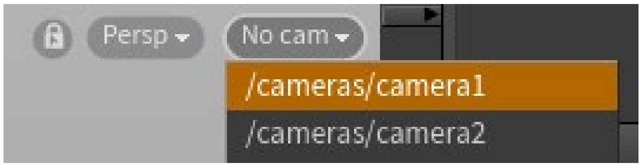
Variants- If a Layer has variants then the chosen one is displayed here.

Solaris: Cameras and Lights

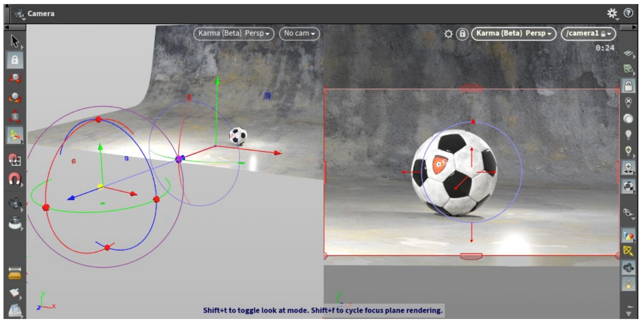
Before you render a shot, you need to look through a camera and light your scene. There are lights and cameras in the Solaris/LOPS context which is especially designed for layout, lookdev, lighting and rendering with Karma or at the object level for rendering with Mantra.

CAMERA

Cameras can be accessed from the **LOP Lights and Cameras** shelf. Press **Alt-click** on the shelf tool to convert your current view into a camera view. If you create the camera node in the Network view, click on the **No Cam** menu in the top left of the viewport to look through it.



To adjust the camera, you can use the Camera handles either from another view or while looking through the camera. There is a 🔒 **lock camera to view** button in the Display Options bar that lets you use the **View tools** to reposition the camera.



Shift+t to toggle look at mode. Shift+f to cycle focus plane rendering.

There is a 🔒 **lock camera to view** button in the Display Options bar that lets you use the **View tools** to reposition the camera. Just make sure that you don't leave this on later otherwise your camera view may get changed by a simple view change. Once you like a camera view, you may want to **lock its transform values** to avoid losing it to a view change.

CAMERA PROPERTIES

The Cameras in the LOP Context have key properties that determine how the camera will generate images.

View Tab

- **Projection** - Choose between perspective or orthoganal projection.
- **Focal Length** - Determines the length of the lens. Smaller values create wider shots and higher values create long shots.
- **Horizontal/Vertical Apperture** - Aperture is a gate that controls how much light goes into your camera.

Sampling Tab

- **Shutter Open/Close** - Determines how long the shutter is open which has an effect on motion blur.
- **Focus Distance** - Distance from the camera to the focal plane. Determines which objects are in focus when using Depth of Field.
- **F-Stop** - Lens aperture. Default is 0, which turns off focusing.

Press **Shift + F** to show a visualization of the focal plane and how it intersects geometry. When looking through a camera, you can **Shift-click** or drag on a surface to move the focal plane to intersect that point. Otherwise, you can use a handle on the focal plane to move it and set your Depth of Field.

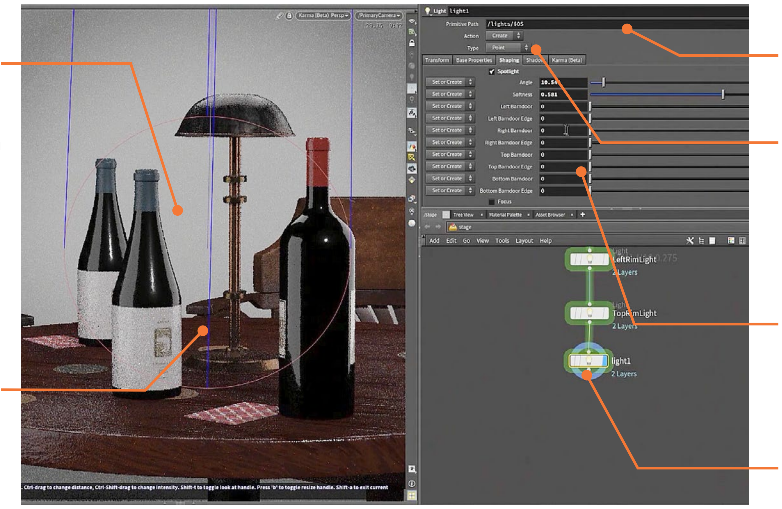
Shift-click
on Surface
SHOW FOCAL PLANE
[Shift- F]

LIGHTING SETUP

Viewport Rendering - To make lighting decisions, it is important be able to render in the viewport using either Karma or other renderers such as RenderMan or Arnold.

You can also use HoudiniGL but this is not as effective as one of the main renderers.

Light Handles - You can step back and manipulate lights in the view in a similar manner to cameras or you can use special controls to set lights right in the camera view.



Ctrl-drag to change distance, Ctrl-Shift-drag to change intensity. Shift-t to toggle look at handle. Press 'b' to toggle resize handle. Shift-a to exit current

Primitive Path - This sets where your light will be in the USD scene graph.

Light Type - You can choose your light type from this menu. The Light LOP gives you access to all the light types and you can switch between them.

Light Parameters - There are a range of parameters for controlling light properties such as cone angle and intensity.

Light LOP Nodes - Every light is added into the network as a LOP node.

LIGHTS

Lights can also be accessed from the shelf and have similar handles to help you position them. There are a number of different light types in Houdini to choose from.

Point Light - Emits light from a point in all directions and is similar to a light bulb.

Spot Light - Radiates a cone shaped beam of light from a point in a certain direction.

Area Light- Automatically distributes a number of light sources over a specified area. There are five area light shapes to choose from: Line, Tube, Grid, Disk an Sphere.

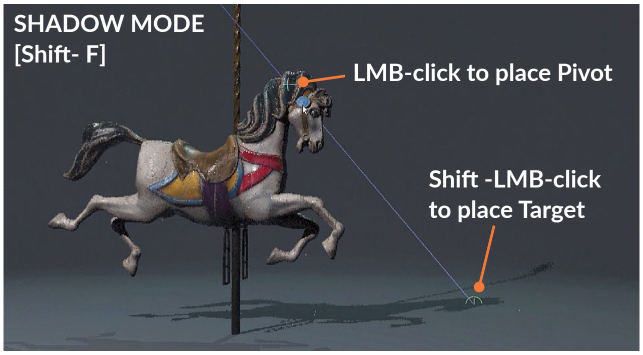
Geometry Light- This object emits light into the scene using a geometry object's surface shader for the colors of the emitted light.

Distant Light- Emits parallel rays of light, which are similar to the rays of the sun.

Environment Light- Casts light into the scene as if from a surrounding hemisphere or sphere.

LIGHTING WHILE IN THE CAMERA VIEW

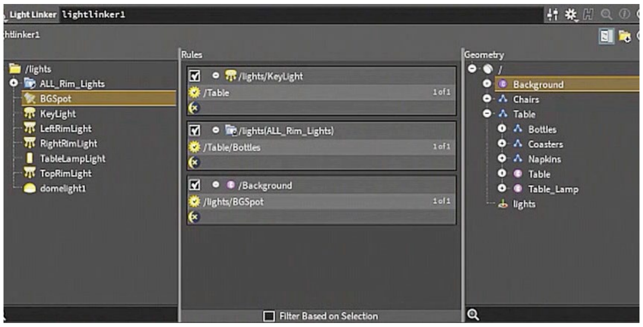
When you have a **Light** or **Light Mixer LOP** selected and displayed, you can set many of its properties while looking through the camera. You can use the **Specular [Shift-S]**, **Diffuse [Shift-D]** or **Shadow [Shift-F]** options that let you click on surfaces in the scene to set up the light.



You can then use **Ctrl-drag** to change the **distance** of the light from your shot and **Ctrl-Shift-drag** to change the **brightness**. Doing this in the viewport lets you stay focused on the shot you are working on instead of pulling away to drag on handles.

LIGHT LINKER

Linking lights to specific objects is a great way to control the lighting of the shot and this can be accomplished in Solaris using a **Light Linker LOP**. This node includes an interface for making the object/light connections that you need.



You can use collections of lights to apply the linking more efficiently using rules that define the interactions between primitives and lights.

INSTANCING LIGHTS

Within the Solaris/LOP context, you can use Houdini's procedural geometry nodes to create points then **Instance Lights** to those points. You can then add attributes to the points to create effects such as a rotating intensity you might find in an old school marquee. This approach makes it easier to set up the lights and even easier to add effects and make changes to meet the needs of the shot.

LIGHT MIXER

Light List - This list shows all the lights feeding into the mixer.

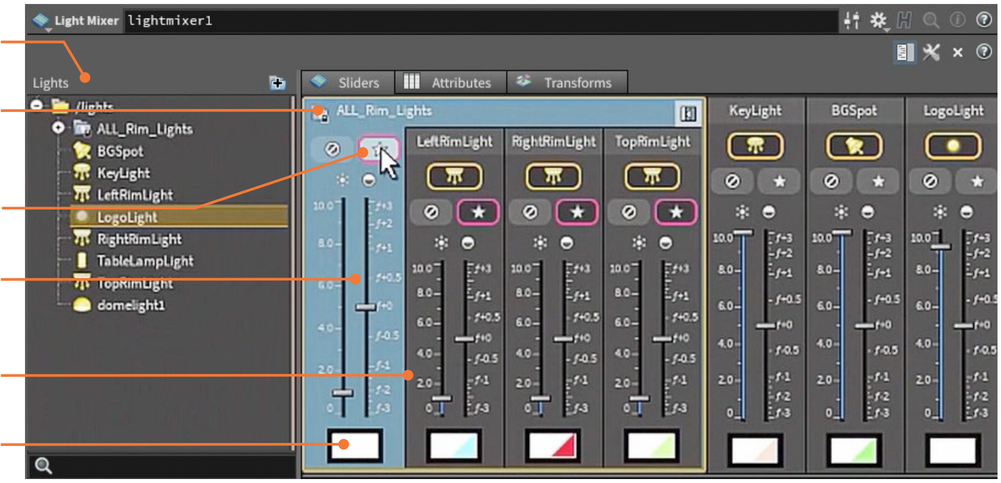
Collection - You can organize lights into collections so that they work as a group in the mixer.

Solo Lights - Click on the star icon to solor the light or the collection.

Intensity Slider - The first slider gives you control over the intensity of your lights or light collections.

Exposure Slider - The second slider gives you control over exposure which offers a tweak to the intensity.

Light Color - Click here to tint the light or the collection of lights.



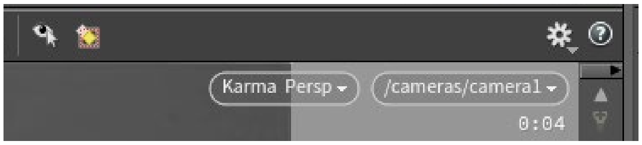
Rendering

When you render a shot, you are digitally photographing or filming your 3D objects using cameras and lights to generate either an image or a sequence of images. Game artists may also use rendering to render game cinematics or to bake textures from a high resolution to a low resolution object.

KARMA

Karma is a physically-based ray-tracer built to work with USD files in the Solaris/LOPS context. It works on the CPU and includes features such as adaptive tesselation for displacement and subdivision surfaces, multi-segment motion blur, instancing, hair & fur and strong volume rendering support.

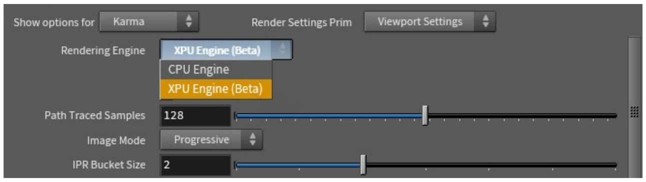
Karma works with **Hydra**,the USD imaging framework. This makes it available in the Viewport for interactive updates or you can render to disk using a Karma node.



Karma works with shaders created using VEX, USD preview and Material X.

KARMA XPU

Houdini 19.5 includes a beta version of the **Karma XPU** render engine. This hybrid GPU/CPU renderer is being released in Alpha. Many features are still under development and this engine is for testing purposes only. You can choose XPU in the Scene view's Display Options or in the Karma node.

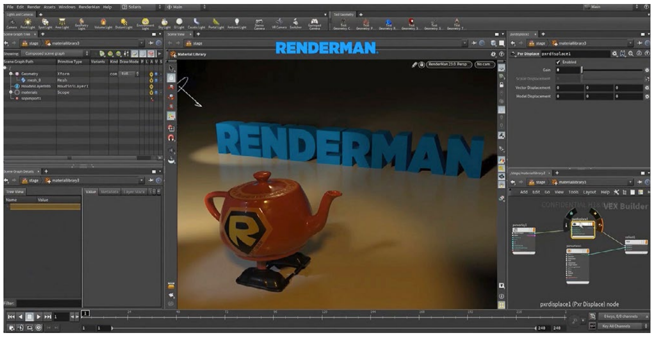


Show options for: Karma
Render Settings Prim: Viewport Settings
Rendering Engine: XPU Engine (Beta)
CPU Engine
XPU Engine (Beta)
Path Traced Samples: 128
Image Mode: Progressive
IPR Bucket Size: 2

Karma XPU works with USD preview shaders and Material X but does not work with VEX.

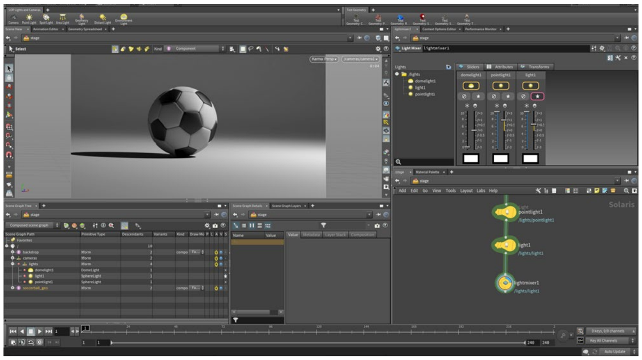
3RD PARTY RENDERERS

With its support for USD, Solaris makes it possible to render to other Hydra delegates such as **RenderMan**, **Autodesk Arnold**, **V-Ray**, **Maxon RedShift** and **AMD ProRender**.



VIEWPORT RENDERING

One of the key benefits of the Karma renderer is the ability to use it in the perspective view. By choosing Karma, you get interactive rendering that helps you make lighting and lookdev decisions within the Solaris/LOPS context.

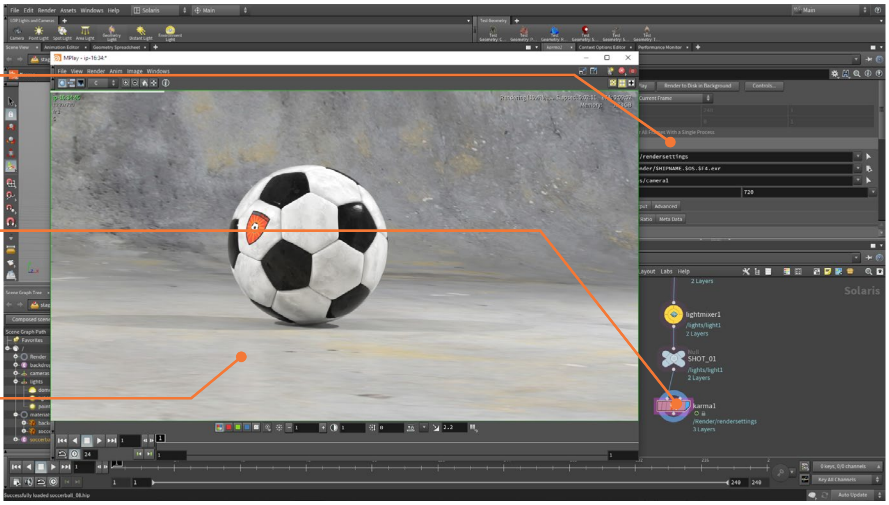


VIEWPORT | KARMA

Render Settings - To render to disk, you can use the Karma LOP to define your render settings. Here you can set a path for rendering to disk, camera settings and more.

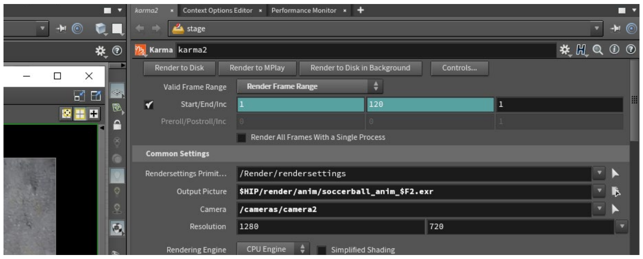
Karma LOP - Add the Karma LOP to the end of a Solaris node network. Different versions of this LOP can be used to set up unique results such as test renderings or final shots.

MPlay - You can either render from both Karma and Mantra to MPlay directly or render to disk then open up with MPlay to review the results.



RENDER SETTINGS

When rendering the Stage, you use the viewport render settings. To create the final look of your rendering, the **Karma LOP** can be used to set a frame range, camera resolution, denoiser and higher quality render settings.


karma2 | Context Options Editor | Performance Monitor

stage

Karma karma2

Render to Disk | Render to MPlay | Render to Disk in Background | Controls...

Valid Frame Range: Render Frame Range

☑ Start/End/Inc: 1 | 120 | 1

Preroll/Postroll/Inc: 0 | 0 | 1

□ Render All Frames With a Single Process

Common Settings

Rendersettings Primit...: /Render/rendersettings

Output Picture: $HIP/render/anim/soccerball_anim_$F2.exr

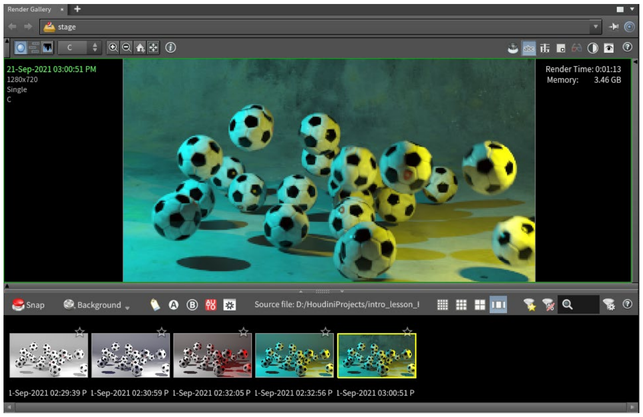
Camera: /cameras/camera2

Resolution: 1280 | 720

Rendering Engine: CPU Engine □ Simplified Shading

RENDER GALLERY

The **Render Gallery** lets you take **Snapshots** of your progress. Each snapshot contains all the settings of the look and at any time the scene can be reverted to match the snapshot. Snapshots can then be labelled and filtered for easy access.


Render Gallery

stage

21-Sep-2021 03:00:51 PM
1280x720
Single
C

Render Time: 0:01:13
Memory: 3.46 GB

Snap | Background | Source file: D:/HoudiniProjects/intro_lesson_I

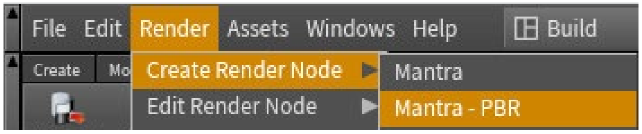
1-Sep-2021 02:29:39 P | 1-Sep-2021 02:30:59 P | 1-Sep-2021 02:32:05 P | 1-Sep-2021 02:32:56 P | 1-Sep-2021 03:00:51 P

MANTRA

Mantra is the Houdini renderer developed before Solaris was introduced. It is a physically-based rendering engine that is deeply integrated with highly efficient rendering of geometry, instances and volumes but it does not work in Solaris/LOPS.

OUTPUT NODES

To render out a shot, you will need to create a render output node. You can do this by choosing **Render > Create Render Node > Mantra - PBR**.



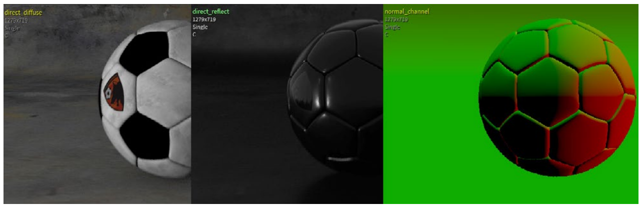
You can also add a **Karma ROP** to the output network using the **tab** key. This has a LOP network inside it that grabs all the visible objects from the object level.

You can use ROP nodes to render to disk or to Mplay. These nodes contain many of the parameters that you need to control the final image such as sampling, noise level and overall render quality.

It is possible to have a different ROP per object or group of objects and you can use them to select Mattes and Phantom objects. You can create ROP dependencies by wiring different nodes together. If you press the render button on the last node in the chain then all the other nodes will render first.

RENDER OUTPUTS | AOVS

On the ROP, you will find controls for setting up **Image Planes** to create render layers for *Direct lighting*, *Indirect lighting*, *Shadows*, *Depth* etc. Both Karma and Mantra can render out these passes which can be loaded in Houdini's compositing context, COPS, or in an external compositor such as Nuke.



The **Background Plate LOP** can be used to matte objects in order to leave holes in the scene to make the background visible. This geometry can take shadows and contribute to reflections to create a more realistic fit for your objects.

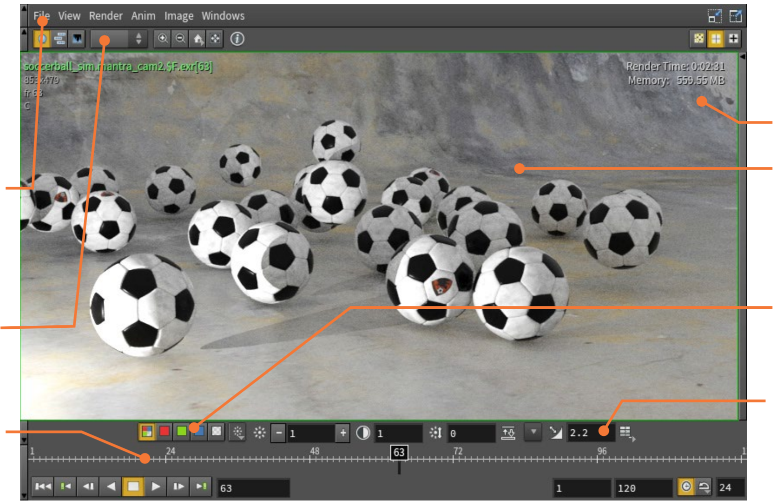
MPLAY

MPlay lets you view images rendered in Karma, Mantra or other renderers.

Main Menu - This menu lets you load images or sequences of images to preview them. You can also save them out to another format if needed.

Render Layers - This menu lets you display different render layers such as *color*, *normal*, *diffuse_direct* or *reflect-direct*.

Playbar - If you have loaded up a sequence of images then you can use these controls to play and scrub through the sequence.


File View Render Anim Image Windows

soccerball_sim.mantra_cam2.$F.exr[63]
853x479
fr 63
C

Render Time: 0:02:31
Memory: 559.55 MB

Render Time - Since you are sometimes rendering directly to this view, render time info will be displayed.

View Options - **MMB-drag** to pan and **RMB-drag** to zoom in and out of the image.

Channels - You can click on these buttons to focus on red, green, blue or alpha channels or to see them combined.

Gamma Settings - Set the brightness, contrast and gamma for the viewport. By default a gamma of 2.2 is used to support a linear workflow.

Time & Motion

Animation involves changes happening over time. Whether it is an object's position, shape or color, once changes occur over time, you are animating. Houdini has a variety of tools for keyframe-based workflows in addition to **Motion FX & CHOPs** for more advanced manipulation of time and motion.

SETTING KEYFRAMES

Keyframes let you set specific parameter values at a specific points in time. As these values change, the objects in your scene are animated. You can then use animation curves to determine the in-between quality of the motion. Here are a few main hotkeys used to set keyframes on your objects while working in the scene view:

Set Keyframe	K
Toggle AutoKey	Alt + K
Key Handle	Ctrl + K
Key Translate	Shift + T
Key Rotate	Shift +R
Key Scale	Shift + E

You can also set keyframes in the parameter pane by pressing the **Alt** key and clicking on either a parameter name or parameter field or by **RMB-clicking** on a parameter and selecting **Keyframes > Set Keyframe**. This lets you set keyframes one parameter at a time

THE PLAYBAR

The **Playbar** is at the bottom of the main workspace and lets you playback and scrub through your animations. Time is measured in frames with a default rate of 24 frames per second.

At the left are the playback controls. Here are some hotkeys for quickly setting up playback and moving through time.

Play Forward	↑
Play Back	↓
Next Frame	→
Previous Frame	←
First Frame	Ctrl + ↑
Next Keyframe	Ctrl + →
Previous Keyframe	Ctrl + ←

The Playbar can also be used to edit keyframes. You can **RMB-click** on the frame range in the Playbar to access options such as **Cut**, **Copy** and **Paste** of keys along with special pasting such as **Replace**, **Cycle**, **Repeat** and **Stretch**. All these options also have their own hotkeys which you can find on the menu. You can accomplish a lot working in the Playbar before moving to the **Animation Editor**.

CHANNELS

When you set a keyframe or display animation curves in the Animation Editor, you are working with **channels**.

If you select an object that has keyframed channels then they become active and the keyframes are loaded into the **Playbar** or **Animation Editor**. If you deselect the object then the channels will no longer be selected unless you pin them.

You can pin channels using the **Channel List** which is available on the right side of the **Playbar**, the left side of the **Animation Editor** or in the **Channel List** pane. In this list, you can select one or more channels to refine which of them you are keyframing and editing.

CHANNEL LIST PANE

The **Channel List** pane, lets you work with **Channel Groups, Animation Layers** and **Active Channels**. You can use the list to create groups of channels so that they can be more easily accessed. You can also use the groups to pin channels so that they are available even if you select different objects. This is a useful pane if you are setting keyframes on characters.

FLIPBOOK

As you animate your scene, you will want to preview the results in motion. The **Flipbook** tool found on the toolbar on the left side of the Scene view lets you capture frames from the viewport then playback the results as a movie in realtime.

PLAYBAR

The Playbar is where you scrub through time and create and edit keyframes. The Playbar can also be used to make quick edits, while the Animation Editor is used for more comprehensive refinements.

Playback Controls

These controls let you quickly play, pause, and move to next key. Below that are buttons for Animation options and Real Time playback.

Current Time

The current time is shown in the field and on the black marker in the frame range. The marker can be used to scrub through the Playbar.

Frame Range

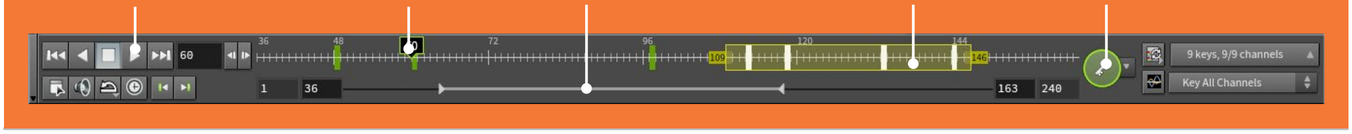
The overall range is defined by the Animation controls button at the far left. Then the visible range can be reduced using the handles at the bottom of the range.

Edit Keys

As you set keys, they are shown in the Playbar. Press the **shift** key to select keys with the **LMB** and then edit the keys by dragging with the **MMB**.

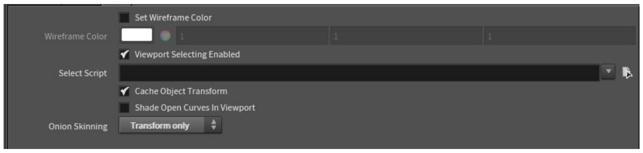
Set Key

The **Set Key** button will set keyframes when you click here. Click on the small arrow to bring up a menu of options such as **Auto key**.



ONION SKINNING

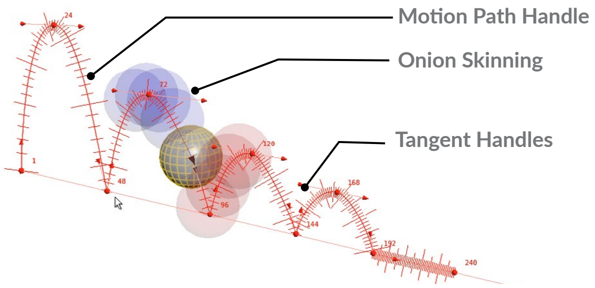
Onion Skinning lets you display a ghosted version of your object on the frames before and after the current frame. Turn it on using the **Misc** tab on your object while the onion skinning options such as Frames Before, Frame After and Frame Increment can be found in the viewport's Display panel [**d**] under the **Scene** tab.



□ Set Wireframe Color
Wireframe Color 1 1 1
☑ Viewport Selecting Enabled
Select Script
☑ Cache Object Transform
□ Shade Open Curves In Viewport
Onion Skinning: Transform only

MOTION PATH HANDLES

When using the **Pose** tool to animate, you can click on the **Motion Path** option to bring up handles that let you see the animation of the selected object over time. You can also use the handle to manipulate the shape of the motion.



ANIMATION EDITOR

Selected channels are loaded into the animation editor where they are represented as keyframes and animation curves, or as a spreadsheet or a dope sheet. The keyframes can be selected and edited and the curves can be shaped using tangent handles. The curves define the motion in-between the keyframes and play a key role in defining the quality of the motion.

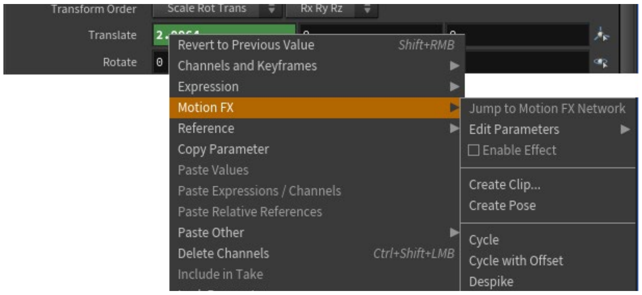
While working with channels, you can view the keyframes and animation curves using these hotkeys:

View All/Home	H
Pan	MMB
Zoom	RMB

MOTION FX

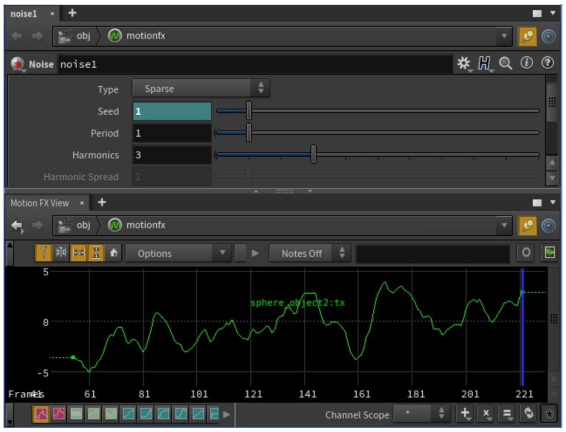
While keyframes and animation curves are stored in the parameters of your nodes, you can also use **channel operators (CHOPs)** for a more procedural node-based approach to working with motion.

The easiest way to create a channel operator is to **RMB-click** on a parameter and select from the **Motion FX** sub-menu. You can also apply these effects to channel groups when working in the Channel List.



Transform Order: Scale Rot Trans, Rx Ry Rz
Translate
Rotate 0

Motion FX can be applied to keyframed motion which is extracted and stored in a **Channel CHOP**. You can then apply effects such as **cycle, noise, smooth, limit** or **lag** to the existing motion. On the **Constraints** shelf, you have tools which let you have one parameter either **look at, lag** or **jiggle** behind another.



Noise noise1
Type: Sparse
Seed: 1
Period: 1
Harmonics: 3
Harmonic Spread: 2

This non-linear approach to working with motion offers a unique way of working that can be very flexible.

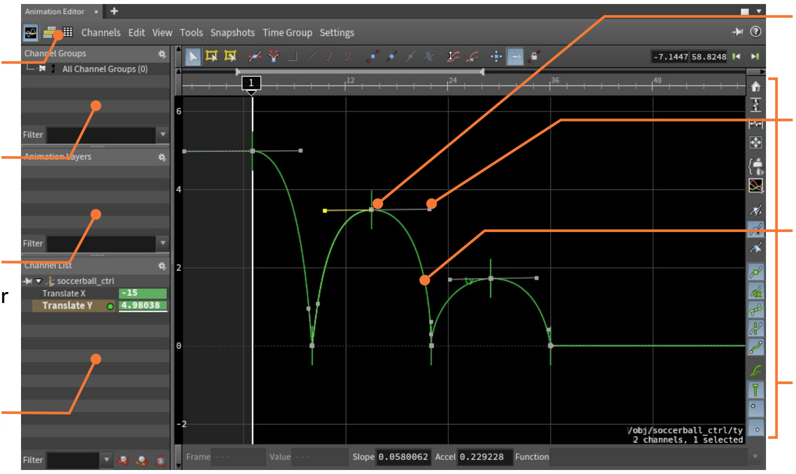
ANIMATION EDITOR

Editor Options - This editor can be shown as a graph, a dope sheet or a table.

Channel Groups - This area of the graph shows channel groups which make it easier to select and pin channels.

Animation Layers - This area lets you layer different channels on top of each other to create multiple iterations.

Channel List - Channels on selected objects show up in this area. You can then select the names of channels you want to see in the graph.



Translate X -15
Translate Y 4.98038
Slope 0.0580062
Accel 0.229228
/obj/soccerball_ctrl/ty
2 channels, 1 selected

Key Handles - Move the key back and forth in time using the vertical bar or edit its value using the box.

Tangent Handles - They define the tangents coming in and out of a keyframe to help you shape the curves.

Curve - The animation curves determines the motion in-between the keyframes, which defines the quality of the motion.

Curve Functions - These let you set various display options for the animation curves and handles.

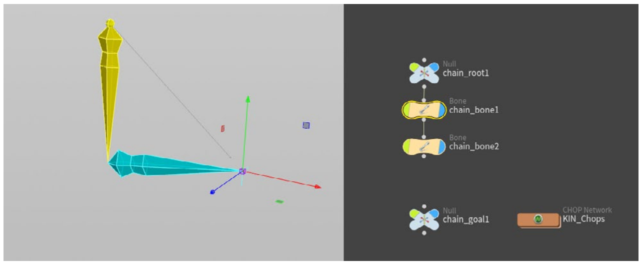
Character Rigging & FX

Houdini includes a wide range of rigging tools for creating characters and creatures that can then be wrapped into Houdini Digital Assets to be handed off to animators. Houdini also has Character FX tools such as hair, fur, muscles, cloth and crowds to enhance the look of your characters.

BONES

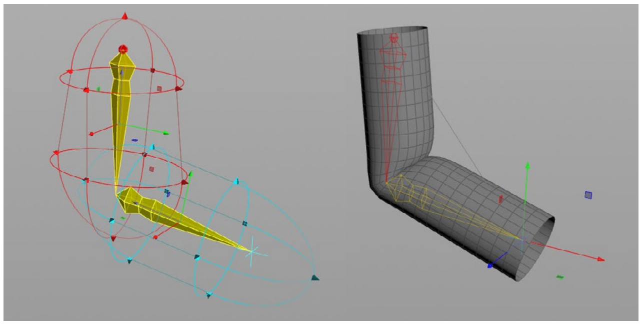
In Houdini, you draw and edit bones using the **Bones** tool and the **Bones from Curve** tool found on the **Rigging** shelf. Each bone chain is made up of a chain root and bones. Whereas other 3D apps are joint-based, Houdini uses **Bone** nodes that have parameters for **Length** and **Rest Angle**.

You can also use the **Bones** tool to add inverse kinematics to the chain which adds an **end effector** and in some cases a **twist effector**. The kinematics are driven by **Channel Operator** or **CHOP** nodes which exist in their own subnetwork.



CAPTURING GEOMETRY

The character's geometry can then be **captured** to the bones to create the deformations needed to convey realistic motion. Houdini bones include **Capture Regions** that you can set up to encompass your geometry while creating the right overlap at the joints. This process results in weighted attributes being assigned to the points that get fed into a **Deform** node that controls the geometry when the bones are moved and rotated.



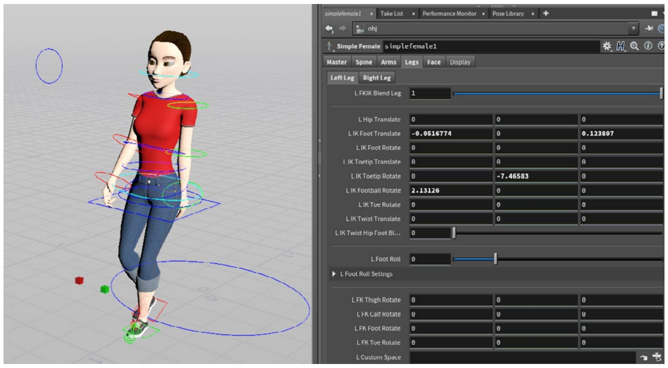
At first, captured geometry might not get you exactly the look you want, therefore you would use various tools to **Edit and Paint Capture Weights**. This lets you smooth out the weighting at the joints to create more realistic bending. You can also smooth out the effect of point deformations using a **Delta Mush** node that wires into the **Deform** node.

A new technique called **Bone Capture Biharmonic** allows you to capture geometry without requiring extensive point weights to get a desirable look at the joints. This method sets up biharmonic functions on a tetrahedral mesh to create a much more holistic solution.

DIGITAL ASSET CHARACTERS

To rig a Houdini character and share it with the animation team, you will need to wrap up the bones, geometry and materials into a **Houdini Digital Asset**.

This creates a file on disk that can be easily referenced by animators into multiple shots. Handles and key parameters are made available at the top level so that Animators can set keyframes without worrying about the inner workings of the rig. You can also save Pose Library and Character picker setups into the asset for quick access.



Simple Female simplefemale1

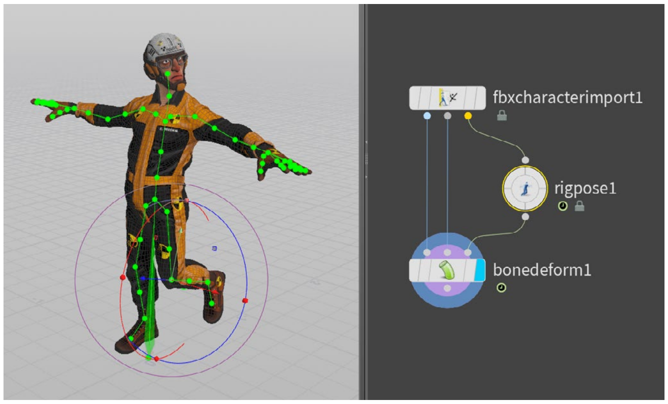
L FKIK Blend Leg	1		
L Hip Translate	0	0	0
L IK Foot Translate	-0.0516774	0	0.123897
L IK Foot Rotate	0	0	0
L IK Toetip Translate	0	0	0
L IK Toetip Rotate	0	-7.46583	0
L IK Football Rotate	2.13126	0	0
L IK Toe Rotate	0	0	0
L IK Twist Translate	0	0	0
L IK Twist Hip Foot Bl...	0		
L Foot Roll	0		
L Foot Roll Settings			
L FK Thigh Rotate	0	0	0
L FK Calf Rotate	0	0	0
L FK Foot Rotate	0	0	0
L FK Toe Rotate	0	0	0
L Custom Space			

Changes made to any part of that character are saved into the asset and all shots will be updated. This creates a robust character pipeline that is easy to manage.

KINEFX

KineFX is a character toolset designed to provide a procedural foundation for retargeting, motion editing, and in future releases, rigging and animation. Set in the geometry context, these new workflows make rigging a fast, plug-and-play experience with unlimited flexibility and caching capabilities.

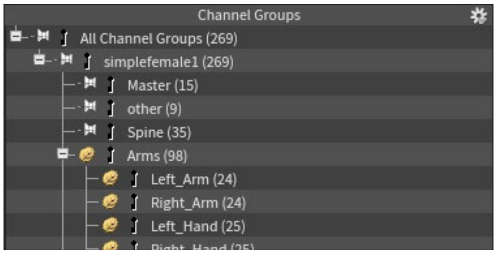
Implemented in the geometry [SOP] context, KineFX treats joints as regular point geometry with edge connections defining the rig hierarchy. You can bring rigs in from the object level of Houdini or import FBX characters.



CHANNEL GROUPS

When you animate in Houdini, channels that are scoped can be keyframed and displayed in the **Animation Editor.** Generally these channels are based on your current selection. You can also put together **Channel Groups** that let you scope and pin down channels to assist with keyframing.

When you have a character set up as a Digital Asset, you can click on its icon at the top left of the parameter pane and choose **Parameters and Channels > Create Nested Channel Groups** to create groups using the asset's folder hierarchy as a guide. A well designed character asset makes this easy.



Channel Groups

- All Channel Groups (269)
  - simplefemale1 (269)
    - Master (15)
    - other (9)
    - Spine (35)
    - Arms (98)
      - Left_Arm (24)
      - Right_Arm (24)
      - Left_Hand (25)
      - Right_Hand (25)

CHARACTER FX | HAIR & FUR

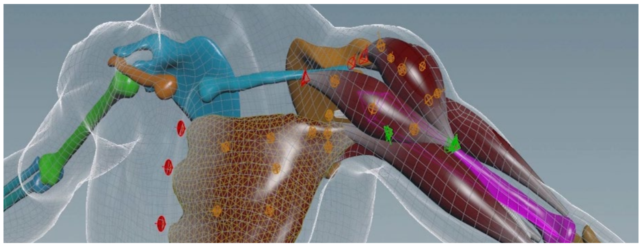
Houdini has a hair and fur toolset that you can use to setup and groom your character starting with the **Add Hair** tool. These tools also let you work with guide hairs and then animate them using wire sims to create added realism.

Andriy Bilichenko

CHARACTER FX | MUSCLES & SKIN

Houdini lets you add muscles to an animated creature and then apply them as a skin deformer without requiring any simulation. Start by creating simple muscle forms using the **Muscle** nodes in the geometry context.

You then adjust the muscle's shape and placement, attach it to your character rig then enable automatic secondary animation or jiggle. Houdini's muscle system has been designed to serve both FEM (dynamics simulations) and non-FEM (skin deformer) workflows while using a unified set of Digital Assets.



CROWD SIMULATIONS

A crowd simulation begins with agents that are made up of a character skeleton, skin geometry, and animation clips. These are assigned to points, where simple rules can combine to create complex behaviors and the agents can interact with other dynamic elements. For example, an agent might be struck by a passing car and become a rag-doll or a crowd might be triggered to react to an action on the field.

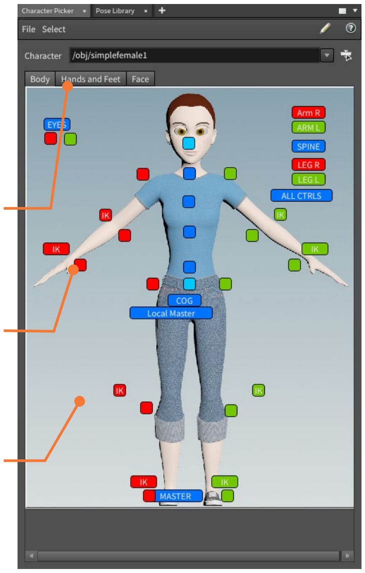
CHARACTER PICKER

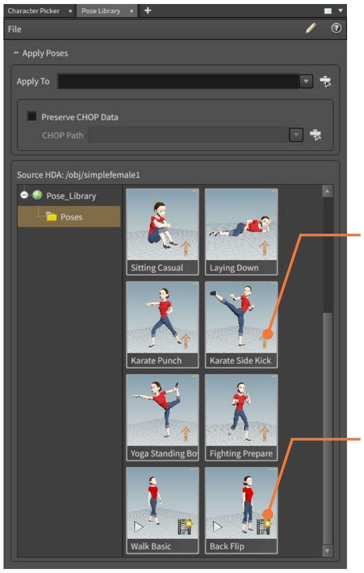
This pane lets you create an interface for choosing parts of your rig. This can then be saved into a file that you add to your Digital Asset file on disk.

Tabs - Set up multiple tabs for different areas of the body such as hands, feet or face.

Controls - Place markers for the different handles on your rig then add text or color to help you distinguish between them.

Background Image - Add a visual representation of your character to properly associate the markers with the parts of the body.


Character /obj/simplefemale1


Source HDA: /obj/simplefemale1

POSE LIBRARY

The Pose Library pane lets you capture poses and clips from your character for future reference. You can go to a frame in your Playbar and apply the pose by clicking on it here.

Pose - These save out a pose taken from a single frame. All of the parameter settings at that pose would be applied to the character in your current scene. You would then use this to interpolate to another pose.

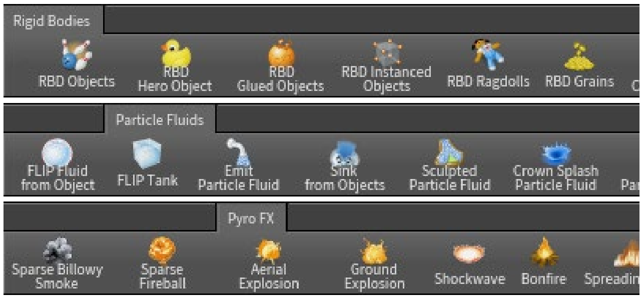
Clip - A clip contains a set of keyframes for a longer time period. These might be a walk cycle or a particular movement like a back clip.

Dynamic Simulations

Whether you are creating Bullet Rigid Body destruction, Pyro FX fire and smoke, Vellum Soft Bodies or FLIP fluids, Houdini lets you work in an integrated dynamics environment. Different solvers know how to talk to each other to allow for more directable results.

SHELF TOOLS

Setting up dynamic simulations involve a network of nodes in the **Dynamic or DOPS** context, as well as nodes at the **Geometry or SOPS** context. It is always a good idea to use the shelf tools because they will add all of these nodes for you and reduce the number of clicks needed to set up a sim. You can then dive into the networks to explore all of the nodes.



The shelf tools are great for setting up groups of nodes automatically. Seeing how these shelf-built networks are put together can be very useful later if you choose to set up DOP networks from scratch.

DYNAMIC SOLVERS

At the center of any simulation is the dynamic solver. It is the brain of the simulation and takes all of the dynamic objects, forces and collision objects and integrates them to create the final result. The shelf tools put these solvers into a Dynamic Network and wire up the nodes for you.

Rigid Body Solver- Simulate rigid objects falling and colliding using the efficient Bullet solver or Houdini's built-in solver.

Static Solver- For situations where you want objects to work as collision geometry but not be affected by the simulation.

Flip Solver - This solver creates FLIP Fluid simulations to create splashing and wave effects.

Whitewater Solver - After completing a FLIP solve, you can run this solver to create foam, spray and bubbles.

Vellum Solver- A type of POP Solver that includes integrated support for cloth, hair, grains, fluids and soft bodies such as balloons.

POP Solver- Used for particles and grains, this solver simulates a wide range of different particle-based scenarios. Grain simulations can also be used for soft body and cloth-like simulations.

Wire Solver- You can use this solver for hair and fur or other wiry objects such as the rigging of a ship or the branches of a tree.

Finite Element Solver- Simulates the physics of continuous materials or solids as determined by tetrahedrons. This solver is used for muscles, soft body sims and destructions shots such as breaking wood.

Cloth Solver- Create cloth simulations that can collide with deforming geometry such as a character.

SOP Solver- Use a SOP network to evolve an object's shape over time such as a wall being dented as it gets hit by objects.

OPENCL

You can use the GPU for faster sim times using **OpenCL** on solvers such as the **POP Grain node**, the **Pyro solver** (**Advanced** tab) and the **FLIP solver** (**Volume Motion > Solver** tab).

FORCES

To create dynamic motion, forces are needed to "get the ball rolling." The most basic of forces is gravity although other external forces such as fans, fluids and magnets can also play a role in initiating motion in your simulation.

Gravity Force A downward force on objects which works as if they were inside a gravity field.

Drag Force - Applies force and torque to oppose an object's existing motion to slow it down or dampen its momentum.

Uniform Force- A precise amount of force and torque that can be augmented by a noise DOP to add turbulence.

Fan Force- Applies a cone-shaped force on objects.

Fluid Force- Deform soft bodies such as cloth or wires with fluids.

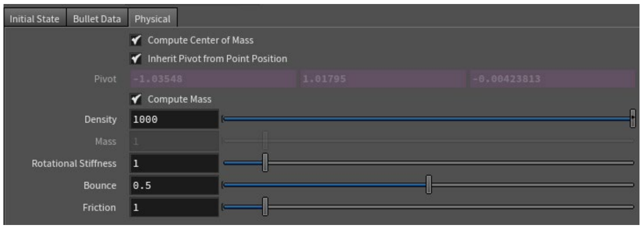
Wind Force- A pushing force that will increase the velocity of objects up to but not beyond its own speed.

Magnet Force- Attracts or repels objects using metaballs to represent a force field.

Vortex Force- Creates a vortex-like force that causes objects to orbit around a curve much like objects around a tornado.

DYNAMIC OBJECTS

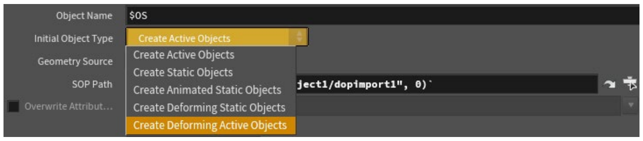
When you select an object and use a shelf tool to add it to your simulation, Houdini creates a Dynamic Object that uses the object's geometry and adds dynamic properties such as *density*, *friction*, and *bounciness*.



☑ Compute Center of Mass
☑ Inherit Pivot from Point Position
Pivot -1.03548 1.01795 -0.00423813
☑ Compute Mass
Density 1000
Mass 1
Rotational Stiffness 1
Bounce 0.5
Friction 1

ACTIVE VS STATIC

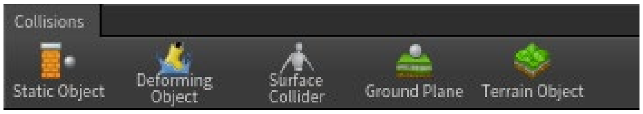
Active dynamic objects are affected by forces and collisions while Static objects are not. If you want to use animated or deforming geometry then you must define this on the dynamic object using either the **Initial Object Typ**e menu or the **Use Deforming Geometry** checkbox.


Object Name $OS
Initial Object Type Create Active Objects
Geometry Source
SOP Path ject1/dopimport1", 0)`
□ Overwrite Attribut...

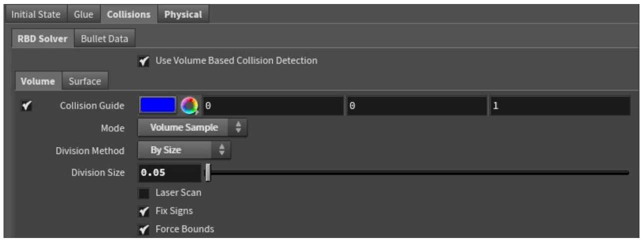
Create Active Objects
Create Static Objects
Create Animated Static Objects
Create Deforming Static Objects
Create Deforming Active Objects

COLLISIONS

Collision objects are also a big part of any simulation. You can set up a **Ground Plane** to create a continuous surface for collisions or use either static or deforming objects.



On each **Dynamic Object**, there are also settings for displaying and optimizing the collision volume. While you often want collisions to be as accurate as possible, you need to balance that with the need for faster simulation times.



☑ Use Volume Based Collision Detection

☑ Collision Guide 0 0 1

Mode: Volume Sample

Division Method: By Size

Division Size: 0.05

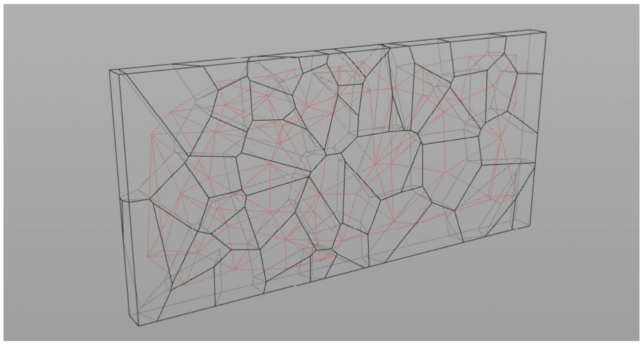
☐ Laser Scan

☑ Fix Signs

☑ Force Bounds

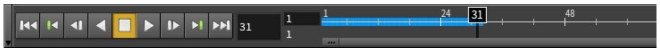
RIGID BODY CONSTRAINTS

On the Rigid Bodies shelf, you will find a number of constraints that can also be used to influence a simulation. These include **Pin**, **Spring** and **Slider** Constraints. You can also use **Glue Objects** when you set up a rigid body sim to hold objects together until you either "loosen up" the glue or a collision occurs.



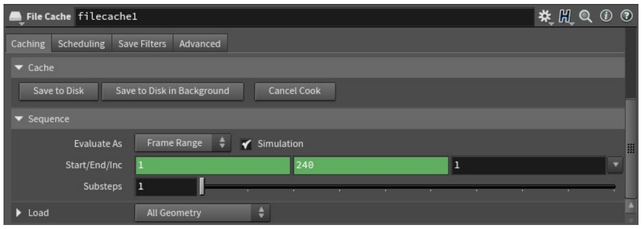
PLAYBAR FEEDBACK

To start a simulation, you press **Play** in the Playbar. As the simulation progresses, the Playbar is highlighted to show how much of the sim has been cached to memory. You can then scrub through that area without re-simming.



CACHING TO DISK

Once you have completed a simulation, you can either lock it down by saving out a **sim** file from within DOPs or more commonly, write out the simulated geometry to a **bgeo** sequence using the **File Cache** node. This will make it easier to work with the results of a sim during the lighting and rendering stages of production.



File Cache filecache1

▼ Cache

▼ Sequence

Evaluate As: Frame Range ☑ Simulation

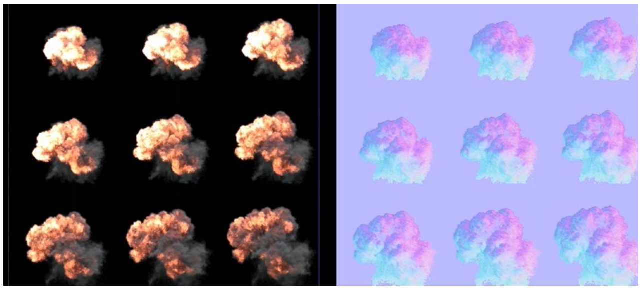
Start/End/Inc: 1 240 1

Substeps: 1

▶ Load: All Geometry

REALTIME FX FOR GAMES

In games, you need effects, such as explosions, to be optimized for real time in the game engine. Check out the **SideFX Labs Tools** to learn more about converting different kinds of Houdini sims such as rigid bodies, Pyro FX and Fluids into game ready art.



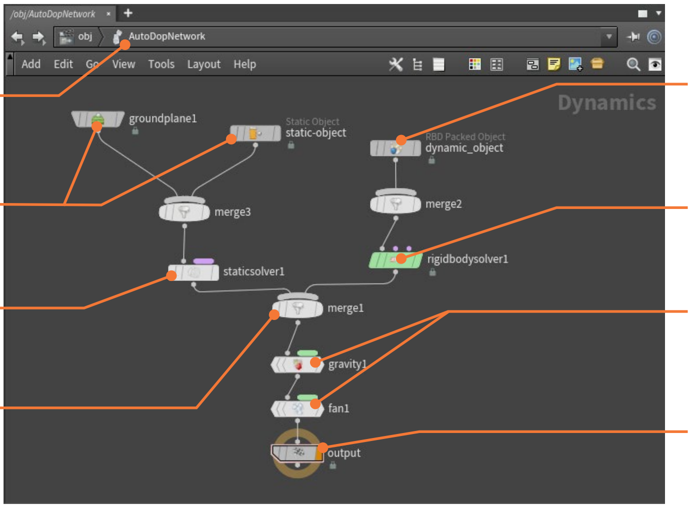
AUTODOPNETWORK

When you use a shelf tool to create a dynamic object, collision object or force, the AutoDopNetwork is created to combine all of the parts.

Static Objects - These nodes set up the properties of the ground plane and a static collision object.

Static Solver - This solver keeps the incoming objects still while dynamic objects interact with them.

Merge Node - Brings together parts of a dynamic system. During simulation nodes are evaluated up and down the chain so that everything interacts.



Dynamic Object - This node brings geometry into the DOPs environment and assigns basic properties.

Rigid Body Solver - The solver that generates the simulation of the participating objects.

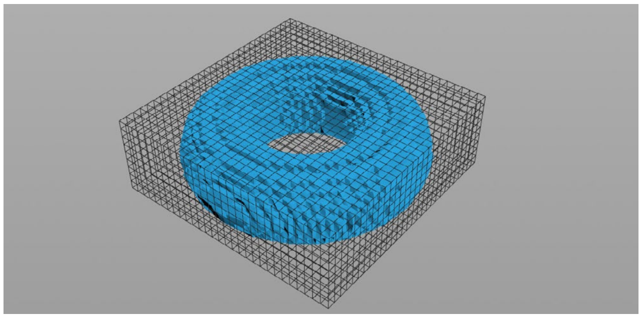
Forces - The nodes that influence the dynamic objects using forces such as gravity or wind.

Output node - You can use this node to output .sim files if you want to cache out the simulation.

Cloud FX & Volumes

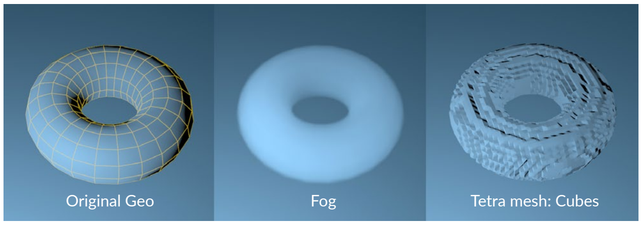
A big part of visual effects in Houdini is the use of volumetric data. In Houdini, volumes often sit under the hood to help tools get the job done but it is a good idea to learn what they are and, in time, learn how to work with them directly.

With volumes, you describe objects using *voxels* rather than points and polygons. A voxel is a 3D pixel, a cubic grid where each voxel contains information that informs how the volume will be displayed which makes it ideal for wispy cloud-like shapes. The visual quality of a volume-based object is defined by the resolution of that 3D grid. With more resolution, the results are of a higher quality but performance may be affected.



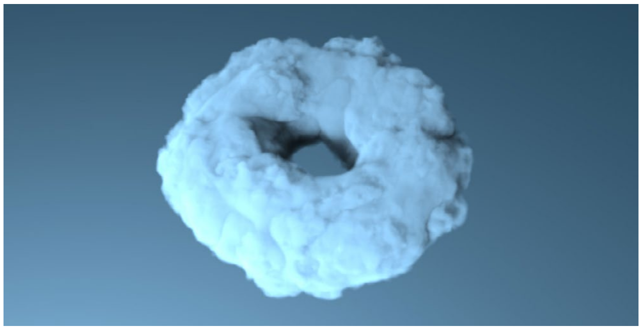
ISO OFFSET

The **Isooffset** node found in the geometry context lets you take any manifold Polygon geometry and construct a Houdini Volume for Houdini to use. You can choose from a variety of different Output types to see the shape as *fog* or a *tetra mesh*.

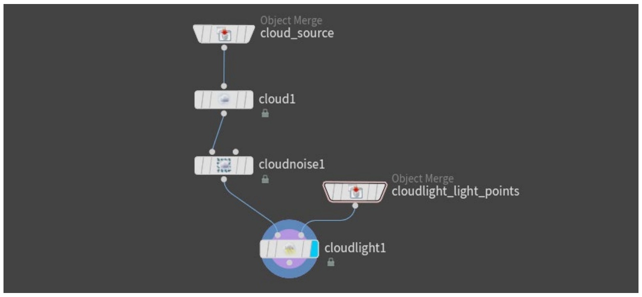


CLOUD FX

This toolset converts geometry into a cloud-like VDB volume complete with lighting. The **Cloud Rig** tool can be useful for shaping an individual cloud, or simply as a way to better understand lower-level tools such as **Cloud**, **Cloud Noise** and **Cloud light** that all contribute to the final look.



The resulting network imports the cloud source then applies these other nodes to create the cloud-like effect using Houdini Volumes and VDBs. Houdini also comes with a **Sky Rig** tool that fills the sky with volumetric clouds.



To create a cloudscape for a game engine such as **Unreal** you can use a Sky rig in Houdini, then convert it to a mesh and use it as a spawn surface. There is a tutorial on the SideFX website by **Andreas Glad** that teaches this approach.

OPEN VDB

"OpenVDB is an Academy Award-winning open-source C++ library comprising a suite of tools for the efficient storage and manipulation of sparse volumetric data discretized on three-dimensional grids. It is developed and maintained by DreamWorks Animation for use in volumetric applications typically encountered in feature film production." - **openvdb.org**

Houdini has a variety of OpenVDB Volume nodes available in geometry [SOP] networks that convert geometry into volumes.

VOLUMES UNDER THE HOOD

Many of the tools in Houdini make use of volumes under the hood where you can't see them. Here are some of the areas where volumes are making contributions to your work.

- **Colliders** - By default, volumes convert geometry into colliders for dynamic simulations.
- **Simulation Fields** - Volumes define fields such as density or velocity that contribute to dynamic simulations.
- **Hair and Fur tools** - These tools use volume data to assist with grooming calculations.
- **Terrain** - Heightfield tools use 2D volumes where each voxel contains the height of the terrain at each grid point.
- **Rendering** - Volumes create water depth and fog effects in Mantra.

Terrain & Heightfields

Procedural terrain generation in Houdini is achieved using a collection of heightfield nodes that let you layer shapes, add noise and run erosion simulations to define the look for your digital landscapes. This a workflow that is similar to compositing, but you do all your work with 3D shapes.

Houdini provides a variety of geometry nodes for generating and shaping terrain. These tools represent terrain using 2D volumes where each voxel contains the height of the terrain at that grid point, called **heightfields**. The data passing through a geometry network can contain multiple heightfields. You can access these tools using the **Terrain** desktop.

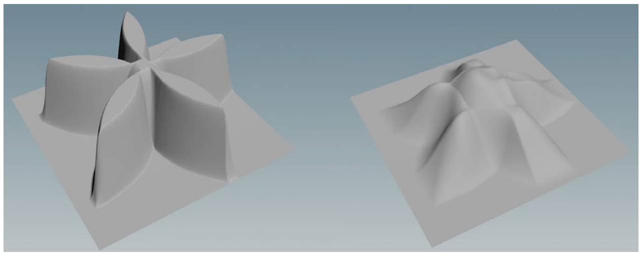
The Houdini viewport lets you visualize the 2D heightfield as a 3D surface, and the mask field is displayed as a red tint on the 3D surface. There is a dedicated Mantra procedural for rendering heightfields and they can be used as collision surfaces for dynamic simulations.

ARON KAMOLZ

PATTERNS

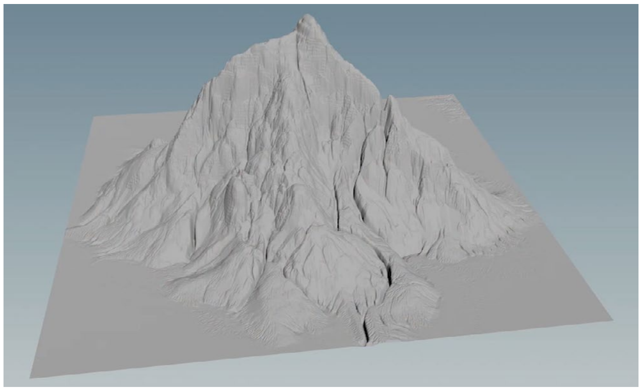
After laying down a **Heightfield** node to define your base resolution, the **Heightfield Pattern** node gives you access to a number of starter shapes. You can set up linear, concentric, or radial ramps, linear steps, radially symmetrical shapes such as stars and voronoi cells.

These shapes can then be blurred and distorted to get shapes that you can use to begin your terrain. You can also combine and layer elements to achieve even more sophisticated results.



NOISE

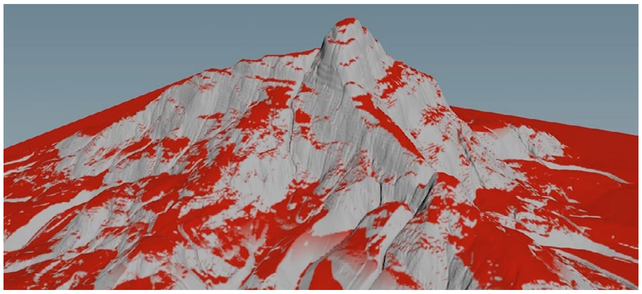
As you build up your terrain, you can then add noise to layer in a natural look. You can choose from a variety of different types of noise including, *Perlin*, *Sinusoid*, *Worley* and more. This adds realism to your terrain and by combining different shapes with different kinds of noise, you can achieve a wide variety of hyper realistic results.



MASKS

The heightfield tools also use a secondary type of 2D volume, where each voxel contains a **mask layer**. Most terrain nodes take a second input that can contain a mask layer to control which parts of the terrain the node will modify.

You can use a variety of different methods to create masks and then use them to assist you as you add detail and shape the terrain. You can also draw or paint masks onto the heightfield.



EROSION

The **Heightfield Erode** node uses rainfall, the erodibility of the soil, and entrainment rates as variables to simulate erosion and deposit buildup. This node works iteratively during playback. It will appear to have no effect on the first frame. You need to press play in the Playbar to watch as it sims the erosion.

EXPORT OPTIONS

There are a couple of different ways to export your terrain for use in another application such as a game engine. You can use the **Heightfield Output** node to export height and/or mask layers to disk as an image then bring these in as textures.

You can also create **Houdini Digital Assets** that will open up in applications such as Unreal and Unity using the Houdini Engine plug-ins. In the game engine, these Digital Assets will interact with built-in Terrain tools.

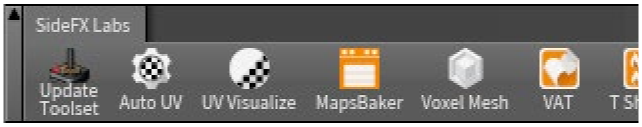
SideFX Labs

SideFX Labs is a collection of high level tools aimed to speed up artist and gamedev related workflows in Houdini. There are a growing number of tools being developed that range from Mesh Processing, Realtime FX, UVing, to creating Motion Vectors from simulations.

While all of Houdini can be used to generate content for film, TV and games, the Labs toolset addresses artist-specific tasks that may not be available in Houdini today. These tools are developed separately from the regular Houdini development cycle and become available the moment they are ready for testing. They can be downloaded directly from within Houdini or accessed through the SideFX Labs **github** page.

DOWNLOADING THE TOOLS

The Labs tools can be installed with Houdini or accessed from the SideFX Labs shelf tab. It not visible on most desktops so you will need to add it. Once it is visible, click on the **Update Toolset** button. This will pop up a dialog prompting you to install. Since many tools are in beta, you may want to turn **Off** the **Production Builds Only** option.



The shelf will be populated with many of the tools but some are only available when you **press tab** in the Viewport or Network view. These nodes are prefaced with **Labs** to make them easy to find.

FX TOOLS

Houdini is known for its strong FX tools and SideFX Labs has tools to process the results for use in a realtime environment for games or virtual production. Labs has a range of tools to help optimize and export your sims to textures, fbx, csv, etc.

Vertex Animation Textures - The Vertex Animation Textures ROP will export a mesh and textures to be used with a realtime material that can playback complex animations for cloth, rigid body destruction, fluids and particles.

Flipbooks Texture - Fast GL or Karma based creation and preview of texture atlases for Pyro FX.

Destruction Cleanup - Prepare rigid body simulation results for export, reducing redundant geometry, cleaning normals, cleaning attributes.

Skinning Converter- Skinning Converter is a SOP that can convert any non-changing topology deforming mesh sequence into a bone based animation.

Make Loop - Takes a mesh, points or volume that is animated and loops them.

Volume to Texture - The Volume Texture tool lets you write out a texture that can be used with Ryan Brucks' volume plugin in UE4.

Flowmap - This utility tool sets up a flowmap template on your input geometry.

Flowmap Visualize - A high quality realtime preview of a flowmap texture in the Houdini viewport.

Flowmap Obstacle - The flowmap obstacle SOP allows for easy modifications on the flowmap based on geometry.

Niagara ROP - All-in-one HDA to extract and write out impacts, split data and interpolation data from a bullet sim to be used with the UE4 Niagara data interface.

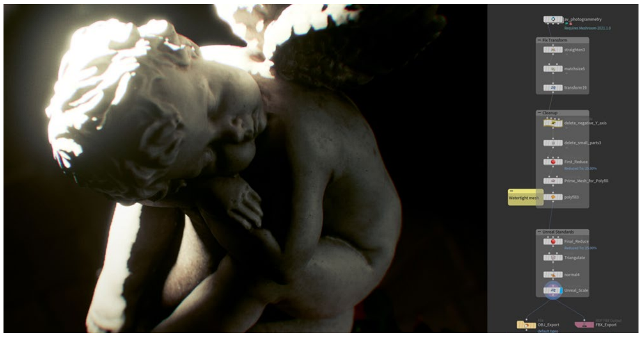
Gamedev Procedural Smoke - The procedural smoke SOP will generate an animated volume to represent smoke.

ROP Vector Field - Generate UE4 compatible vector fields from volumes or point clouds.

MESH PROCESSING

There are a lot of steps to get quality meshes into your games - photogrammetry, topology cleanup, mesh reduction, uv layout, baking maps. Lab tools let you simplify that process with wrapped up workflows and integrations with popular software.

AliceVision Photogrammetry - AliceVision is a Photogrammetric Computer Vision Framework which provides a 3D Reconstruction and Camera Tracking algorithms.



ZBrush Bridge - GoZ is Zbrush's fast file transfer feature that lets you send meshes between Houdini and Zbrush seamlessly without having to deal with file paths or extensions.

Delete Small Parts - Removes parts based on connectivity and size.

Delight - Removes ambient lighting information found in high-res photogrammetry scans.

GameRes - Full Pipeline Node to Take High Res Models to Low Res.

Maps Baker - Generates textures bakes from a high resolution to low resolution model at near interactive speeds.

LOD Hierarchy - Create and export an LOD Hierarchy as FBX.

Mesh Sharpen - This tool sharpens the geometry based on the curvature found on the mesh.

Edge Damage - This tool will add edge wear to your geometry.

WORLD BUILDING

Digital worlds are becoming bigger and more complex and it is important to have an efficient world building workflow. Whether you want to recreate New York City, grow a dense forest or add interior details to your sci-fi adventure there are Lab tools for you.

Physics Painter - Physics Painter is a SOP that allows users to paint physics objects onto any other object.

Building Generator - Convert low-resolution blockout geometry into detailed buildings using a library of user defined modules.

OSM Import - Open Street Map is a great database for city street data. This node efficiently loads the OSM files into Houdini as well as all of the different tagged attributes on the buildings and streets.

OSM Buildings - Generate Buildings from OSM Data.

Tree Tools - The Tree Tools in Labs consist out of several tools that can be used together to create intricate branching structures such as trees, bushes, plants and much more.

Cable Generator - Given a curve that represents the high ‘pin’ points and low ‘sag’ points of a cable, this sop will generate sagging cables, with user definable cable count, shape, color.

Curve Branches- Scatters curves over curves, with many intuitive controls to go from clean geometric branches to organic vines. Duplicates of this sop can be chained together for recursive growth, approximating the look of L-Systems but much more controllable.

Dirt Skirt - Create a geometry ‘skirt’ where an object and ground plane intersect, to be used as a soft blend in a game engine.

Lot Subdivision - Divide polygons into panels. Useful for city blocks or greeble.

MapBox - Generate color, height and Open Street Map (OSM) curves using data provided by mapbox.com.

SciFi Panels - Example HDA to generate Sci Fi Paneling.

Snow Buildup - Adds geometry to an input mesh to mimic the build up of snow.

Terrain Texture Output - The Terrain Texture Rop SOP renders image data from a heightfield.

MODELING

The Labs Tools includes a variety of modeling tools designed to make it easier to create game-ready geometry.

Decal Projector - Project a decal (localized piece of geometry and a texture) onto geometry.

Calculate Slope - Calculate the slope of a surface by comparing to a direction, and optionally blur and remap the result.

Curve Sweep - Sweep a profile along input curves, with simple controls for profile type, width, and twist behavior.

Extract Silhouette - Create an outline of an object projected from one of the axes, xyz.

UV MAPPING

Texture UVs are a big part of creating game art and these tools augment Houdini’s existing UV toolset to make you faster and more efficient.

Auto UV - Automatically generates the seams for an object and immediately runs a UV Flatten after the fact.

Inside Face UVs - Create UV’s for inside faces of fractured geometry.

UV Transfer - Transfer uv’s between a source and target geometry.

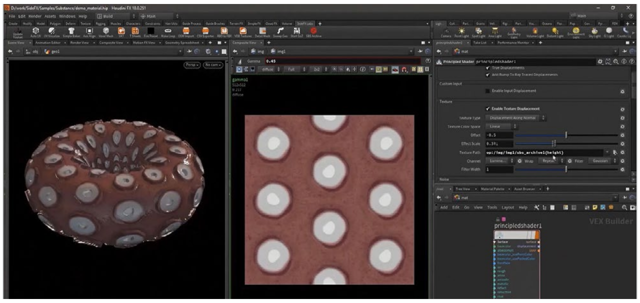
UV Visualize - Helper script to visualize UVs. Including features such as: Visualize Seams, Warp between UV space and Model Space, Modify the tiling of the grid texture and Visualize Islands.

Texel Density - This tool calculates the current texel density of an asset per primitive based on the asset and project resolution.

INTEGRATIONS

These tools make it easier to import and export data into Houdini and out to game engines.

Substance COP - The Substance Plugin for Houdini lets you load Substance Archive files into Houdini in COPs.



Rizom UV- The RizomUV Bridge is a set of 4 different SOPs that facilitate the communication between Houdini and RizomUV.

Quad Remesher - The QuadRemesher node is a wrapper around Exoside’s QuadRemesher command line interface.

Instant Meshes - Reads in DDS (DirectDraw Surface) Files.

Sketchfab - Uploads geometry to Sketchfab.

3D Facebook Image - Quickly render a 3D scene to a 2.5D image that can be uploaded to Facebook.

Marmoset ROP- The Marmoset ROP allows you to quickly generate an mview inside Houdini.

Gaea Tor Processor - The Gaea Tor Processor allows you to load up build .TOR files made in Gaea.

UX

Some Labs tools are specifically designed to enhance the user experience for artists working with Houdini.

Crash Recovery - Found under the File> menu, this functionality allows for quick recovery from an unfortunate crashed file.

Network Paint - Allows for colorful annotations of the network by simply drawing in the network editor.

Sticker Placer - Helpful for annotating networks by placing numbers, icons and user-created graphics.

External Script Editor - Sets up a live connection with an external IDE when working with VEX, Python, OpenCL and expressions.

AND MUCH MORE...

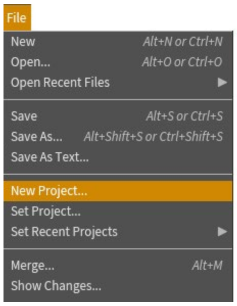
More Tools are being added on a regular basis. Go to *SideFX.com/labs*

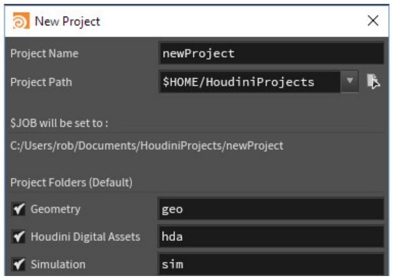
File Management

Understanding how to manage all of the files you create while working with Houdini is very important to your success as an artist. A typical scene file can have outside dependencies on disk and managing these is important especially if you are moving your files to a different computer.

PROJECT DIRECTORIES

While Houdini can work with files scattered all over your hard drive, this will make it harder to share your work and manage file dependencies. It is better to set up project directories using **File > New Project** or use **File > Set Project** to choose an existing project directory as the home base for your work. This will make it easier to set up local dependencies with respect to all of the required project files.




New Project

Project Name: newProject

Project Path: $HOME/HoudiniProjects

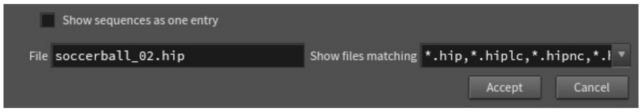
$JOB will be set to :
C:/Users/rob/Documents/HoudiniProjects/newProject

Project Folders (Default)

☑ Geometry: geo
☑ Houdini Digital Assets: hda
☑ Simulation: sim

SCENE FILES | .HIP

The main file type when working with Houdini is the **.hip** file. This file contains all your nodes and networks and is the file type used when you save your work.


□ Show sequences as one entry

File: soccerball_02.hip

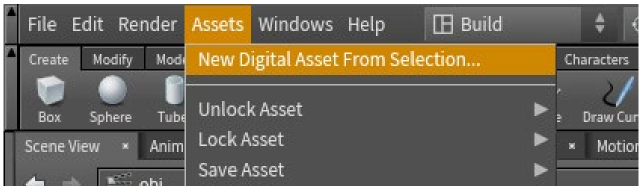
Show files matching: *.hip,*.hiplc,*.hipnc,*.l

UNIVERSAL SCENE DESCRIPTION | USD

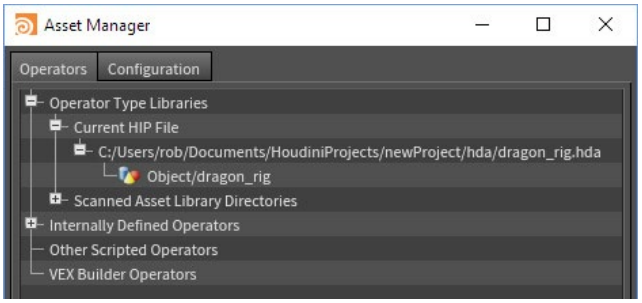
In Houdini, the Solaris lighting and lookdev environment works with USD [**Universal Scene Description**] which is an open source initiative created by PIXAR. In Solaris, USD is native and you can use procedural nodes to manage references, payloads, layers, collections, variants and level of detail.

HOUDINI DIGITAL ASSETS | .HDA

You can also encapsulate then save out Houdini networks into **Houdini Digital Asset** or **.hda** files. Parameters from inside the asset can then be promoted to the top level to create a custom UI for the asset. These files can be easily shared with other artists and provide a robust referencing architecture as your assets evolve through the life cycle of a project.

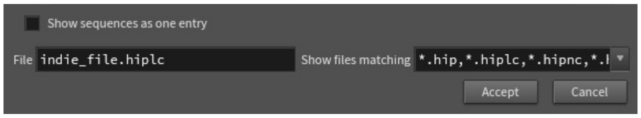


To create and load assets you can use the **Asset** menu. You can also manage assets loaded into your scene using the **Asset Manager** found on that menu. If you have two HDA files loaded into your scene that have the same name, Houdini will choose one of them based on rules set up in the manager. Changes made to an asset definition in an HDA file will be automatically pulled into scenes that reference that file. Note that older Digital Asset files may have a .otl extension which will work exactly the same as .hda files.



APPRENTICE AND INDIE FILES

Houdini Apprentice and **Houdini Indie** use different file types that cannot be opened in a commercial version of Houdini. Apprentice uses **.hipnc** (non-commercial) for scenes and **.hdanc** files for assets and Indie uses **.hiplc** (limited commercial) for scenes and **.hdalc** files for assets.

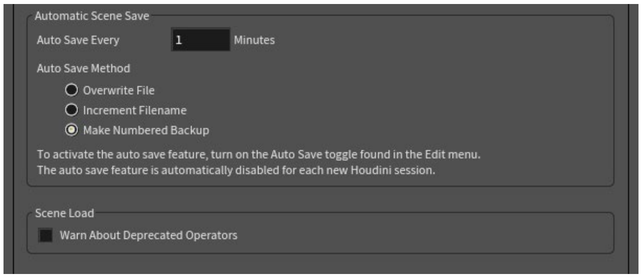

□ Show sequences as one entry

File: indie_file.hiplc

Show files matching: *.hip,*.hiplc,*.hipnc,*.l

BACKING UP YOUR WORK

By default, Houdini creates a numbered backup of your scene files and Digital Asset files every time you save. This gives you a file to go back to if you want to review an early iteration or if something happens to your working file. You can also set up Houdini to **AutoSave** in the **Edit > Preferences > Save and Load Options**. Just remember that all those backup files take up disk space and you will want to clear them from time to time.


Automatic Scene Save

Auto Save Every: 1 Minutes

Auto Save Method

○ Overwrite File
○ Increment Filename
● Make Numbered Backup

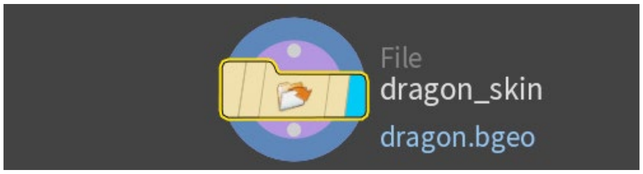
To activate the auto save feature, turn on the Auto Save toggle found in the Edit menu.
The auto save feature is automatically disabled for each new Houdini session.

Scene Load

□ Warn About Deprecated Operators

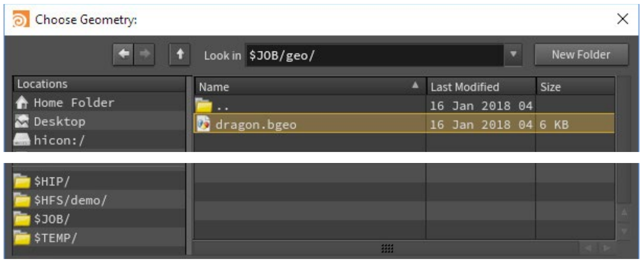
FILE SOP

When you import geometry into Houdini using **File > Import > Geometry** it puts down a **File** node at the geometry (SOP) level. This file maintains a connection to the file on disk and changes made to that file will also update in your Houdini scene. If you want to break this connection then you would need to lock the File node.



FILE DEPENDENCIES [$HIP/$JOB]

When you work with nodes that reference files on disk such as geometry or texture files, the path you use will determine what happens if you move the project directory to another computer or to the cloud. A direct path will break if you move the files therefore you should either use **$HIP** which uses the scene file as the "home base" for the path or **$JOB** which uses the project directory. You can use **Render > Preflight Scene** to check to make sure that your scene file is set up properly.


Choose Geometry:

Look in $JOB/geo/

Name	Last Modified	Size
..	16 Jan 2018 04	
dragon.bgeo	16 Jan 2018 04	6 KB

DISK SPACE MANAGEMENT

Large scene files, backup files and large simulations can take up **lots of disk space**. Be sure that you are not filling up too much space on your computer which could lead to instability issues. Try to use external drives to save out the largest files and leave the main disk on your computer with enough space to accomplish your day-to-day work.

INTEROPERABILITY

To import and export from Houdini, there are a wide variety of file formats that you can use. Here is a list of some of the main formats you will work with in a typical Houdini pipeline.

Houdini Files - Here are some file formats, other than .hip and .hda that work exclusively in Houdini.

.bgeo - This format saves geometry along with related attributes such as UVs, velocity and normals. Animations and simulations can be saved out as numbered bgeo files to save out motion. A bgeo.gz file is a compressed version of this format.

.sim - These files let you save out simulation data to cache the sim to disk. Some people use these files while others use .bgeos to cache sims.

.ifd - This is a scene description format that is created when rendering to Mantra. Typically these are created while rendering in Houdini but sometimes they are saved to disk to be rendered by Mantra directly.

.pic - This is an image file format that was used by Houdini in the past. It was replaced as the default format by the open source EXR.

.rat - This image format is ideal for texture maps being rendered in Mantra. All textures get converted to this format anyway so it speeds up rendering to convert to this format using Mplay.

Image Formats - These industry-standard formats are used to render out shots and for texture maps.

.exr - OpenEXR is a high dynamic-range (HDR) image file format developed by Industrial Light & Magic that is now the default format for saving out renderings from Houdini.

.jpg/.png - These formats are used to publish images to the web

.tga/.tif - These formats are often used to texture map video games.

Geometry Formats - When importing and exporting geometry, these formats are the most popular.

.usd - This is the format used in Solaris/LOPS and provides an open source interchange format for sharing with other applications.

.abc - Alembic is an open computer graphics interchange framework.

.fbx - This format owned by Autodesk is popular when exchanging data with game engines and other 3D applications. It can hold geometry, rigging, motion and shader information.

.obj - This is an simple geometry format originally created by Wavefront.

PREFLIGHT PANEL

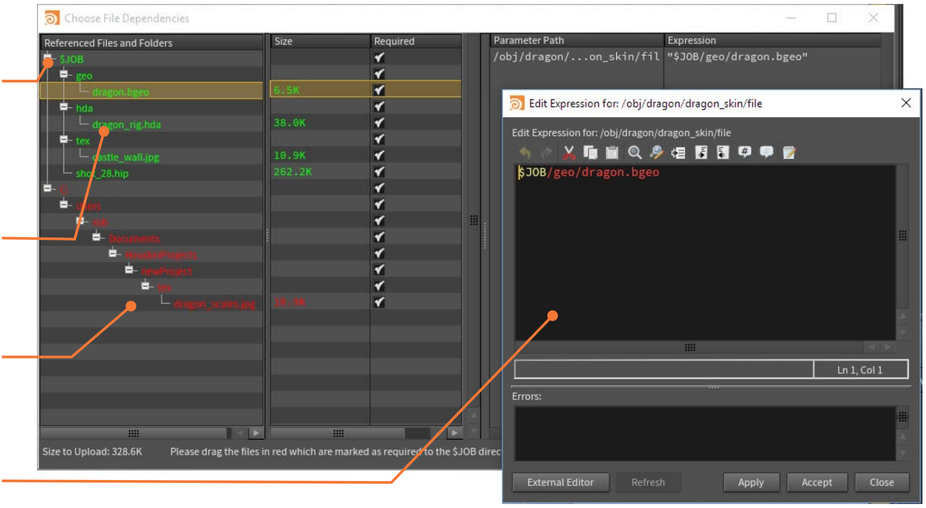
From the **Render** menu, select **Preflight Scene** to evaluate your scene setup.

Referenced Files - The preflight panel can either reference $HIP or $JOB when verifying file references for your scene file.

Greenlit Reference - If the reference is relative to either $HIP or $JOB then it will be displayed in green to indicate it is working.

Incorrect Reference - If a file reference is a direct path and not relative to $HIP or $JOB then it will be displayed in red and will need to get fixed before sharing your project with other artists or on the cloud.

Edit Expression - Click on any file name then on the right click on the expression to open up the edit expression window.


Choose File Dependencies

Referenced Files and Folders	Size	Required
$JOB		✓
geo		✓
dragon.bgeo	6.5K	✓
hda		✓
dragon_rig.hda	38.0K	✓
tex		✓
castle_wall.jpg	10.9K	✓
shot_28.hip	262.2K	✓
C:		✓
Users		✓
rob		✓
Documents		✓
HoudiniProjects		✓
newProject		✓
tex		✓
dragon_scales.jpg	10.9K	✓

Parameter Path	Expression
/obj/dragon/...on_skin/fil	"$JOB/geo/dragon.bgeo"

Size to Upload: 328.6K

Please drag the files in red which are marked as required to the $JOB direc

Edit Expression for: /obj/dragon/dragon_skin/file

Edit Expression for: /obj/dragon/dragon_skin/file

```
$JOB/geo/dragon.bgeo
```

Ln 1, Col 1

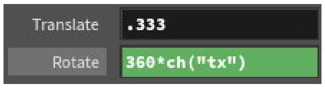
Errors:

Expressions & Scripting

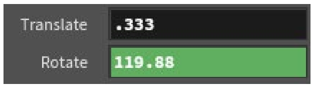
Houdini is a production-level solution which means that scripting will play an important role in your work. Artists can usually get by with simply writing expressions while technical directors will spend more time using these techniques. Houdini includes support for Hscript, Python and VEX.

HSCRIPT EXPRESSIONS

HScript is designed to be a fast and concise way to retrieve and manipulate information that can be used to write expressions. An expression is typically any value that is not either a simple string or number. This can be something as simple as a variable, a math equation or an expression function.



Translate `.333`
Rotate `360*ch("tx")`



Translate `.333`
Rotate `119.88`

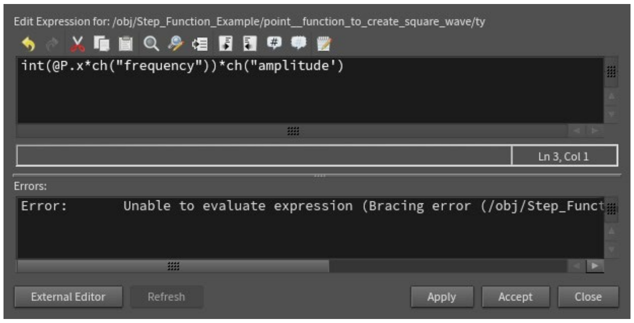
You can enter expressions directly into a parameter by simply typing into a field. When you press **Enter** the field highlights in green. You can click on the parameter name to toggle back and forth between the expression and the result of the expression.

If you are creating channel references then you can **RMB-click** on a parameter and choose **Copy Parameter** then go to the parameter you want to link it to and choose **Paste Relative References**.

You can also achieve this by RMB clicking on the second parameter then choosing **Reference > Scene Data**. This opens up a panel where you can choose data from other objects and nodes and an expression will be built for you. This method can even set expressions on multiple parameters.

EXPRESSION EDITOR

Depending on the complexity of your function, or the type of parameter, you may instead choose to use the **Expression Editor**. The expression editor can be opened by **RMB-clicking** on a parameter and selecting **Expression > Edit Expression**, or by placing the mouse over the parameter and pressing **Alt - E**.



Edit Expression for: /obj/Step_Function_Example/point__function_to_create_square_wave/ty

```
int(@P.x*ch("frequency"))*ch("amplitude')
```

Ln 3, Col 1

Errors:

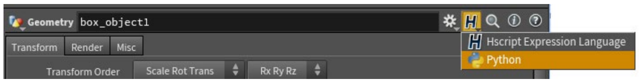
```
Error:       Unable to evaluate expression (Bracing error (/obj/Step_Funct
```

PYTHON

Python is a popular scripting language that is well known in the CG industry that supports integration and standardization. This makes it perfect for tool development.

Python in Houdini is built on the Houdini Object Model (HOM) which is an API that lets you get information from and control Houdini using the Python scripting language. In Python, the `hou` package is the top of a hierarchy of modules, functions, and classes that define the HOM. The `hou` module is automatically imported when you are writing expressions in the parameter editor and in the hython command-line shell.

You can also use it to write expressions in Houdini. To do this, change the expression language option at the top of the parameter pane for the node.

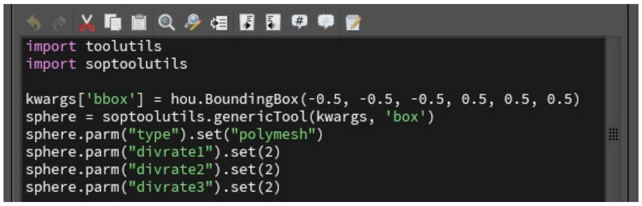


Geometry `box_object1`

There is also a **Python Shell Panel** which you can use to enter Python commands. You can also import the `hou` module into a regular Python shell to integrate Houdini into your existing Python-based scripts.

TOOL SHELVES

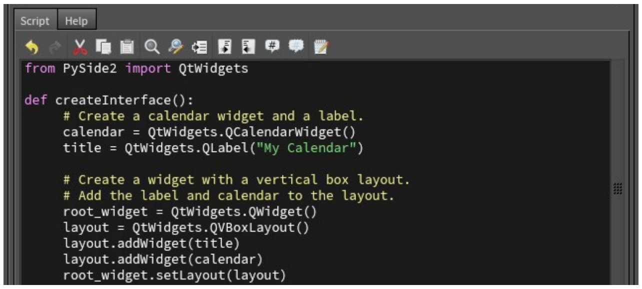
The shelf tools are also set up using Python. You can see this code by **RMB-clicking** on any shelf tool and choosing **Edit Tool.**



```
import toolutils
import soptoolutils

kwargs['bbox'] = hou.BoundingBox(-0.5, -0.5, -0.5, 0.5, 0.5, 0.5)
sphere = soptoolutils.genericTool(kwargs, 'box')
sphere.parm("type").set("polymesh")
sphere.parm("divrate1").set(2)
sphere.parm("divrate2").set(2)
sphere.parm("divrate3").set(2)
```

PYSIDE/PYQT

The **Python Panel Editor** pane lets you create, edit and delete PySide2 or PyQt5 interfaces. The editor also lets you manage the entries in the Python Panel interfaces menu as well as the entries in the Houdini pane tab menu. The panel comes with some sample code that you can try out for yourself.



```
from PySide2 import QtWidgets

def createInterface():
    # Create a calendar widget and a label.
    calendar = QtWidgets.QCalendarWidget()
    title = QtWidgets.QLabel("My Calendar")

    # Create a widget with a vertical box layout.
    # Add the label and calendar to the layout.
    root_widget = QtWidgets.QWidget()
    layout = QtWidgets.QVBoxLayout()
    layout.addWidget(title)
    layout.addWidget(calendar)
    root_widget.setLayout(layout)
```

PYTHON STATES

You can also write viewer states in Python that let you customize user interaction in the viewport for your node. You can use these to build more artist friendly interfaces for tools and you can refer to the documentation for more detailed info.

VEX

VEX is a high-performance expression language used in many places in Houdini, such as writing shaders. VEX evaluation is typically very efficient, giving performance close to compiled C/C++ code.

VEX is not an alternative to scripting, but rather a smaller, more efficient general purpose language for writing shaders and custom nodes. VEX is loosely based on the C language, but takes ideas from C++ as well as the RenderMan shading language.

VEX is used in several places in Houdini:

Modeling – The VEX SOP allows you to write a custom surface node that manipulates point attributes. This can move points around, adjust velocities, change colors. As well, you can group points or do many other useful tasks.

Rendering – Karma and Mantra use VEX for shading computation. This includes light, surface, displacement and fog shaders.

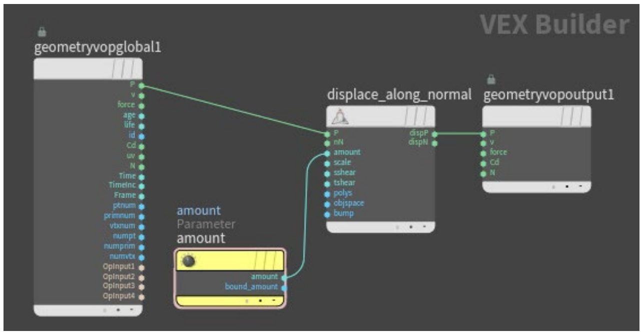
Compositing – The VEX Generator and VEX Filter COPs allows you to write complex custom COPs in VEX. The expressions evaluate very close to C/C++ speeds and run 1000's of times faster than the Pixel Expression COP.

CHOPs – The VEX CHOP lets you create custom CHOPs. The CHOP functions can manipulate arbitrary numbers of input channels and process channel data in arbitrary ways. In some cases, the VEX code can run faster than compiled C++ code.

Fur – Procedural fur behavior is implemented with VEX.

VOPS

If you want to use VEX but don't want to write the code then you can use the VOP context to use a node-based interface. You can do this in the SOP context using an **Attribute VOP** node that lets you dive in and use VOPs to create VEX code. You can take input geometry and manipulate it.



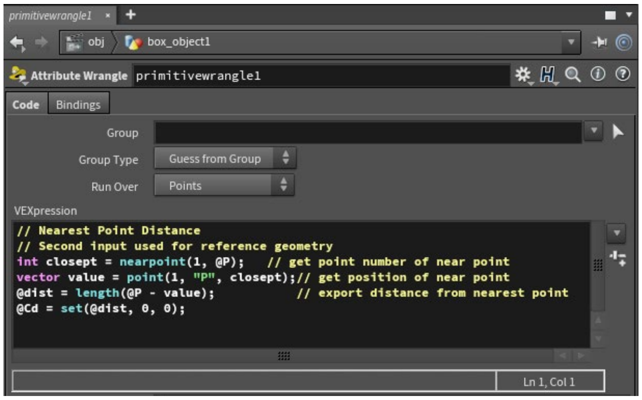
You can use parameter vops to build interface element such as float sliders that are then available at the SOP level. This way you can execute the VEX code without diving back down to the VOP level.

Displacement Amount 0

The VOPs context is designed to give artists an interactive way of creating VEX code. For people with a scripting background, it might make more sense to write the code directly into a Wrangle node.

WRANGLE NODES

You can also use a wrangle node such as the **Attribute Wrangle** which provides a low-level node that lets coders who are familiar with VEX tweak attributes. There are also wrangle nodes for working with channels, volumes and deformations.



Attribute Wrangle primitivewrangle1

Group

Group Type: Guess from Group

Run Over: Points

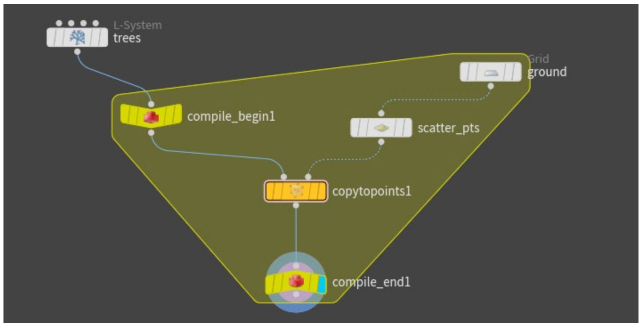
VEXpression

```
// Nearest Point Distance
// Second input used for reference geometry
int closept = nearpoint(1, @P);   // get point number of near point
vector value = point(1, "P", closept);// get position of near point
@dist = length(@P - value);          // export distance from nearest point
@Cd = set(@dist, 0, 0);
```

If you are interested in learning how to work with wrangle nodes, you should take a look at **Entagma.com** where you will find lots of great tutorials that generally take a more technical approach to creating content but with an artist's mindset.

COMPILE BLOCKS

In geometry networks [SOPs], you can put a part of the network inside a compiled block that makes it function as efficiently as if you had written code. This imposes a number of restrictions on how the network can work, but can potentially deliver big benefits in the right circumstances.



HOUDINI DEVELOPERS KIT | HDK

An even deeper way to work with Houdini is to use the HDK which is the same comprehensive set of C++ libraries that SideFX programmers use to develop the Houdini family of products. With the HDK, you can create plug-ins which customize different areas in the Houdini interface. Here are some examples of what you can do with the development kit:

- Add custom expression functions
- Add custom commands (hscript or HOM)
- Add custom operators (SOPs, COPs, DOPs, VOPs, ROPs, CHOPs, and even Objects)
- Add output nodes to support a non-standard Renderer
- Add custom lighting or atmospheric effects to the renderer

To learn more about working with the HDK, go to the SideFX website and choose **Support > Documentation > HDK**.

Tasks

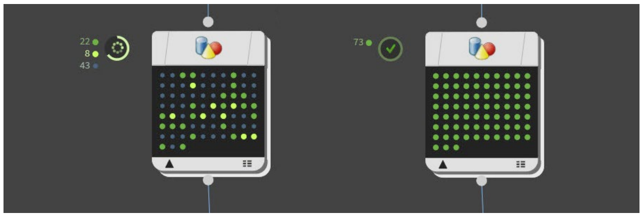
With the Task Operators or TOPs, you can organize and schedule tasks then distribute them intelligently to your compute farm. This allows for parallel processing of data while maintaining a dependency graph that shows how each task relates to proceeding tasks.

PROCEDURAL DEPENDENCY GRAPH

TOPs is a network type in Houdini built using the Procedural Dependency Graph, a technology which makes it possible to describe complex dependencies visually with nodes, then generate a set of actionable tasks which can be distributed to a compute farm with the help of a scheduler. Once you evaluate the results, it is possible to make changes to parts of the graph without re-cooking the whole network.

TOP NODES

Task or TOP nodes let you manage pipeline tasks with the ultimate goal of parallelizing the processing and distribution of each task. As a TOP node generates a task, the task is displayed as a dot. Once the task is cooked then new tasks can be executed on this node and on children TOP nodes.



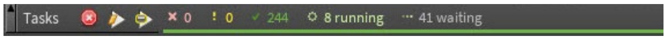
SCHEDULERS

Scheduler nodes take tasks that have met required dependencies and assigns compute resources. As each task is completed, the scheduler informs the task graph, which in turn informs the PDG graph to move on to the next available task. PDG supports industry-standard schedulers such as HQueue, Deadline, Tractor, or any scheduler plugged in with Python.

COOKING TOP NODES

Once you wire together a task graph, you will want to cook the nodes. You can either cook a node in the middle of the graph or cook the output node at the end of the chain.

Cook Selected Node	Shift-G
Dirty and Cook Selected Node	Shift-V

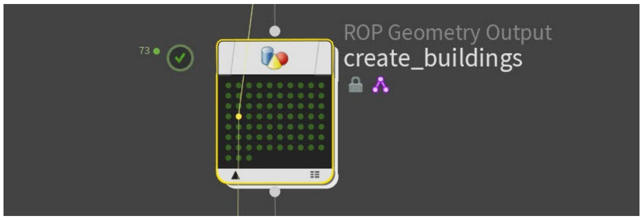


Use the Task Bar to monitor your progress. On the TOP nodes, you can RMB-click on a task dot and choose to Cook or Dirty the task. When you dirty a task, it means that if you recook the network those tasks will be recomputed. Clean tasks will not be recooked which is one of the benefits of TOPs because you don't have to redo work that is already completed.

DEPENDENCIES

When you click on a task dot in the graph, you will see a thin line that connects to upstream tasks it is dependent on and downstream tasks that depend on it.

If there are changes upstream then tasks may be automatically dirtied and this will in turn dirty tasks downstream where there are dependencies. This process is an important part of how PDG graphs work as an effective pipeline tool.



TOP NODE

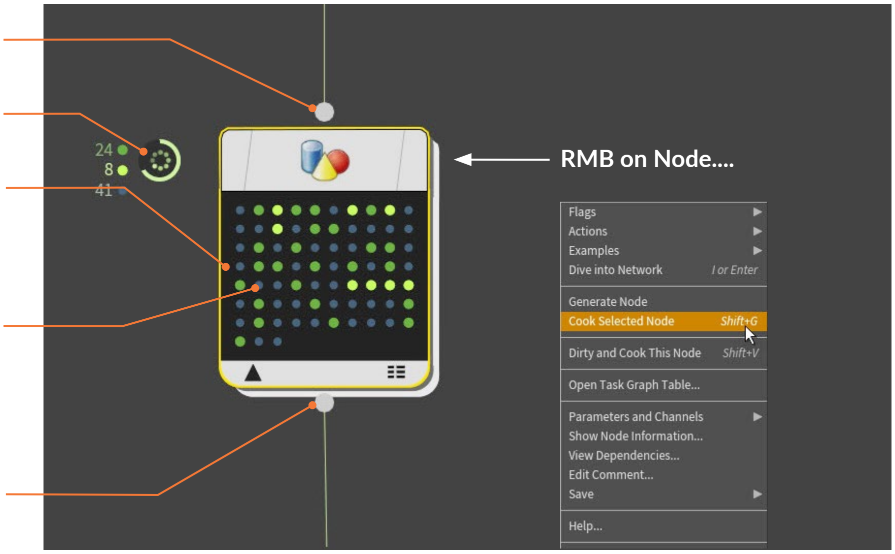
Input - The node takes the information feeding into the Input and breaks it into one task for every piece of data.

Progress Wheel - The progress wheel shows you how many tasks are completed, how many are in progress and how many are in the queue.

TOP Node - This is the node that is currently being cooked. It contains the instructions for the tasks being executed. You can RMB-click on the node for a menu of supporting actions.

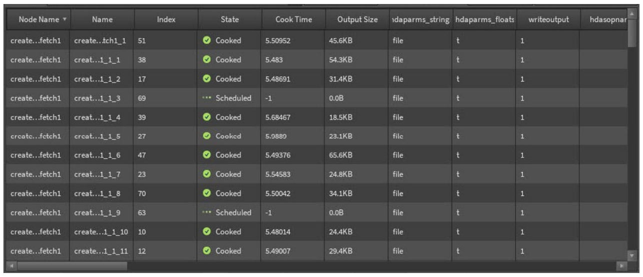
Tasks - Each task is represented by a small dot. The coloring indicates their current status and you can RMB-click on a task dot to learn more about that one part of the graph.

Output - Once tasks are completed, the output passes the results on to the next node even if other tasks on this node are still active.



TASK GRAPH TABLE

If you **RMB-click** on a node, you can choose to **Open Task Graph Table**. This gives you an itemized list of tasks along with information such as index, state, cook time and priority. Clicking on items in this window will highlight the task dot on the node in the Network view.



Node Name ▾	Name	Index	State	Cook Time	Output Size	ıdaparms_string	hdaparms_floats	writeoutput	hdasopnar
create…fetch1	create..tch1_1	51	✓ Cooked	5.50952	45.6KB	file	t	1	
create…fetch1	creat…1_1_1	38	✓ Cooked	5.483	54.3KB	file	t	1	
create…fetch1	creat…1_1_2	17	✓ Cooked	5.48691	31.4KB	file	t	1	
create…fetch1	creat…1_1_3	69	··· Scheduled	-1	0.0B	file	t	1	
create…fetch1	creat…1_1_4	39	✓ Cooked	5.68467	18.5KB	file	t	1	
create…fetch1	creat…1_1_5	27	✓ Cooked	5.9889	23.1KB	file	t	1	
create…fetch1	creat…1_1_6	47	✓ Cooked	5.49376	65.6KB	file	t	1	
create…fetch1	creat…1_1_7	23	✓ Cooked	5.54583	24.8KB	file	t	1	
create…fetch1	creat…1_1_8	70	✓ Cooked	5.50042	34.1KB	file	t	1	
create…fetch1	creat…1_1_9	63	··· Scheduled	-1	0.0B	file	t	1	
create…fetch1	create…1_1_10	10	✓ Cooked	5.48014	24.4KB	file	t	1	
create…fetch1	create…1_1_11	12	✓ Cooked	5.49007	29.4KB	file	t	1	

IMPORT/EXPORT DATA

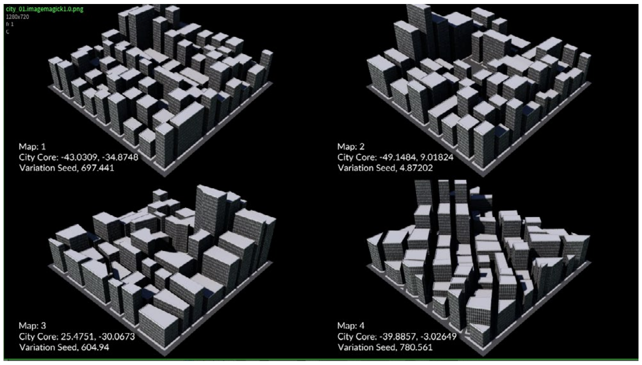
To get data into the TOP graph, there are a number of different options giving you access to geometry, images, scripts and other kinds of data. Houdini Digital Assets can be used to apply procedural networks or you can connect with other parts of Houdini to import and export data.

WEDGE NODE

A key workflow in PDG is wedging that lets you quickly create multiple iterations of a design. You can then process all of the different options through the TOP graph then collect them at the end for final output.

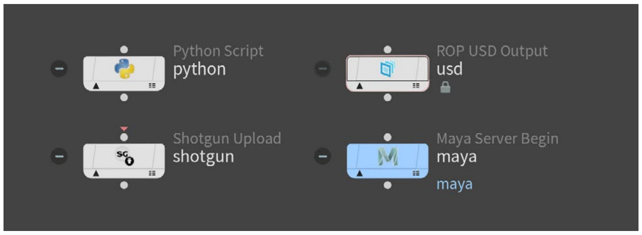
OUTPUT IMAGE MOSAICS AND MOVIES

In TOPS, you can interface with **ImageMagik** to create a contact sheet that can be used to evaluate design iterations to make the best choice or to generate prop variations to richly populate your scene. You can use an overlay to pull info from the network to help you make the best decision.


city_01.imagemagick1.0.png
1280x720
fr 1
C
Map: 1
City Core: -43.0309, -34.8748
Variation Seed, 697.441
Map: 2
City Core: -49.1484, 9.01824
Variation Seed, 4.87202
Map: 3
City Core: 25.4751, -30.0673
Variation Seed, 604.94
Map: 4
City Core: -39.8857, -3.02649
Variation Seed, 780.561

INTEGRATIONS WITH OTHER APPS

TOPs includes nodes for working with other applications such as Shotgun or Autodesk Maya. This allows your network to extend beyond Houdini to help with all parts of the pipeline.



PILOT PDG APPLICATION

While TOP networks can be set up and executed from within Houdini, wranglers who are managing the farm or pipeline TDs who are exclusively creating TOP networks can use **PilotPDG**. Tasks that are Houdini-related will call on Houdini Engine to work non-graphically to complete the task.

TOP NETWORK

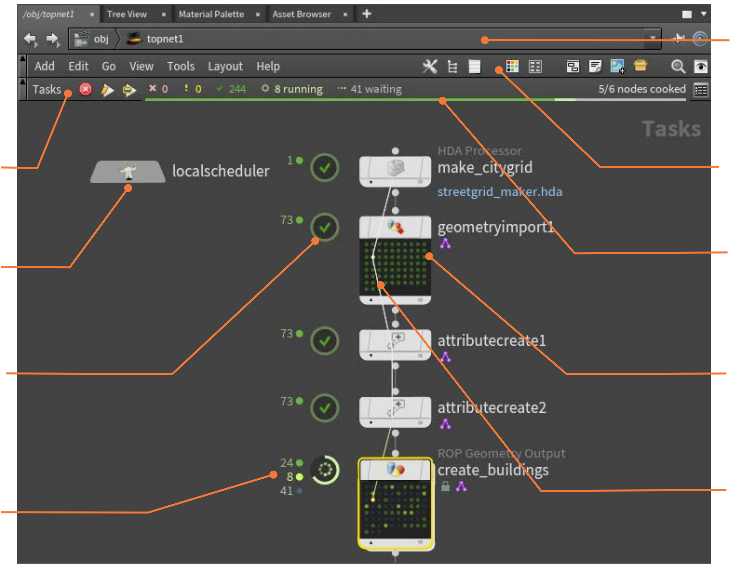
This network type lets you manage and view the network being processed.

Task Bar- The task bar lets you start and stop a network and monitor its progress.

Scheduler- The scheduler node determines where your data is being processed and how many nodes are participating.

Completed Tasks - When a node is finished processing all its tasks, a check mark appears.

In Progress Tasks - While in progress, you can see which tasks still need to be completed.



Network Path- This shows you the path to the TOP network where the graph is set up.

TOP Menu- This menu includes a range of options for organizing and processing a TOP network.

Progress Bar - This bar lets you see the progress of the overall network tasks.

TOP nodes - These nodes are where specific commands are turned into tasks and sent by the scheduler to be completed.

Dependency Line - You can click on a task to see how it connects to other tasks in the network.

HOUDINI DIGITAL ASSETS
Procedural Tool Building

Networks of nodes give Houdini its procedural nature and define a recipe that can be applied over and over. Houdini Digital Assets let you wrap up these networks to create custom tools and smart assets. These artist-built tools can be used repeatedly to increase productivity across your studio.

One of the things that Houdini's node-based workflow is great at is allowing artists to avoid repetitive steps and to generate multiple iterations by making changes to an existing network of nodes. This lets you achieve results that are unique without starting the whole process from scratch.

Houdini Digital Assets take this one step further by letting you encapsulate a network or collection of networks into a single node with parameters that have been promoted to the top level. This node is then saved to disk which creates a shareable file that other artists can load into their scenes.

ARTIST BUILT TOOLS

The process of creating a Houdini Digital Asset works with the interactive tools in Houdini. You build a high level interface by dragging parameters from nodes to an asset properties panel which allows you to create custom tools without writing any code. This means that technical artists can build custom tools then deploy them quickly to colleagues.

A Houdini Digital Asset might be a procedural prop such as a staircase or a piece of furniture, a visual effect such as an explosion, or a more generalized tool such as a populate tool for scattering objects over a surface. Whether you are creating content specifically for your current project or building a larger toolset for all your projects, your artists can build a collection of Houdini Digital Assets to meet your production needs.

PIPELINE FRIENDLY

When a Houdini Digital Asset is loaded into a scene file, it references the **.hda** file on disk. This means that changes made to the asset will be picked up automatically by everyone who is referencing that file.

This makes it very easy to deploy updates throughout your pipeline. Now artists can point to a single asset on disk knowing that once it gets updated with the most current iteration, they will immediately have access.

Houdini Digital Asset files can also hold more than just the asset definition. You can store images, geometry files and scripts that are used by the asset. This ensures that all the relevant parts are available when other people work with the asset.

CONTENT LIBRARY & ORBOLT

The **Content Library** is an online asset repository which hosts 2D and 3D assets, from complete scene files, to fully-rigged props, to render-ready visual effects, animatable characters, game assets and more. Go to **Get > Content Library** on the SideFX website to access it.

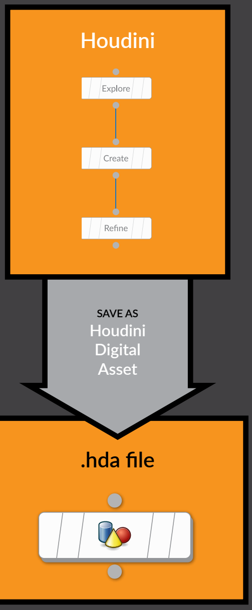
Orbolt an online asset marketplace that offers a wide variety of digital assets. There is a panel in Houdini where Orbolt assets you download or purchase can be stored and made available as you work.

CREATING DIGITAL ASSETS

1 Create nodes and networks in Houdini

2 Package up the networks to be saved out as a Houdini Digital Asset [.hda] file that can be shared with other artists.

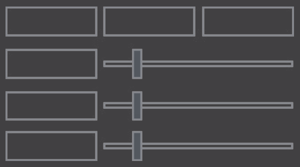
3 Build an interface for your asset by promoting parameters and handles to the top level of the asset.



4 Load the .hda file back into Houdini to use the asset.

Only those parameters promoted to the asset level can be used. All others are locked.

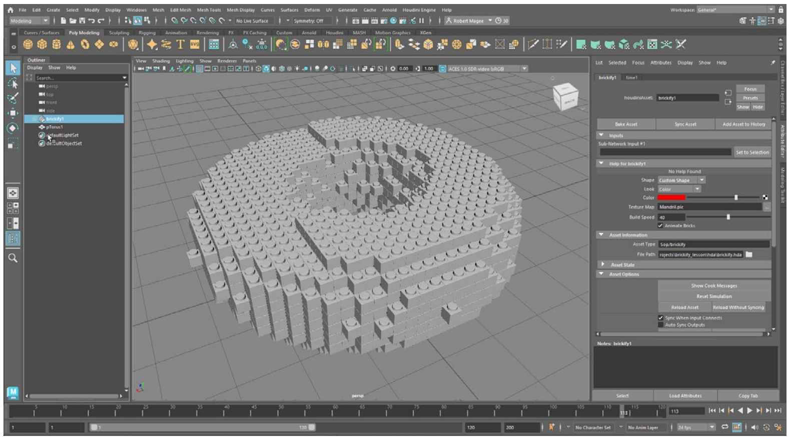
You can use the asset in any number of Houdini scenes. If you make changes to the HDA file then all other assets can be easily synced to the changes.



HOUDINI ENGINE
Sharing with other Apps

Houdini Engine brings a procedural node-based approach to your favorite app. This technology lets you share Houdini Digital Assets with colleagues who can load them directly into 3D apps such as Autodesk® Maya® or 3DS MAX® or into game editors such as Unity® or Unreal.®

The benefits of Houdini Digital Assets can be experienced by artists using other applications thanks to the Houdini Engine plug-ins. Created with the Houdini Engine API, these plug-ins allow host applications to load .hda files and all of the handles and controls. When parameters are set on the asset, Houdini works "under-the-hood" to cook the nodes and networks then deliver the results back to the host.



A Houdini Digital Asset loaded into Autodesk Maya using the Houdini Engine

HOUDINI ENGINE API

This is made possible by the Houdini API which is used to create plug-ins for host applications. HAPI is a flat and small API that is easy to learn and is available on **github** for developers that want to create their own proprietary plug-in.

HOUDINI ENGINE PLUG-INS

There are a number of Houdini Engine plug-ins that artists can access either through the Houdini installer or online. These have been production tested and can be used confidently by artists and studios.

Each of the plug-ins are designed to create a bridge between the features in a typical Houdini asset and the nature of the host application. For instance a cloud asset that use volumes would work fine in Maya but would not make sense in Unity or Unreal where volumes are not supported.

Plug-ins that work with **FREE Houdini Engine for Unity/Unreal** or **FREE Houdini Engine Indie** licenses:

- **Unreal**
- **Unity**

Plug-ins that work with **Houdini Engine** licenses or **FREE Houdini Engine Indie** licenses:

- **Autodesk Maya**
- **Autodesk 3DS Max**
- Proprietary Plug-ins

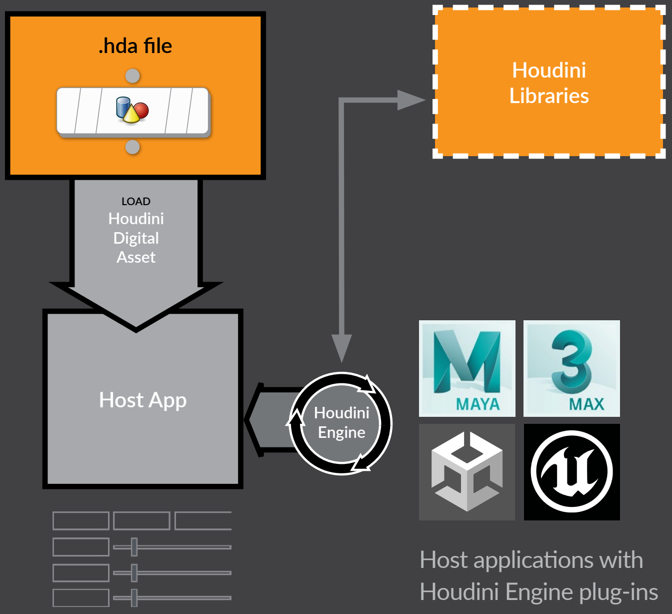
HOUDINI ENGINE PIPELINE

1 Load the .hda file into a host application using the Houdini Engine plug-in.

2 The Host Application accepts the asset and interfaces with the Houdini Engine.

3 The Houdini Engine calls on the Houdini library files to "cook" the nodes and network inside the asset.

4 When an asset is loaded or a parameter is changed then the Engine grabs the Houdini libraries, cooks the nodes, then delivers the results back to the Host.



Host applications with Houdini Engine plug-ins

FILM & TV PIPELINE
Animation and VFX

Whether you are creating live action plates enhanced with visual effects or full CG shots, the ultimate goal of Film and TV projects is moving pictures. These pictures are created using assets such as characters, sets and effects which all come together in a final composition.

Houdini is a full featured package that contributes to all stages of a Film & TV pipeline. From modeling to rendering to animation and final compositing, Houdini has procedural tools that support your creative process. Over the years, VFX is one area where Houdini is known as an industry standard. SideFX has been honored with several Scientific and Technical Achievement awards including an ACADEMY AWARD OF MERIT Oscar.

Other areas such as procedural modeling, lighting or character work continue to get stronger to the point where a growing request from studios is more skilled Houdini artists.

HOUDINI CORE / HOUDINI FX

There are two commercial versions of Houdini that you use in your pipeline. Houdini Core covers all of Houdini's tools except for DOPS, and Houdini FX has a full toolset. Scenes and VFX created in Houdini FX can be staged, animated, lit and rendered in Houdini Core. This gives you a robust pipeline with Houdini FX licenses for your FX artists and Houdini Core licenses for everyone else.

One solution is for senior technical directors to use Houdini FX to solve a particular production challenge then wrap up the resulting nodes and networks into Houdini Digital Assets. An artist-friendly UI is then built to support the animators and VFX artists who can then use the more cost effective Houdini Core to execute shots.

INTEROPERABILITY

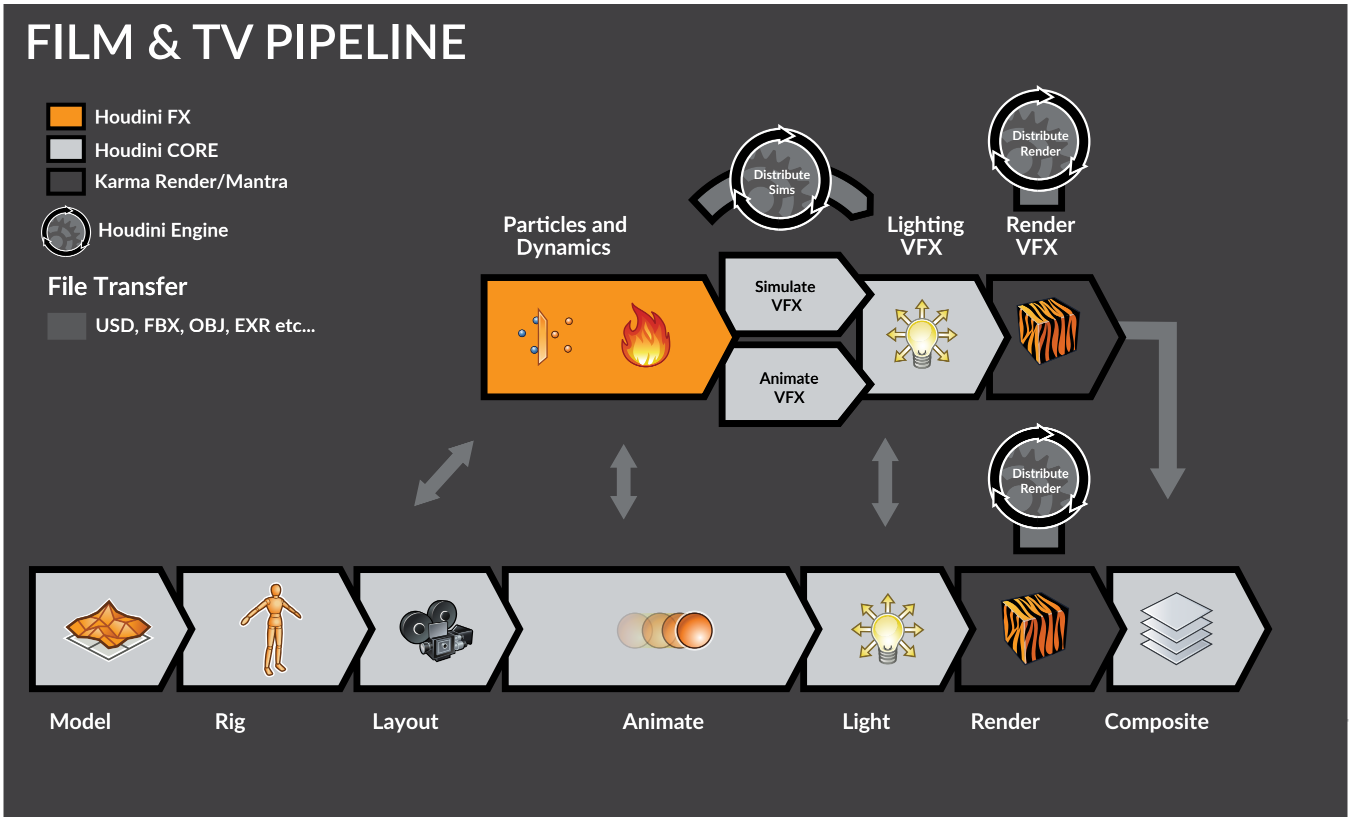
Most studios are equipped with a variety of 3D applications to each handle a different part of the pipeline. Houdini has a lot of strong interoperability tools to allow for this interchange of data. Whether they are using USD, Alembic, FBX or EXR, your artists can easily work back and forth with a wide variety of DCC applications. They can also use the Houdini Engine plug-ins to bring the Houdini Digital Assets into other applications, such as Autodesk® Maya® or 3DS MAX,® while maintaining the asset's procedural controls.

Smaller studios may want to avoid extensive file exchange, especially with tight deadlines, therefore Houdini provides a full featured procedural "pipeline-in-a-box" that can take you through all of the stages under one roof.

DISTRIBUTED RENDERS AND SIMS

Rendering images and simulating VFX can be time consuming, especially as you aspire towards photorealistic results. For this reason, Houdini lets you distribute both rendering and simulation tasks to a compute farm using **Houdini Engine** in **Batch** mode.

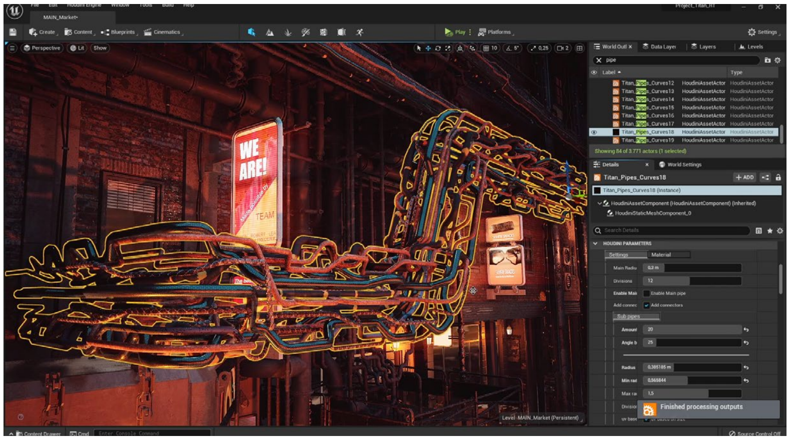
Distributed simulations allow you to work faster or to handle effects that would max out the memory on any one computer. By slicing the sim and distributing it, memory is managed without compromising the final result. Studios should definitely consider using **Houdini Engine** to simulate on the farm.



GAMEDEV & VR PIPELINE
Interactive Experiences

In Video Game and Virtual Reality projects, the main focus is creating interactive 3D worlds built using content that is highly optimized for a smooth gameplay experience. This creates a different kind of pipeline compared to rendered out game cinematics which are more like film.

At the core of a games pipeline is a game engine like Unreal or Unity. The engine is where the game art and the game interactions are put together to create a playable experience. Houdini can be used by game artists to create terrain, design and populate levels, build procedural models, build and animate characters and create Realtime FX such as fire, fluids and destruction.


Houdini Digital Assets loaded into Unreal using the Houdini Engine

EXPORTING TO GAME ENGINES

There are two ways of getting content from Houdini to a game engine. The traditional approach is to export out to a format like FBX or OBJ and import this into the engine. You would create procedural systems in Houdini then flatten out the results.

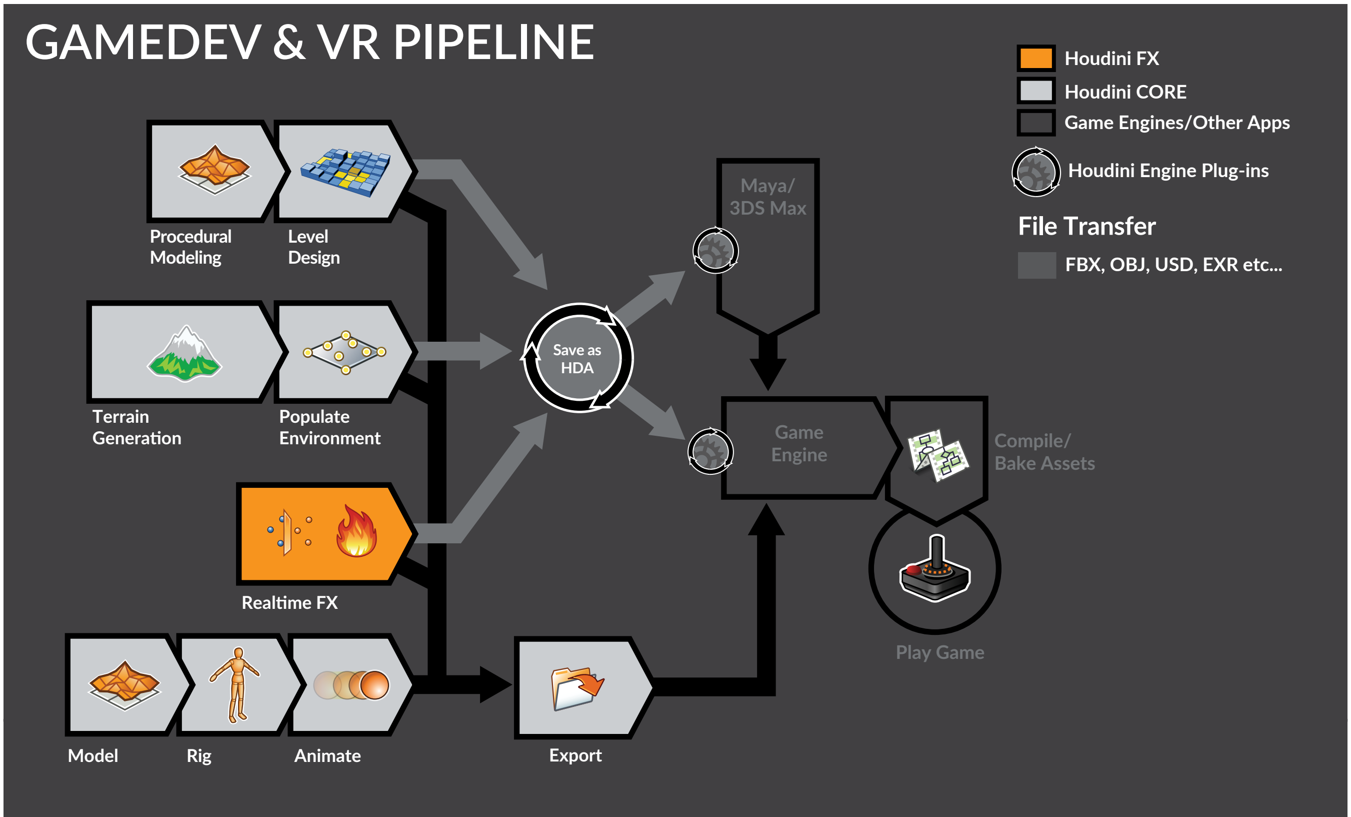
The second approach is to create **Houdini Digital Assets** and load these into the game engines using the **Houdini Engine plug-ins** for Unreal and Unity. These assets import into the game editor with their parameters and controls intact. You can therefore make changes inside the game editor and the Houdini Engine works in the background to update the artwork.

This proceduralism is available to game artists inside the editor then when the game is compiled the artwork is baked down. The Houdini Engine is not a runtime solution and you cannot access it as part of the gameplay.

REALTIME FX

Houdini is known for VFX and it is a great tool for creating FX for games. But these FX need to be optimized using techniques such as texture sheets, flowmaps and vertex animation textures. This way the footprint for the effect is as light as possible and does not take away from the frames per second of the game. The SideFX Labs Tools mentioned earlier in this document have been designed to support these kinds of workflows.

GAMEDEV & VR PIPELINE



Products & Licensing

As you begin working with Houdini, it is useful to understand what Houdini products are available for you to work with. Whether you are a large studio, small studio or a team of indies just getting started, there are different Houdini products to suit your needs. There are also versions of Houdini for school labs and for students who want to learn for free.

COMMERCIAL LICENSES

Houdini Core – Designed for modelers, lighters, character riggers, animators and game artists, Houdini Core also includes features such as compositing and motion editing. Scenes created in Houdini FX can be opened and rendered in Houdini Core which makes it an ideal lighting tool for your VFX.

Houdini FX – Houdini FX has all the tools found in Houdini Core but adds particle and dynamic simulation tools. With its procedural workflow, Houdini FX lets you create fluids, Pyro FX, grains, cloth, hair & fur, crowds and soft body effects.

Houdini Engine – Houdini Engine gives you command-line access to run in batch mode to batch process renderings and distributed dynamic simulations. Houdini Engine also lets you load Houdini Digital Assets into other digital content creation applications, such as Autodesk® Maya,® Autodesk® 3DS MAX,® Unity® or Unreal.®

INDIE LICENSES

Houdini Indie – Houdini Indie makes all of Houdini's animation and VFX tools available under a limited commercial [less than $100K USD] license to animators and game makers who want to use Houdini during the incubation stage of their business.

Houdini Engine Indie – Your Houdini Engine Indie license can be used to run Houdini Indie in batch mode or to load Houdini Digital Assets into other content creation apps.

LEARNING LICENSES

Houdini Education – Houdini Education is a full-featured version of Houdini FX designed for use by schools and training centres. Designed to be used in labs and classrooms, Houdini Education will open files created by students using Houdini Apprentice.

Houdini Apprentice – Houdini Apprentice is a free version of Houdini FX which can be used by students, artists and hobbyists to create personal non-commercial projects. With Houdini Apprentice, you have access to virtually all of the features of the award-winning Houdini FX to develop your skills and work on personal projects. Apprentice lets you save to disk and render out with a word mark.

If a student wants to work without the word mark and they don't have access to Houdini Education at their school then we recommend working with Houdini Indie.

Note: *Scene files and Assets created in Indie, Apprentice or Education cannot be used in commercial Houdini. The file formats are different and the EULA [End User License Agreement] prevents you from sharing files between different license types.*

LICENSE TYPES

Workstation [Node-Locked] – This license type can be used on a single computer and can only be accessed either from a local server or from SideFX.com.

Local/Global Access [Floating] – These licenses can be set up on a server and shared with a team of artists. When an artist starts Houdini a license is checked out of the server as long as there is one available. Local licenses are designed for a single studio and global licenses are for sharing between studios in different locations.

INSTALLING LICENSES

Once you have acquired a license, you will install it by opening up the **Houdini License Administrator [hkey]** application. From there you can choose **File > Install Licenses**. You will be asked for a log in and a password that will match the ones you set up on the SideFX.com website.

You can now use sidefx.com as the license server instead of installing locally. To use **Login licensing**, you need to be constantly logged in with your sidefx account. You can login using different computers but only one of them can be used at a time. This approach is ideal for Indie and Education users.

Local and Global Access licenses can be installed using this method on a central server. You will then need to make that server available to anyone who needs access to the licenses.

You can also view your licenses on the SideFX.com website by clicking on your avatar in the top right and choosing **Services**. You can then click on the **Manage Licenses** link.

ANNUAL UPGRADE PLAN

For visual effects studios, games studios and 3D artists who want to maximize their investment in Houdini, the Annual Upgrade Plan provides key advantages such as production-level technical support and access to full and dot releases containing the latest software enhancements as well as daily builds containing bug fixes.

SIDEFX SUPPORT

All customers including Apprentice customers can contact SideFX using our email support system to discuss installation and licensing issues. After that, only Annual Upgrade Plan and Commercial Rental Customers may contact our support team to discuss more in depth production issues.

Our Support Specialists can be contacted directly via **support@sidefx.com** . Be sure to include the following information in your email:

- *Your Operating system [Windows XP, etc.]*
- *Version and Build Number of Houdini*
- *Summary of the installation issue and a diagnostic file if you are having a licensing issue.*

To learn about support programs visit **SideFX.com/support**.

Comparison Chart

	COMMERCIAL		INDIE	LEARNING	
PRODUCT	HOUDINI FX	HOUDINI CORE	HOUDINI INDIE	EDUCATION	APPRENTICE
INTENDED USER	Studios | Commercial Artists		Indies | Freelancers	Schools	Students | Hobbyists
PRICING	Visit SideFX.com		$269 USD per year	$75 USD per year	FREE
Operating System	Windows, LINUX, Mac OSX				
FEATURES					
Modeling	✓	✓	✓	✓	✓
Character	✓	✓	✓	✓	✓
Animation	✓	✓	✓	✓	✓
Solaris: Layout Tools	✓	✓	✓	✓	✓
Solaris: Lookdev and Lighting	✓	✓	✓	✓	✓
Karma/Mantra Rendering	✓	✓	✓	✓	✓
Terrain	✓	✓	✓	✓	✓
Compositing	✓	✓	✓	✓	✓
Volumes	✓	✓	✓	✓	✓
Pyro FX	✓	Simple Fireball	✓	✓	✓
Fluids	✓	Simple Flip	✓	✓	✓
Rigid Bodies	✓	Simple Fracture	✓	✓	✓
Particles	✓	-	✓	✓	✓
Vellum Cloth	✓	Simple Cloth	✓	✓	✓
Wire Dynamics	✓	-	✓	✓	✓
Crowds	✓	-	✓	✓	✓
LICENSING	Commercial		Limited Commercial	Non-Commercial	
Workstation [Node-Locked]	✓	✓	✓	-	✓
Local/Global Access [Floating]	✓	✓	-	✓	-
USER INTERFACE					
Houdini GUI Access	✓	✓	✓	✓	✓
Command Line Access	✓	✓	✓	✓	✓
GUI Watermark	-	-	Unobtrusive	Unobtrusive	Unobtrusive
Plug-in Support	✓	✓	✓	✓	✓
HOUDINI ENGINE					
Houdini Engine Plug-ins	✓	✓	✓	✓	No
Create Assets for Engine	✓	✓	✓	✓	For Education Licenses
Create Assets for Orbolt	✓	✓	✓	✓	✓
RENDERING					
Karma Tokens	5 / 10*	5 / 10*	1	10	1
Mantra Tokens	Unlimited	Unlimited	1	10	1
3rd Party Rendering	✓	✓	✓	✓	No
Render Watermark	-	-	-	-	✓
Resolution	Unlimited	Unlimited	Unlimited	Unlimited	1280x720
FORMATS					
SCENE					
.hip	✓	✓	.hipalc	.hipanc	.hipanc
.hda	✓	✓	.hdalc	.hdanc	.hdanc
GEOMETRY					
USD	✓	✓	✓	✓	.usdnc
FBX	✓	✓	✓	✓	IMPORT
Alembic	✓	✓	✓	✓	IMPORT
.bgeo	✓	✓	✓	✓	✓
IMAGES					
.pic	✓	✓	.piclc	✓	.picnc
.exr	✓	✓	✓	✓	watermarked
.tif	✓	✓	✓	✓	watermarked
.png/.jpg	✓	✓	✓	✓	watermarked

* Commercial Workstation Licenses come with 5 Karma Tokens and Local and Global Access Licenses come with 10 Karma tokens

SCENE VIEW SHORTCUTS

TOOLS

Select	S
Move	T
Rotate	R
Scale	E
Pose	Ctrl-R
Handle	Enter
View	Esc
Tool Menu	Tab
Custom Radial Menu	C
Repeat Last Tool	G

VIEW

Tumble	Space/Alt + LMB
Track	Space/Alt + MMB
Dolly	Space/Alt + RMB
Home Grid	Space + H
Home All	Space + A
Home Selected	Space + G

VIEW RADIAL MENU

Selection Tools	V ➡
Selection Options	V ⬆
Viewport	V ⬅
Shading	V ⬇

SELECTION MODES

Objects	1
Points	2
Edges	3
Primitives (Faces)	4
Vertices	5
Select Groups/Connected Geometry	9
Toggle Objects/Geometry	F8

SELECTING

Select	LMB
Add to Selection	Shift + LMB
Remove from Selection	Ctrl + LMB
Toggle Selection	Ctrl + Shift + LMB
Select All	N
Select Nothing	Shift-N

SNAPPING RADIAL MENU

Grid Snap	X ➡
Primitive (Curve) Snap	X ⬆
Point Snap	X ⬅
Multi-Snapping Snap	X ⬇

VIEWPORTS

Expand Viewport	Space + b
Select Viewport	Space + n
Perspective View	Space + 1
Top View	Space + 2
Front View	Space + 3
Right View	Space + 4
UV View	Space + 5
Toggle Wireframe/Shaded	W
Display Options	D

VIEWPORT LAYOUT

Single View	Ctrl + 1
Four Views	Ctrl + 2
Two Views Stacked	Ctrl + 3
Two Views Side by Side	Ctrl + 4
Three Views Split Bottom	Ctrl + 5
Three Views Split Left	Ctrl + 6
Four Views Split Bottom	Ctrl + 7
Four Views Split Left	Ctrl + 8

FINDING THINGS

Dashbox	Ctrl + D

NETWORK VIEW SHORTCUTS

VIEW

Pan	Space + LMB or MMB
Zoom	Space + RMB or Scroll Wheel
Show all Nodes	H
Show Selected Nodes	G

CREATE

Node Menu	Tab
Add File Node	=
Create Subnet	Shift + C
Add Background Image	Shift - I

NOTES AND NETWORK BOXES

Add Network Box	Shift + O
Add Sticky	Shift - P
Minimize Selected Notes/Boxes	Shift - J
Expand Selected Notes/Boxes	Shift - K
Shrink box to fit contents	Shift - M

WIRING

Connect Nodes	LMB on Connector
Connect Multiple Nodes	J drag over nodes
Insert Node	RMB on Connector
Branch	MMB on Connector
Connector List	Alt + MMB on Node
Cut Wire	Y drag across wire
Disconnect from Wires	Shake Node

DOTS

Add Dot	Alt + LMB on wire
Pin/Unpin Dot	Alt + LMB on dot

TOOLS

Toggle Parameter Pane	P
Toggle Tree View	Shift + W
Toggle Network Overview	O
Toggle Color Palette	C
oggle Shape Palette	S

CLICKS AND DRAGS

Select	LMB
Add to Selection	Shift + LMB
Remove from Selection	Ctrl + LMB
Start Wiring from Node	Alt + LMB
Select Node + Inputs	Alt + Shift + LMB
Select Node + Output	Alt + Ctrl + LMB
Select Inputs + Outputs	Alt + Shift + Ctrl + LMB
Move Node	LMB-Drag
Move Node + Inputs	Shift + LMB-Drag
Move Node + Outputs	Ctrl + LMB-Drag
Copy Selected Nodes	Alt + LMB-Drag
Copy Node + Inputs	Alt + Shift + LMB-Drag
Copy Node + Output	Alt + Ctrl + LMB-Drag
Reference Copy	Alt + Shift + Ctrl + LMB-Drag

NAVIGATION

Enter a Node	Double-click or Enter
Go up a level	U
Radial Menu	N
Create a Quickmark	Ctrl + <# 1-5>
Go to a Quickmark	Shift + <# 1-5>
Go to Previous View	` (Backtick)
Select the Node Upstream	PgUp
Select the Node Downstream	PgDn
Select Previous Sibling	Shift + PgUp
Select Next Sibling	Shift + PgDn

ORGANIZE NODES

Layout all	L
Align	A + LMB-Drag Down/Across

DISPLAY FLAGS \| SOP LEVEL

Render	T + LMB
Display	R + LMB
Template	E + LMB
Footprint	W + LMB
Bypass	G or B + LMB